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THIRD EDITION

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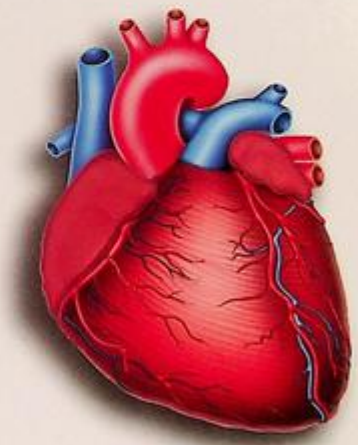
- Extensive coverage of questions for short answers and very short answers



A Free Companion to Essentials of Medical Physiology, 8/e

K Sembulingam
Prema Sembulingam

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Review of Medical Physiology

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Preface to the Third Edition

We are humbled by the popularity of our textbook titled *Essentials of Medical Physiology* achieved. Now we are publishing eighth edition of textbook and third edition of this book together. We would like to thank the students, faculty and health professionals around the world for their support, feedback and appreciation without which we would not have made it where we are now.

Modern trend of learning and teaching along with examination pattern is diverted from long question-answer system towards short question-answer system all over the world.

This type of change in education system enables faculty and examiners to cover a wide area of subject. It is also easier for students read and remember the answers in short form.

Our study on these issues and suggestions from our colleagues and fellow teachers made us to publish this book *Review of Medical Physiology*. This edition is based on the latest (eighth) edition of the textbook *Essentials of Medical Physiology*. The special aspect of this edition is to help the students to revise the whole subject in short duration before appearing for their examinations. This book will also enable them to prepare well for short answers.

Students are advised to read the textbook thoroughly to understand physiology in depth. After understanding the subject, this book will be useful for quick revision before appearing for examinations.

Both the books have come a long way since the first edition. This would not have become possible without the efforts and hard work of my wife Dr Prema Sembulingam who was also the co-author of both the books. Her encouragement, emotional and professional support has been a driving force for us. Though we miss her, her thoughts will always be with us.

As always, we welcome and appreciate your opinions, feedback, comments and suggestions. This has and will help us improve the quality and content of both the books.

K Sembulingam

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Preface to the First Edition

First of all, we would like to express our gratitude to all the students and teachers of various medical colleges, dental colleges and colleges of physiotherapy, pharmacy, nursing and other allied health sciences all over India for their overwhelming support, acceptance, appreciation and valuable suggestions regarding our textbook titled *Essentials of Medical Physiology* published in 1999 and revised in 2000.

The trend of learning and teaching and the pattern of examination are changing from "long question-answer" to "short question-answer" not only in India but also all over the world because this enables the teachers and the examiners to cover wide area of subject. It is easier for students also to read and remember the answers in short form.

Moreover, while studying the long answers, the students feel it difficult to pick up the short answers from the long description. At the same time, answering in viva voce, which is an equally important part of the examination, becomes difficult while reading the long answers from the textbook.

In view of all these facts and the feedbacks on our textbook received from students and our fellow teachers all over India, we have made an attempt to bring out a book on *Viva Voce in Physiology*. The special aspect of this book is that apart from helping the students to prepare for their viva voce, it will also enable them to prepare for the short answers. Of course, for understanding physiology in depth, the students must read the textbook. After understanding the subject well, this book will be very helpful for quick revision before examination and for viva voce.

We will be very happy to receive opinions, comments and valuable suggestions on this book from students and our fellow teachers. This will enable us to improvise and revise it accordingly in the succeeding editions.

"Our motto is to serve the student community"

Prema Sembulingam

K Sembulingam

Contents

Section 1 General Physiology

1. **Define physiology.**
   Physiology is defined as the study of functions of various systems and organs of the body.
2. **Define cell.**
   Cell is defined as the structural and functional unit of living body.
3. **What are the primary tissues of the body?**
   i. Muscle tissue: Skeletal muscle, smooth muscle and cardiac muscle.
   ii. Nervous tissue: Neurons and supporting cells.
   iii. Epithelial tissue: Squamous, columnar and cuboidal epithelial cells.
   iv. Connective tissue: Connective tissue proper, cartilage, bone and blood.
4. **What is extracellular space? What are its divisions?**
   Space outside the cell is called extracellular space.
   It divided into two spaces.
   i. Interstitial space or tissue space: Space in between cells.
   ii. Vascular space: Extracellular portion of circulation.
5. **What is extracellular fluid? Name its components.**
   Body fluid present outside the cells is called extracellular fluid. It includes interstitial fluid, plasma, transcellular fluid, etc.
6. **What is extracellular matrix? What are its major components?**
   It is the complex meshwork of components present in interstitial space. These components secreted by the cells. Its major components are glycoproteins, proteoglycans and fibrous proteins (such as collagen and elastin)
7. **What is the composition of the cell membrane?**
   Cell membrane contains:
   i. Proteins: 55%
   ii. Lipids: 40%
   iii. Carbohydrates: 5%.
8. **Name the structural models of cell membrane. Mention the accepted one.**
   i. Danielli-Davson model
   ii. Unit membrane model
   iii. Fluid mosaic model.
   Fluid mosaic model is the accepted one.
9. **What are the layers of the cell membrane?**
   One central lipid layer and two outer protein layers.
10. **What is the characteristic feature of the lipid layer of cell membrane? What is its advantage?**
    Lipid layer of the cell membrane is fluid in nature. Because of this, the portions of the cell membrane move from one point to another point along the surface of the cell.
    Advantage of lipid layer is that the materials dissolved in lipid layer can move to all the areas of the cell membrane.
11. **Name the types of proteins present in the cell membrane.**
    i. Integral proteins
    ii. Peripheral proteins.
12. **What is the physiological importance of integral proteins in cell membrane?**
    Integral proteins pass through the entire thickness of the cell membrane along with pores of the lipid layer. Thus, these proteins form the channels for the diffusion of water, electrolytes and other substances, which cannot pass through lipid layer.
13. **Name the integral proteins.**
    i. Cell adhesion proteins
    ii. Cell junction proteins
    iii. Carrier (transport) proteins
    iv. Channel proteins
    v. Hormone receptors
    vi. Antigens
    vii. Enzymes
14. **What are the types of peripheral proteins? Give examples.**
    i. Intracellular peripheral proteins: Located on inner surface of cell membrane.
       Examples:
       a. Receptors
       b. Transport proteins
       c. Some enzymes.
    ii. Extracellular peripheral proteins: Located on outer surface of cell membrane
       Examples:
       a. Antigens
       b. Adhesion proteins
       c. Some enzymes.
15. **What are the functions of proteins in the cell membrane?**
    Proteins:
    i. Integral proteins: Provide structural integrity of cell membrane
    ii. Channel proteins: Help in diffusion of water-soluble substances
    iii. Carrier or transport proteins: Help in transport of substances across the cell membrane
    iv. Pump: Some carrier proteins act as pumps which transport ions actively across the cell membrane
    v. Receptor proteins: Serve as receptor sites for hormones and neurotransmitters
    vi. Enzymes: Some protein molecules form enzymes
    vii. Antigens: Some proteins act as antigens
    viii. Cell adhesion molecules: Responsible for attachment of cells to their neighbors or to basal lamina.
16. **Name the carbohydrates present in the cell membrane.**
    i. Glycoproteins attached to proteins
    ii. Glycolipids attached to lipids.

17. What is the functional importance of carbohydrates in the cell membrane?
Carbohydrate molecules are negatively charged and so, do not allow the negatively charged particles to move out of the cells. This helps in the maintenance of resting membrane potential.

18. List the functions of the cell membrane.
i. Protective function: Protects cytoplasm and organelles present in the cytoplasm
ii. Acts as a semipermeable membrane and allows only some substances to pass through it
iii. Absorptive function: Nutrients are absorbed into cell through cell membrane
iv. Excretory function: Metabolites and other waste products from cell are excreted out through the cell membrane
v. Exchange of gases: Oxygen enters the cell from blood and carbon dioxide leaves the cell and enters the blood through cell membrane
vi. Maintenance of shape and size of the cell: Cell membrane is responsible for the maintenance of shape and size of the cell.

19. Name the cytoplasmic organelles which are bound with limiting membrane.
i. Endoplasmic reticulum
ii. Golgi apparatus
iii. Lysosome
iv. Peroxisome
v. Centrosome and centrioles
vi. Secretory vesicles
vii. Mitochondria
viii. Nucleus.

20. Name the cytoplasmic organelles which are not bound with limiting membrane.
Ribosomes and cytoskeleton.

21. What is endoplasmic reticulum?
Endoplasmic reticulum is the interconnected network of tubular and microsomal vesicular structures in the cytoplasm.

22. Name the two types of endoplasmic reticulum. Mention the function of each.
i. Rough or granular endoplasmic reticulum: Ribosomes are attached to it
It is concerned with:
a. Synthesis of proteins in the cell
b. Degradation of worn-out granules
ii. Smooth or agranular endoplasmic reticulum: Ribosomes are not attached to it.
It is concerned with:
a. Synthesis of lipids and steroids
b. Cellular metabolism
c. Storage and metabolism of calcium
d. Catabolism and detoxification of toxic substances.

23. What are the functions of Golgi apparatus?
i. Processing of materials
ii. Packaging of materials (post office of the cells)
iii. Labeling and delivery of materials (shipping department of cell).

24. What are the two types of lysosomes?
i. Primary lysosome: Pinched off from Golgi apparatus.
ii. Secondary lysosome: Formed by fusion of a primary lysosome with phagosome or endosome.

25. Why are lysosomes called garbage system of the cell?
Because of their degradation activity.

26. What are the functions of lysosomes?
i. Degradation of macromolecules
ii. Degradation of worn out organelles
iii. Removal of excess secretory products in the cells
iv. Secretory function: Some lysosomes secrete perforin, granzymes, melanin and serotonin.

27. What are the important hydrolytic enzymes present in lysosomes?
i. Proteases: Hydrolyze proteins into amino acids
ii. Lipases: Hydrolyze lipids into fatty acids and glycerides
iii. Amylases: Hydrolyze polysaccharides into glucose
iv. Nucleases: Hydrolyze nucleic acids into mononucleotides.

28. Mention the functions of important secretory lysosomes?
i. Secretory lysosomes in cytotoxic T cells and natural killer cells: Secrete perforin and granzymes
ii. Secretory lysosomes in melanocytes: Secrete melanin
iii. Secretory lysosomes in mast cells: Secrete serotonin.

29. What are peroxisomes? What are the enzymes present in peroxisomes?
Peroxisomes or microbodies are the membrane limited vesicles derived from endoplasmic reticulum.
Oxidative enzymes in peroxisomes:
i. Catalase
ii. Urate oxidase
iii. D-amino oxidase

30. What are the functions of peroxisomes?
Peroxisomes are concerned with:
i. Breakdown of fatty acids by means of beta-oxidation
ii. Degradation of toxic substances like hydrogen peroxide by detoxification
iii. Oxygen utilization
iv. Acceleration of gluconeogenesis from fats
v. Degradation of purine to uric acid
vi. Formation of myelin
vii. Formation of bile acids.

31. Why is mitochondrion called 'power house' of the cell?
Because, mitochondrion produces energy required for cellular functions.

32. What are the functions of mitochondrion?
Functions of mitochondrion:
i. Production of energy
ii. Synthesis of ATP
iii. Initiation of apoptosis
iv. Storage of calcium
v. Detoxification of ammonia in liver.

33. Name the two types of ribosomes?
i. Ribosomes attached to rough endoplasmic reticulum
ii. Free ribosomes distributed in cytoplasm

34. What are the functions of ribosomes?
Ribosomes are concerned with protein synthesis.
Ribosomes attached to rough endoplasmic reticulum are involved in the synthesis of hormonal proteins, lysosomal proteins and proteins of the cell membrane.
Free ribosomes are concerned with synthesis of protein in hemoglobin, and proteins present in peroxisomes and mitochondria.

35. What is cytoskeleton of the cell? What are the protein components of cytoskeleton?
Cytoskeleton of cell is a cellular organelle formed by complex network of structures in various sizes present throughout the cytoplasm.

Protein components of cytoskeleton:
i. Microtubules
ii. Intermediate filaments
iii. Microfilaments.

36. What are the functions of cytoskeleton?
Cytoskeleton is concerned with:
i. Determination of shape of the cell
ii. Structural strength to cell
iii. Cellular movements.

37. What are microtubules? What are their functions?
Microtubules are straight, hollow and tubular structures of cytoskeleton. Microtubules are formed by the tubulin molecules.
Functions of microtubules:
i. Determine the shape of the cell
ii. Give structural strength to the cell
iii. Act like conveyer belts which allow the movement of granules, vesicles, protein molecules and some organelles like mitochondria to different parts of the cell
iv. Form the spindle fibers which separate the chromosomes during mitosis
v. Are responsible for the movements of centrioles and the complex cellular structures like cilia.

38. What are intermediate filaments? What are their functions?
Intermediate filaments are structures of cytoskeleton that form a network around nucleus and extend to periphery of the cell. Intermediate filaments made up of fibrous proteins.
Functions of intermediate filaments:
i. Help to maintain shape of the cell
ii. Connect the adjacent cells through desmosomes.

39. What are microfilaments? What are their functions?
Microfilaments are long and fine thread like structures of cytoskeleton present in the cytoplasm of the cell. Microfilaments in ectoplasm are made up of actin molecules and the filaments in endoplasm are made up of actin and myosin molecules.
Functions of microfilaments:
i. Give structural strength to the cell
ii. Provide resistance to the cell against the pulling forces
iii. Are responsible for cellular movements like contraction, gliding and cytokinesis (partition of cytoplasm during cell division).

40. What is chromosome?
Chromosome is a rod-shaped nuclear structure that carries a complete blueprint of all the hereditary characteristics of that species.

41. What are diploid cells and haploid cells?
Diploid cells are the cells of the body that contain 23 pairs of chromosomes. Each pair consists of one chromosome inherited from each parent. All the cells of the body except reproductive cells are diploid cells. Haploid cells are the reproductive cells or gametes that contain only 23 single chromosomes.

42. What are sex chromosomes? What are autosomes?
Sex chromosomes are the pair of chromosomes concerned with determination of sex of the persons. Autosomes are the remaining 22 pairs of chromosomes that are not concerned with sex determination.

43. List the functions of nucleus.
i. Control of all activities of the cell
ii. Synthesis of RNA
iii. Formation of ribosomal subunits
iv. Sending genetic instruction to the cytoplasm through mRNA for protein synthesis
v. Control the cell division through genes
vi. Storage of hereditary information (in genes) and transformation of this information from one generation of the species to the next.

44. What is DNA? Where is it present?
DNA (deoxyribonucleic acid) is a nucleic acid that carries genetic information to the offspring of an organism. It is present in nucleus and mitochondria of cell.

45. What is RNA?
RNA (ribonucleic acid) is a nucleic acid derived from DNA.

46. What are the types of RNA? Mention their functions.
i. Messenger RNA: Carries genetic code of the amino acid sequence for synthesis of protein from DNA to cytoplasm
ii. Transfer RNA: Responsible for decoding the genetic message present in mRNA
iii. Ribosomal RNA: Responsible for assembly of protein from amino acids in ribosome.

47. Define gene.
A gene is a basic hereditary unit of the cell. It is a portion of DNA molecule that contains the message or code for the synthesis of a specific protein from amino acids.

48. What is genetic disorder?
Genetic disorder is a disease or condition that occurs due to absence of gene or a defective gene or by a chromosomal abnormality.

49. What is Turner's syndrome? What is the cause for it? What are its characteristics?
Turner's syndrome is a genetic disorder affecting females. It is due to partial or complete missing of one of the two sex (X) chromosomes.

It is characterized by short stature, infertility, heart abnormalities, renal problems and learning difficulties.

50. What is Down syndrome? What is the cause for it? What are its characteristics?
Down syndrome is a genetic disorder that occurs due to the presence of an extra copy of chromosome 21. The person has 47 chromosomes instead of usual 46.

It is characterized by physical disabilities and mental retardation.

51. What is gene expression?
Gene is the process by which the information (code word) encoded in the gene is converted into functional gene product or document of instruction (RNA) that is used for protein synthesis.

52. Define transcription and translation.
Transcription is the copying of genetic code from DNA to RNA.

Translation is the process by which protein synthesis occurs in the ribosome of the cell under the direction of genetic instruction given by mRNA.

53. What are growth factors? Name some growth factors.
Growth factors are proteins which act as cell signaling molecules like cytokines and hormones.
Growth factors:
i. Platelet derived growth factor
ii. Colony stimulating factors
iii. Nerve growth factors
iv. Neurotropins
v. Erythropoietin

vi. Thrombopoietin
vii. Insulin like growth factors
viii. Epidermal growth factor
ix. Basic fibroblast growth factor
x. Myostatin
xi. Transforming growth factors

54. What is autophagy?
Autophagy is a normal physiological process by which cells are destroyed in the body by protein degradation to maintain the normal functions.

55. What is apoptosis?
Apoptosis is the programmed cell death under genetic control.

56. What is necrosis?
Necrosis is the uncontrolled and unprogrammed death of cells due to unexpected and accidental damage.

57. What is hypertrophy?
Hypertrophy is the increase in the size of a cell. Hypertrophy of many cells results in enlargement or overgrowth of an organ or a part of the body.

58. What is hyperplasia?
Hyperplasia is the increase in number of cells due to increased cell division (mitosis). Hyperplasia results in gross enlargement of the organ.

59. What is neoplasm or tumor? What are its types?
Neoplasm or tumor is an abnormal growth of any tissue or organ in the body. It may be benign (non-cancerous or malignant (cancerous).

60. Define stem cells. Name the types of stem cells.
Stem cells are the primary cells capable of reforming themselves through mitotic division and differentiating into specialized cells.
Stem cells are of three types:
i. Embryonic stem cells
ii. Stem cells from umbilical cord blood
iii. Adult stem cells.

61. Define cell junction.
Cell junction or membrane junction is the connection between the neighboring cells or the contact between the cell and extracellular matrix.

62. Classify cell junctions with examples.
i. Occluding junctions. Examples are tight junctions
ii. Communicating junctions. Examples are gap junctions and chemical synapse
iii. Anchoring junctions. Examples are adherence junctions, focal adhesions, desmosomes and hemidesmosomes.

63. Name the proteins present in tight junctions.
i. Tight junction membrane proteins or integral membrane proteins such as occludin, claudin and junctional adhesion molecules (JAMs)
ii. Scaffold (platform) proteins or peripheral membrane proteins or cytoplasmic plaque proteins such as cingulin, symplekin and ZO–1, 2, 3.

64. What are the functions of tight junction?
i. Strength and stability to the tissues
ii. Selective permeability (gate function)
iii. Fencing function
iv. Maintenance of cell polarity
v. Formation of blood-brain barrier.

65. What are connexons or connexins?
Connexons or connexins are the protein subunits present in gap junctions.

66. What are the functions of gap junction?
i. Allows the passage of small molecules, ions and chemical messengers
ii. Helps in exchange of chemical messengers between the cells
iii. Helps in propagation of action potential from one cell to another cell.

67. Define anchoring junctions.
Anchoring junctions are the junctions that provide strength to the cells by acting like mechanical attachments, between two cells or between a cell and the extracellular matrix. Anchoring junctions are responsible for the **structural integrity** of the tissues.

68. Name different types of anchoring junctions.
i. Adherens junction
ii. Focal adhesion
iii. Desmosome
iv. Hemidesmosome

69. Define cell adhesion molecules and give examples.
Cell adhesion molecules (CAMs) or cell adhesion proteins are the protein molecules situated on the cell surface. Examples are cadherins, integrins, IgG super family and selectins.

70. What are the functions of CAMs?
i. CAMs are responsible for binding of cells to their neighbors or to basal lamina (or basal membrane)
ii. CAMs are responsible for structural organization of tissues.

71. What is adherens junction?
Adherens junction is the cell to cell junction, which connects the actin filaments of one cell to those of another cell.

72. What is focal adhesion?
Focal adhesion is the cell to matrix junction, which connects the actin filaments of the cell to extracellular matrix.

73. What is desmosome?
Desmosome is the cell to cell junction, where intermediate filaments connect two adjacent cells.

74. What is hemidesmosome?
Hemidesmosome is the cell to matrix junction, which connects intermediate filaments of the cells to extracellular matrix.

75. What are the types of transport mechanism? Define them.
Transport mechanism is of two types—passive transport and active transport.
i. Passive transport or diffusion: Transport of substances along the concentration gradient or electrical gradient or both (electrochemical gradient) across cell membrane (from higher concentration to lower concentration)
ii. Active transport: Transport of substances against the concentration gradient or electrical gradient or both across cell membrane (from lower concentration to higher concentration.

76. What is the basic difference between passive transport and active transport?
Passive transport does not require energy whereas the active transport requires energy.

77. Name the types of passive transport or diffusion.

i. Simple diffusion
ii. Facilitated diffusion.

78. Explain simple and facilitated diffusion briefly.

Simple diffusion occurs through lipid layer and protein layer of the cell membrane. Lipid soluble substances like oxygen, carbon dioxide and alcohol are transported through lipid layer. Water soluble substances like electrolytes are transported through protein layer.

Facilitated diffusion or carrier mediated diffusion involves the help of a carrier protein present in the cell membrane. Substances with larger molecules like glucose and amino acids are attached to the carrier protein and are transported into the cell.

79. Name the factors affecting diffusion of substances across the cell membrane.

i. Permeability of cell membrane
ii. Temperature
iii. Concentration gradient or electrical gradient
iv. Solubility of the substances
v. Thickness of cell membrane
vi. Size of the molecules
vii. Size of the ions
viii. Charge of the ions.

Diffusion is directly proportional to permeability of cell membrane, temperature, concentration gradient or electrical gradient and the solubility of the substances. It is inversely proportional to thickness of the cell membrane, size of the molecules and ions and charge of the ions.

80. What is bulk flow? Give example.

Bulk flow is the movement of large number of molecules of a substance in bulk along the concentration gradient. Example is the diffusion of respiratory gases across the respiratory membrane.

81. What is filtration? Where does it occur in the body?

Filtration is movement of water and solutes from an area of high hydrostatic pressure to an area of low hydrostatic pressure. It occurs in arterial end of capillaries and glomeruli of kidney.

82. What is osmosis?

Osmosis is the movement of water or any other solvent from an area of lower concentration to an area of higher concentration of a solute, through a semipermeable membrane. The semipermeable membrane permits the passage of only water or other solvents but not the solutes.

83. What is osmotic pressure? What is its significance?

Osmotic pressure is the pressure created by the solutes in a fluid. During osmosis, when water or other solvent moves from area of lower concentration to area of higher concentration, solutes in the area of higher concentration get dissolved in the solvent. This creates a pressure which is known as osmotic pressure.

Significance of osmotic pressure is that it prevents further movement of water or other solvent during osmosis.

84. What is reverse osmosis?

Reverse osmosis is a process in which water or other solvent flows in reverse direction (from the area of higher concentration to the area of lower concentration of the solute) if an external pressure is applied on the area of higher concentration.

85. What is oncotic pressure or colloidal osmotic pressure? What is its normal value?

Oncotic pressure or colloidal osmotic pressure is part of the osmotic pressure created by larger colloidal substances particularly proteins. Normal oncotic pressure is about 25 mm Hg.

86. Name the types of osmosis.

i. Endosmosis: Movement of water into the cell
ii. Exosmosis: Movement of water out of the cell.

87. Name the substances transported actively.

Substances in ionic form: Sodium, potassium, calcium, hydrogen, chloride and iodide.

Substances in non-ionic form: Glucose, amino acids and urea.

88. Name types of active transport. Explain them briefly.

i. Primary active transport: In this, the energy is liberated from break down of ATP. The electrolytes like sodium, potassium, calcium, hydrogen and chloride are transported by this method
ii. Secondary active transport: In this type of active transport, a carrier protein is involved in transport of a substance like sodium ion and this carrier protein is capable of transporting another substance along with the primary substance. Energy is derived from process involved in the transport of the primary substance.

89. What are the sites present in α-subunit of the Na^+-K^+ pump?

The α-subunit of the Na^+-K^+ pump has got six sites:

i. Three receptor sites for sodium ions on the inner (towards cytoplasm) surface of the protein molecule
ii. Two receptor sites for potassium ions on the outer (towards ECF) surface of the protein molecule
iii. One site for enzyme adenosine triphosphatase (ATPase), which is near the sites for sodium.

90. What is electrogenic activity of Na^+-K^+ pump?

Na^+-K^+ pump moves three sodium ions outside the cell and two potassium ions inside cell. Thus, here is a net loss of one positively charged ion from the cell. Continuous activity of the sodium-potassium pumps causes reduction in the number of positively charged ions inside the cell leading to increase in the negativity inside the cell. This is called the electrogenic activity of Na^+-K^+ pump.

91. Name the types of secondary active transport. Explain them briefly.

i. Cotransport: In this, along with the primary substance like sodium, the carrier protein carries another substance. Substances like glucose and amino acids are transported by this method.
ii. Counter transport: In this mechanism, the substances are carried in exchange of the primary substance like sodium. The different counter transport mechanisms are Sodium–Calcium counter transport, Sodium–Hydrogen counter transport, Sodium–Magnesium counter transport, Sodium–Potassium counter transport, Calcium–Magnesium counter transport, Calcium–Potassium counter transport, Chloride–Bicarbonate counter transport and Chloride–Sulfate counter transport.

92. Name the carrier proteins of active transport.

i. Uniport or uniport pump: Carrier protein that carries only one substance in a single direction.
ii. Symport or antiport: Carrier protein that transports two substances at a time.

vi. Thrombopoietin
vii. Insulin like growth factors
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61. Define cell junction.
Cell junction or membrane junction is the connection between the neighboring cells or the contact between the cell and extracellular matrix.

62. Classify cell junctions with examples.
i. Occluding junctions. Examples are tight junctions
ii. Communicating junctions. Examples are gap junctions and chemical synapse
iii. Anchoring junctions. Examples are adherence junctions, focal adhesions, desmosomes and hemidesmosomes.

63. Name the proteins present in tight junctions.
i. Tight junction membrane proteins or integral membrane proteins such as occludin, claudin and junctional adhesion molecules (JAMs)
ii. Scaffold (platform) proteins or peripheral membrane proteins or cytoplasmic plaque proteins such as cingulin, symplekin and ZO–1, 2, 3.

64. What are the functions of tight junction?
i. Strength and stability to the tissues
ii. Selective permeability (gate function)
iii. Fencing function
iv. Maintenance of cell polarity
v. Formation of blood-brain barrier.

65. What are connexons or connexins?
Connexons or connexins are the protein subunits present in gap junctions.

66. What are the functions of gap junction?
i. Allows the passage of small molecules, ions and chemical messengers
ii. Helps in exchange of chemical messengers between the cells
iii. Helps in propagation of action potential from one cell to another cell.

67. Define anchoring junctions.
Anchoring junctions are the junctions that provide strength to the cells by acting like mechanical attachments, between two cells or between a cell and the extracellular matrix. Anchoring junctions are responsible for the **structural integrity** of the tissues.

68. Name different types of anchoring junctions.
i. Adherens junction
ii. Focal adhesion
iii. Desmosome
iv. Hemidesmosome

69. Define cell adhesion molecules and give examples.
Cell adhesion molecules (CAMs) or cell adhesion proteins are the protein molecules situated on the cell surface. Examples are cadherins, integrins, IgG super family and selectins.

70. What are the functions of CAMs?
i. CAMs are responsible for binding of cells to their neighbors or to basal lamina (or basal membrane)
ii. CAMs are responsible for structural organization of tissues.

71. What is adherens junction?
Adherens junction is the cell to cell junction, which connects the actin filaments of one cell to those of another cell.

72. What is focal adhesion?
Focal adhesion is the cell to matrix junction, which connects the actin filaments of the cell to extracellular matrix.

73. What is desmosome?
Desmosome is the cell to cell junction, where intermediate filaments connect two adjacent cells.

74. What is hemidesmosome?
Hemidesmosome is the cell to matrix junction, which connects intermediate filaments of the cells to extracellular matrix.

75. What are the types of transport mechanism? Define them.
Transport mechanism is of two types—passive transport and active transport.
i. Passive transport or diffusion: Transport of substances along the concentration gradient or electrical gradient or both (electrochemical gradient) across cell membrane (from higher concentration to lower concentration)
ii. Active transport: Transport of substances against the concentration gradient or electrical gradient or both across cell membrane (from lower concentration to higher concentration.

76. What is the basic difference between passive transport and active transport?
Passive transport does not require energy whereas the active transport requires energy.

77. Name the types of passive transport or diffusion.

i. Simple diffusion
ii. Facilitated diffusion.

78. Explain simple and facilitated diffusion briefly.

Simple diffusion occurs through lipid layer and protein layer of the cell membrane. Lipid soluble substances like oxygen, carbon dioxide and alcohol are transported through lipid layer. Water soluble substances like electrolytes are transported through protein layer.

Facilitated diffusion or carrier mediated diffusion involves the help of a carrier protein present in the cell membrane. Substances with larger molecules like glucose and amino acids are attached to the carrier protein and are transported into the cell.

79. Name the factors affecting diffusion of substances across the cell membrane.

i. Permeability of cell membrane
ii. Temperature
iii. Concentration gradient or electrical gradient
iv. Solubility of the substances
v. Thickness of cell membrane
vi. Size of the molecules
vii. Size of the ions
viii. Charge of the ions.

Diffusion is directly proportional to permeability of cell membrane, temperature, concentration gradient or electrical gradient and the solubility of the substances. It is inversely proportional to thickness of the cell membrane, size of the molecules and ions and charge of the ions.

80. What is bulk flow? Give example.

Bulk flow is the movement of large number of molecules of a substance in bulk along the concentration gradient. Example is the diffusion of respiratory gases across the respiratory membrane.

81. What is filtration? Where does it occur in the body?

Filtration is movement of water and solutes from an area of high hydrostatic pressure to an area of low hydrostatic pressure. It occurs in arterial end of capillaries and glomeruli of kidney.

82. What is osmosis?

Osmosis is the movement of water or any other solvent from an area of lower concentration to an area of higher concentration of a solute, through a semipermeable membrane. The semipermeable membrane permits the passage of only water or other solvents but not the solutes.

83. What is osmotic pressure? What is its significance?

Osmotic pressure is the pressure created by the solutes in a fluid. During osmosis, when water or other solvent moves from area of lower concentration to area of higher concentration, solutes in the area of higher concentration get dissolved in the solvent. This creates a pressure which is known as osmotic pressure.

Significance of osmotic pressure is that it prevents further movement of water or other solvent during osmosis.

84. What is reverse osmosis?

Reverse osmosis is a process in which water or other solvent flows in reverse direction (from the area of higher concentration to the area of lower concentration of the solute) if an external pressure is applied on the area of higher concentration.

85. What is oncotic pressure or colloidal osmotic pressure? What is its normal value?

Oncotic pressure or colloidal osmotic pressure is part of the osmotic pressure created by larger colloidal substances particularly proteins. Normal oncotic pressure is about 25 mm Hg.

86. Name the types of osmosis.

i. Endosmosis: Movement of water into the cell
ii. Exosmosis: Movement of water out of the cell.

87. Name the substances transported actively.

Substances in ionic form: Sodium, potassium, calcium, hydrogen, chloride and iodide.

Substances in non-ionic form: Glucose, amino acids and urea.

88. Name types of active transport. Explain them briefly.

i. Primary active transport: In this, the energy is liberated from break down of ATP. The electrolytes like sodium, potassium, calcium, hydrogen and chloride are transported by this method
ii. Secondary active transport: In this type of active transport, a carrier protein is involved in transport of a substance like sodium ion and this carrier protein is capable of transporting another substance along with the primary substance. Energy is derived from process involved in the transport of the primary substance.

89. What are the sites present in α-subunit of the Na^+-K^+ pump?

The α-subunit of the Na^+-K^+ pump has got six sites:

i. Three receptor sites for sodium ions on the inner (towards cytoplasm) surface of the protein molecule
ii. Two receptor sites for potassium ions on the outer (towards ECF) surface of the protein molecule
iii. One site for enzyme adenosine triphosphatase (ATPase), which is near the sites for sodium.

90. What is electrogenic activity of Na^+-K^+ pump?

Na^+-K^+ pump moves three sodium ions outside the cell and two potassium ions inside cell. Thus, here is a net loss of one positively charged ion from the cell. Continuous activity of the sodium-potassium pumps causes reduction in the number of positively charged ions inside the cell leading to increase in the negativity inside the cell. This is called the electrogenic activity of Na^+-K^+ pump.

91. Name the types of secondary active transport. Explain them briefly.

i. Cotransport: In this, along with the primary substance like sodium, the carrier protein carries another substance. Substances like glucose and amino acids are transported by this method.
ii. Counter transport: In this mechanism, the substances are carried in exchange of the primary substance like sodium. The different counter transport mechanisms are Sodium–Calcium counter transport, Sodium–Hydrogen counter transport, Sodium–Magnesium counter transport, Sodium–Potassium counter transport, Calcium–Magnesium counter transport, Calcium–Potassium counter transport, Chloride–Bicarbonate counter transport and Chloride–Sulfate counter transport.

92. Name the carrier proteins of active transport.

i. Uniport or uniport pump: Carrier protein that carries only one substance in a single direction.
ii. Symport or antiport: Carrier protein that transports two substances at a time.

Carrier protein that transports two different substances in the same direction is called symport or symport pump.

Carrier protein that transports two different substances in opposite directions is called antiport or antiport pump.

93. Define and classify endocytosis.

Endocytosis is the process by which the larger molecules (which cannot enter the cell by means of active or passive transport) are transported into the cell.

Endocytosis is of two types namely pinocytosis and phagocytosis.

94. What is pinocytosis? Give example.

The movement of larger particles by means of evagination of the cell membrane is called pinocytosis. It is otherwise known as 'cell drinking'.

Example: Transport of macromolecules like bacteria and antigens.

95. What is phagocytosis? Give example.

The process by which the particles larger than the macromolecules are engulfed into the cells is called phagocytosis. It is also known as 'cell eating'.

Example: Transport of larger bacteria, larger antigens and other larger foreign bodies inside the cell.

96. Name the cells showing phagocytosis.

Neutrophils, monocytes and tissue macrophages.

97. What is transcytosis? Give example.

Transcytosis is a transport mechanism in which an extracellular macromolecule enters through one side of a cell, migrates across cytoplasm of the cell and exits through the other side.

Example: Transport of proteins from capillary blood into the cell and transport of pathogens like HIV.

98. Define homeostasis.

The maintenance of constant internal environment is known as homeostasis.

99. What are the mechanisms involved in homeostatic control system? Explain them briefly.

The homeostatic control system is mainly by the feedback mechanisms:

i. Negative feedback: If the activity of a particular system increases, it will be immediately regulated by reduction (example: thyroxin secretion). The negative feedback controls most of the homeostatic mechanisms.

ii. Positive feedback: When the activity of a particular system increases, it will be further increased (examples: formation of prothrombin activator during coagulation, secretion of oxytocin during milk ejection reflex and the pain produced during labor).

100. What are motor molecules? Name the types.

Motor molecules are the protein-based molecular machines that perform intracellular movements in response to specific stimuli.

Motor molecules are classified into three super families:

i. Kinesin
ii. Dynein
iii. Myosin

101. What are the functions of motor molecules?

i. Transport of synaptic vesicles containing neurotransmitters form nerve cell body to synaptic cleft.
ii. Roll in cell division by pulling the chromosomes.
iii. Transport of viruses and toxins to interior of cell for their own detriment.

102. Define homeostasis.

Homeostasis refers to the maintenance of constant internal environment of the body.

103. List the components of homeostatic system.

i. Sensors or detectors or receptors: Which recognize the deviation in any activity in internal environment and transmit the message to control center.
ii. Control center integrator center: Which receives the message from receptors and immediately sends commands to concerned effectors.
iii. Effectors: Which receive the commands from the center and either accelerate or inhibit the activity so that normalcy is restored.

104. What is negative feedback? Give examples.

Negative feedback is the one in which the homeostatic mechanism reacts in such a way as to arrest the change or reverse the direction of change. After receiving the message, effectors send negative feedback signals back to control center. Now the control center modifies the commands and makes an attempt to maintain homeostasis.

Examples:

i. Regulation of secretion of many hormones.
ii. Maintenance of water balance in body.

105. What is positive feedback? Give examples.

Positive feedback is the one in which the homeostatic mechanism reacts in such a way as to increase the intensity of change in the same direction. After receiving the message, effectors send positive feedback signals back to control center. Now the control center intensifies the activities and makes an to maintain homeostasis.

Examples:

i. Formation of thrombin during second stage of blood clotting
ii. Secretive of oxytocin during milk ejection reflex
iii. Secretion of oxytocin during parturition.

106. What is homeostatic imbalance? Mention some common diseases or disorders associated with homeostatic imbalance.

Homeostatic imbalance refers to failure of the body to maintain homeostasis. It is the starting point of diseases or disorders in the body. Common diseases or disorders associated with homeostatic imbalance are acidosis, diabetes mellitus, infections, dehydration and hypertension.

107. What is feedforward control system?

Feedforward control system is the control system in homeostasis that anticipates the change or deviation that may occur in a later stage and takes appropriate control action to avoid the disturbance. Whereas the feedback control systems detect the deviation only when it happens.

Section 2 Blood and Body Fluids

1. What is the normal volume of total body water (TBW)?

Males : 60% of body weight
Females : 50%
Infants : 70%

TBW is about 40 liters in a person weighing 70 kg.

2. Name the compartments of body fluid.

i. Intracellular fluid (ICF): Present inside the cells and forms 55% of the TBW (22 liters)
ii. Extracellular fluid (ECF): Present outside the cells and it forms 45% TBW (18 liters).

3. Name the subunits of ECF?

ECF is distributed in five subunits:

i. Interstitial fluid and lymph: 20%
ii. Plasma: 7.5%
iii. Fluid in bones: 7.5%
iv. Fluid in connective tissues: 7.5%
v. Transcellular fluid: 2.5%.

Transcellular fluid includes cerebrospinal fluid, intraocular fluid, digestive juices, serous fluid (like intrapleural fluid, pericardial fluid and peritoneal fluid), synovial fluid and fluid in urinary tract.

4. What is the composition of body fluids?

Body fluids contain water and solids. Solids are organic and inorganic substances.

Organic substances: Glucose, amino acids, proteins, fatty acids and other lipids, hormones and enzymes.

Inorganic substances: Sodium, potassium, calcium, magnesium, chloride, bicarbonate, phosphate and sulfate.

5. Mention the main differences between ECF and ICF?

i. Composition: ECF contains more of sodium, chlorides and bicarbonates whereas ICF contains more of potassium, magnesium, phosphates, sulfates and proteins
ii. Volume: The quantity of ECF is less (18 liters) and that of ICF is more (22 liters)
iii. pH: The pH of ECF is 7.4 and that of ICF is 7.0.

6. Name the method by which volume of body fluids is measured.

Indicator (dye) dilution method.

7. What are the characteristics of marker substance?

Marker substance:

i. Must be nontoxic
ii. Must mix well with fluid compartment within reasonable time
iii. Should not be excreted rapidly
iv. Should not be excreted from body completely within reasonable time
v. Should not change the color of body fluid
vi. Should not alter the volume of body fluid.

8. Give the formula to measure fluid volume by indicator dilution method.

$$V = \frac{M - \text{Amount of substance excreted}}{C}$$

V = Volume of fluid in the compartment.
M = Mass or total quantity of marker substance injected.
C = Concentration of the marker substance in the sample fluid

9. Which type of marker substances is used to measure TBW? Give examples.

Marker substances which can move freely into all the compartments of the body fluid are used to measure TBW.

Examples: Deuterium oxide, tritium oxide and antipyrine.

10. Which type of marker substances is used to measure ECF volume? Give examples.

Substances which remain within the compartments of ECF and do not enter inside the cells are used to measure ECF volume.

Examples: Radioactive ions of sodium, chloride, bromide, sulfate and thiosulfate, and nonmetabolizable saccharides like inulin, mannitol and sucrose.

11. What are sodium space, chloride space, inulin space and sucrose space?

Some of the marker substances like sodium, chloride, inulin and sucrose, which are used to measure ECF volume move widely throughout all the sub-compartments of ECF. The measured volume of ECF by using these substances is called sodium space, chloride space, inulin space or sucrose space.

12. How is the ICF volume measured?

Volume of ICF cannot be measured directly because there is no substance, which can enter the cells without mixing with ECF. So, the ICF volume can be measured only by indirect method i.e., by measuring the volume of TBW and ECF.

Thus, ICF volume = TBW – ECF volume.

13. Which type of substance is used to measure plasma volume? Give examples.

Plasma volume can be measured by using marker substances, which bind strongly with plasma proteins and do not diffuse into interstitium.

Examples: Radioactive iodine (I-131) and Evans blue (T–1824).

14. How is interstitial fluid volume measured?

It cannot be measured directly. It is calculated from the values of ECF volume and plasma volume.

Interstitial fluid volume = ECF volume – Plasma volume.

15. Define osmolality and osmolarity.

Both are the terms to measure the osmotic (osmolar) concentration of a fluid.

Osmolality is expressed as the number of particles (osmoles) per kilogram of solution (osmoles/kg H_2O).

Osmolarity is the number of particles (osmoles) per liter of solution (osmoles/L).

16. What is dehydration? What are the types of dehydration?

Dehydration is defined as excessive loss of water from the body.

Types of dehydration:

i. Mild dehydration: When fluid loss is about 5%
ii. Moderate dehydration: When fluid loss is about 10%
iii. Severe dehydration: When fluid loss is about 15%.

17. Name the causes of dehydration?

i. Severe diarrhea or vomiting
ii. Excess urinary output due to renal disorders
iii. Excess loss of water through urine due to diabetes mellitus, diabetes insipidus and adrenal insufficiency
iv. Insufficient water intake
v. Prolonged physical activity without proper water intake insufficient intake of water
vi. Excessive sweating
vii. Excessive use of laxatives or diuretics.

18. What are the features of severe and very severe dehydration?

Severe dehydration: Decrease in blood volume, decrease in cardiac output and hypovolemic shock.

Very severe dehydration: Damage of organs like brain, liver and kidneys, mental depression, confusion, renal failure and coma.

19. What is oral rehydration therapy (ORT)?

Oral rehydration therapy is the treatment for dehydration in which oral rehydration solution (ORS) is administered orally.

20. What is water intoxication or overhydration or hyperhydration?

Water intoxication is the condition characterized by great increase in water content of the body.

21. List the causes of overhydration.

i. Heart failure
ii. Renal disorders
iii. Hypersecretion of ADH
iv. Administration of large quantities of medications and fluids
v. Underdeveloped kidney in first month of infancy
vi. Swimming practice during infancy
vii. Consumption of excess water (> 8 liters/day).

22. Name the features of severe conditions of overhydration.

Delirium, seizures and coma.

23. Define blood.

Blood is defined as a red color fluid that circulates through vascular system in humans and other vertebrates, carrying nutrients and oxygen to and waste products including carbon dioxide from all parts of the body.

24. Give normal value of blood volume.

5 liters in normal adult.

25. What is the color of blood?

Generally, the blood is red in color. Arterial blood is scarlet red and venous blood is purple red.

26. What is the normal pH of blood?

7.4.

27. What is the normal specific gravity of blood?

Total blood : 1.052 to 1.061
Blood cells : 1.092 to 1.101
Plasma : 1.022 to 1.026

28. What is normal viscosity of the blood?

Five times more viscous than water.

29. What is the cause for the viscosity of the blood?

Presence of red blood cells and plasma proteins.

30. What is the composition of blood?

Blood contains blood cells (formed elements) and plasma. Plasma contains 91 to 92% of water and 8 to 9% of solids. It also contains some gases. The solids are organic and inorganic substances.

31. Define plasma. What is its composition?

Plasma is the straw-colored liquid part of blood. It contains 91 to 92% of water and 8 to 9% of solids. Solids are organic and inorganic substances.

32. Name the organic substances present in plasma.

i. Plasma proteins: Albumin, globulin and fibrinogen
ii. Amino acids
iii. Carbohydrates: Glucose
iv. Fats: Triglycerides, cholesterol and phospholipids
v. Internal secretions: Hormones
vi. Enzymes
vii. Non-protein nitrogenous substances: Ammonia, creatin, creatinine, xanthine, hypoxanthine, urea and uric acid
viii. Antibodies.

33. Name the inorganic substances present in plasma.

Sodium, calcium, potassium, magnesium, bicarbonate, chloride, phosphate, iodide, iron and copper.

34. Name the gases present in plasma.

Gases present in blood are oxygen and carbon dioxide.

35. What are the formed elements of the blood?

i. Erythrocyte or red blood cell (RBC)
ii. Leukocyte or white blood cell (WBC)
iii. Platelet (thrombocyte).

36. What is hematocrit? What is the other name for it? What is its normal value?

Hematocrit is the volume of RBCs in blood expressed in percentage. It is also called packed cell volume (PCV). Normal value: 45%.

37. How is hematocrit determined?

It is determined by using Wintrobe's tube or hematocrit tube. Blood is mixed with anticoagulant (EDTA), filled in this tube and centrifuged for 30 minutes at a speed of 3000 revolutions per minute (RPM). Then the tube is taken out and reading is taken.

38. What are the different layers noticed in the hematocrit tube after centrifuging?

i. Upper clear supernatant fluid is plasma and it is 55%
ii. Lower red colored column is packed red blood cells, which is about 45%
iii. In between plasma and red blood cells, there is a thin white buffy coat, which is formed by the collection of WBCs and platelets.

39. Enumerate the functions of blood.

i. Nutritive function
ii. Respiratory function
iii. Excretory function
iv. Transport of hormones and enzymes

v. Regulation of water balance
vi. Regulation of acid base balance
vii. Regulation of body temperature
viii. Storage function
ix. Defense function.

40. Name the plasma proteins.
Serum albumin, serum globulin and fibrinogen.

41. What is serum?
Serum is the straw-colored fluid that oozes from blood clots.

42. What is the composition of serum?
It contains all the substances present in plasma except fibrinogen. Fibrinogen is converted into fibrin during the process of clotting. That is why serum is usually expressed as plasma minus fibrinogen.

43. Give the normal values of plasma proteins.

Total plasma proteins	: 7.3 g%
Albumin	: 4.7 g%
Globulin	: 2.3 g%
Fibrinogen	: 0.3 g%

44. Name the methods to separate plasma proteins.
i. Precipitation method
ii. Salting out method
iii. Electrophoretic method
iv. Cohn's fractional precipitation method
v. Ultracentrifugation method
vi. Gel filtration chromatography
vii. Immunoelectrophoretic method.

45. What are the functions of plasma proteins?
i. Help in coagulation of blood (fibrinogen)
ii. Play important role in defense mechanism against invading organism (gamma globulin)
iii. Help in transport of hormones (albumin and globulin)
iv. Maintain the osmotic pressure of the blood (albumin plays important role)
v. Regulate the acid base balance in blood (buffering action)
vi. Provide viscosity to the blood
vii. Help in the erythrocyte sedimentation rate
viii. Help in maintaining the suspension stability of the red blood cells
ix. Along with leukocytes, the plasma proteins produce trephone bodies in tissue culture
x. Act as reserve proteins during conditions like starvation.

46. Name the conditions when hypoproteinemia occurs.
i. Diarrhea
ii. Hemorrhage
iii. Burns
iv. Pregnancy
v. Malnutrition
vi. Prolonged starvation
vii. Cirrhosis of liver
viii. Chronic infections like chronic hepatitis or chronic nephritis.

47. Name the conditions when hyperproteinemia occurs.
i. Dehydration
ii. Hemolysis
iii. Acute infections like acute hepatitis or acute nephritis
iv. Respiratory distress syndrome
v. Excess of glucocorticoids
vi. Leukemia
vii. Rheumatoid arthritis
viii. Alcoholism.

48. What is plasmapheresis?
Plasmapheresis is the experimental procedure done in animals to demonstrate the importance of plasma proteins.

49. What is therapeutic plasma exchange?
It is the process of plasmapheresis. It is used as a blood purification procedure for an effective temporary treatment of many autoimmune diseases like myasthenia gravis, thrombocytopenic purpura etc.

50. Why erythrocytes are red in color?
Because of the presence of hemoglobin.

51. What is normal RBC count in adults?
Males : 5 millions/cu mm of blood
Females : 4.5 millions/cu mm of blood.

52. What is the normal size of RBC?

Diameter	: 7.2 microns (μ)
Thickness	: 2.2 μ in periphery and 1 μ in center
Surface area	: 120 square μ
Volume	: 90 cubic μ.

53. What is the normal shape of RBC?
When seen from front: Spherical
When seen from side: Biconcave or dumb bell shaped
Reason for the dumb bell shape of RBC is the thicker periphery (2.2 μ) and thinner center (1 μ).

54. What are the advantages of the biconcave shape of RBC?
i. It helps in equal and rapid diffusion of oxygen and other substances into the interior of the cell.
ii. It provides large surface area for absorption or removal of different substances.
iii. It offers minimal tension on the membrane when the volume of cell alters.
iv. While passing through minute capillaries, these cells can squeeze through the capillaries very easily without being damaged.

55. Why DNA is absent in human RBC?
Because of absence of nucleus.

56. What is rouleaux formation?
Rouleaux formation is the piling up of RBCs pile up one above the other like the pile of coins, when blood is taken out of blood vessel and allowed to stand without movement.

57. What is the normal life span of RBC?
120 days.

58. How is the life span of RBC determined?
By radioisotope method.

59. What is the fate of RBC after its life span?
After the life span of 120 days, the RBC is destroyed and heme and globin are released. From heme, iron and bilirubin are released. The iron is stored as ferretin. The globin part is stored as protein.

60. What are the functions of RBC?
i. RBC helps in the transport of oxygen
ii. RBC helps in the transport of carbon dioxide
iii. Hemoglobin in RBC acts as a buffer to maintain pH of the blood
iv. Antigens on the cell membrane help to determine the blood group of the person and help to avoid transfusion reactions.

61. What is polycythemia?
Increase in RBC count is called polycythemia.

62. What is physiological polycythemia? Name some conditions when it occurs.

Increase in the number of RBC in physiological conditions is known as physiological polycythemia. It occurs in:

i. Age: in infancy
ii. Sex: in males
iii. High altitude
iv. Muscular exercise
v. Emotional conditions
vi. Increased environmental temperature
vii. After meals.

63. Describe pathological polycythemia in brief.

Abnormal increase in RBC count is called pathological polycythemia.

It is of two types:

i. Primary polycythemia or polycythemia vera: Persistent increase in RBC count occurs because of malignancy of bone marrow.
ii. Secondary polycythemia: Increase in number of RBC because of diseases other than the bone marrow diseases, i.e. it is secondary to some pathological conditions.

64. Name the diseases when secondary polycythemia occurs.

i. Respiratory diseases
ii. Congenital heart disease
iii. Ayerza's disease
iv. Chronic carbon monoxide poisoning
v. Poisoning by chemicals like phosphorus and arsenic
vi. Repeated mild hemorrhages

65. What are the physiological conditions when RBC count decreases?

i. After sleep
ii. During pregnancy
iii. At high barometric pressure.

66. What are the possible variations in the size of RBC?

i. Microcyte: Decrease in the size of RBC as in the case of iron deficiency anemia.
ii. Macrocytes: Increase in the size of RBC as in the case of megaloblastic anemia.
iii. Aniosocytosis: Unequal sizes of RBC as in the case of pernicious anemia.

67. What are the abnormal shapes of RBC?

i. Crenation: Shrunken cell
ii. Spherocytosis: Globular form
iii. Elliptocytosis: Elliptical shape
Sickle shape: Crescent shape
Poikilocytosis: Unusual shapes.

68. Define erythropoiesis. What is hemopoiesis or hematopoiesis?

Erythropoiesis is the process of origin, development and maturation of red blood cells. Hemopoiesis or hematopoiesis is the process of origin, development and maturation of all the blood cells.

69. What are the sites of erythropoiesis?

i. Fetal life:
   a. Mesoblastic stage: From mesenchyme of yolk sac during the first 2 months
   b. Hepatic stage: From liver, spleen and lymphoid organs from 3rd month
   c. Myeloid stage: From bone marrow and liver during last trimester
ii. Children: From the red bone marrow in all the bones.
iii. Adults: From the membranous bones and the head of long bones.

70. What are the changes taking place in the cell during the process of erythropoiesis?

i. Reduction in size of the cell (from diameter of 25 μ to 7.2 μ)
ii. Disappearance of nucleoli and nucleus
iii. Appearance of hemoglobin
iv. Change in the staining properties of the cytoplasm.

71. What are stem cells? What are hemopoietic stem cells?

Stem cells are primary cells capable of self-renewal and differentiating into specialized cells. Hemopoietic stem cells are primitive cells in bone marrow which give rise to blood cells are called stem cells.

72. What are the different types of hemopoietic stem cells?

i. Uncommitted pluripotent hemopoietic stem cells
ii. Committed pluripotent hemopoietic stem cells.

73. What are the different types of committed pluripotent hemopoietic stem cells?

i. Lymphoid stem cells: Which develop into lymphocytes
ii. Colony forming blastocytes: Which are of three types:
   a. Colony forming unit Erythrocytes (GFU – E) which develop into the red blood cells
   b. Colony forming unit Granulocytes/Monocytes (GFU–GM) from which the granulocytes and monocytes develop
   c. Colony forming unit Megakaryocytes (CFU–M), which give rise to the platelets.

74. Name the stages of erythropoiesis.

i. Proerythroblast
ii. Early normoblast
iii. Intermediate normoblast
iv. Late normoblast
v. Reticulocyte
vi. Matured red blood cell.

75. In which stage, nucleoli disappear?

Early normoblast stage.

76. In which stage, hemoglobin appears?

Intermediate normoblast stage.

77. In which stage, nucleus disappears? How does the nucleus disappear?

Nucleus disappears in late normoblast stage and it disappears by the process called pyknosis.

78. What is the normal reticulocyte count?

In newborn baby: 2 to 6% of red blood cells
In adults: 1% or less than 1% of red blood cell

79. Why the reticulocyte is called the immature red blood cell?

Reticulocyte has large quantity of hemoglobin and nucleus is absent. It is larger than the red blood cell, round in shape with remnants of disintegrated organelles. So, it is called the immature red blood cell.

80. How long does it take for the complete development of red blood cells?

It takes 7 days for formation and maturation of red blood cells. It takes 5 days up to the stage of reticulocyte and 2 more days for the development of matured red blood cells.

81. What are the factors necessary for erythropoiesis?

i. Stimulating factors: Hypoxia, erythropoietin, thyroxine, hemopoietic growth factors (interleukins 3, 6 and 11) and vitamins B3, B6, C, D and E

ii. Maturation factors: Vitamin B12, intrinsic factor of Castle, and folic acid
iii. Factors necessary for hemoglobin formation: Proteins, iron, copper, cobalt, nickel and vitamins.

82. What is the role of iron in hemoglobin formation?
It is necessary for formation of heme part of hemoglobin.

83. What is the role of copper in hemoglobin formation?
It is necessary for absorption of iron from gastrointestinal tract.

84. Define hemoglobin.
Hemoglobin is the iron-containing coloring matter of the red blood cells.

85. What is normal hemoglobin content in the blood?
Males: 15 g%
Females: 14.5 g%.

86. What are the functions of hemoglobin?
i. Transport of respiratory gases
ii. Buffer action.

87. What are the components of hemoglobin?
i. Globin (protein)
ii. Heme (iron containing pigment). Pigment part of heme is porphyrin.

88. What are the types of normal hemoglobin?
i. Adult hemoglobin (HbA).
ii. Fetal hemoglobin (HbF).

89. What are the differences between adult hemoglobin and fetal hemoglobin?
Structural difference: Adult hemoglobin has got two alpha chains and two beta chains whereas the fetal hemoglobin has two alpha chains and two gamma chains.
Functional difference: Fetal hemoglobin has got more affinity for oxygen than the adult hemoglobin.

90. Name the abnormal hemoglobin.
i. Hemoglobinopathies: Hemoglobin S, C, E and M
ii. Hemoglobin in thalassemia and related disorders: Hemoglobin G, H, I, Bart's, Kenya, Lepore and constant spring.

91. What are the abnormal hemoglobin derivatives.
i. Carboxyhemoglobin: Combination of Hb with carbon monoxide
ii. Methemoglobin or ferrihemoglobin: Oxidation of Hb to ferric state
iii. Sulfhemoglobin: Combination of Hb with hydrogen sulfide.

92. What is the quantity of iron in the body?
About 4 g.

93. How is iron transported in the blood?
Iron is transported in blood in the form of transferrin. In blood, iron combines with beta globulin called apotransferrin and forms transferrin.

94. How is iron stored in the body?
Large quantity of iron is stored in reticuloendothelial cells and liver hepatocytes and small quantity is stored in other cells. In the cell cytoplasm, iron combines with a protein to form apoferritin. This is converted into ferritin and stored in the cytoplasm. A small quantity of iron is also stored in the form of hemosiderin.

95. How is ESR determined?
By Westergren's method or Wintrob's method.

96. What is ESR? What is its normal value?
ESR or erythrocyte sedimentation rate is the rate at which the RBCs settle down when the blood is allowed to stand.
Normal value by Westergren's method:
Males : 3 to 7 mm in one hour
Females : 5 to 9 mm in one hour
Infants : 0 to 2 mm in one hour

97. What is the clinical importance of determining ESR?
Determination of ESR helps for diagnosis and prognosis. It has got more of prognostic value than the diagnostic importance.

98. Name the physiological conditions when ESR increases.
ESR increases in infants, children and females. In females, it further increases during menstruation and pregnancy.

99. Name the pathological conditions when ESR increases.
Tuberculosis, some types of anemia, rheumatoid arthritis, rheumatic fever and liver diseases.

100. Name the pathological conditions when ESR decreases.
Allergic conditions, sickle cell anemia, peptone shock and polycythemia.

101. What is packed cell volume (PCV)?
Packed cell volume is the volume of RBCs packed at the bottom of a hematocrit tube when the blood is centrifuged for 30 minutes at a speed of 3000 RPM.
Normal value is 40 to 45% in males and 38 to 42% in females. (Refer Questions 36 to 38 of this section for further details)

102. Name the condition when PCV increases.
Polycythemia.

103. Name the conditions when PCV decreases.
Anemia and pregnancy.

104. What are blood indices?
Blood indices are the values, which indicate the size, volume and the hemoglobin content of RBCs.

105. Define and give the normal values of blood indices.
i. Mean corpuscular volume (MCV): The average volume of a single red blood cell. It is 78 to 90 cu μ.
ii. Mean corpuscular hemoglobin (MCH): The quantity or amount of hemoglobin present in one red blood cell. It is 27 to 32 pg.
iii. Mean corpuscular hemoglobin concentration (MCHC): The concentration of hemoglobin in one red blood cell. It is 30 to 38%.
iv. Color index (CI): The ratio between percentage of hemoglobin and the percentage of RBCs in the blood. It is 0.8 to 1.2.

106. What is the advantage of blood indices?
Blood indices help to determine the type of anemia.

107. What is anemia?
Anemia refers to reduction in red blood cell count or hemoglobin content or packed cell volume. It is the condition when the hemoglobin content decreases very much below normal.

108. What is the morphological classification of anemia?
Classification of anemia according to the size and color (hemoglobin content) of RBC is known as morphological classification.

By this, the anemia is classified into four types:

i. Normocytic normochromic anemia: Size and the hemoglobin content of the cells are normal but number is reduced
ii. Macrocytic normochromic anemia: Cells are larger with normal hemoglobin content and number is reduced
iii. Macrocytic hypochromic anemia: Cells are larger in size with less hemoglobin content
iv. Microcytic hypochromic anemia: Cells are smaller with less hemoglobin content.

109. What is the etiological classification of anemia?

The classification of anemia depending upon the cause is known as etiological classification. By this, anemia is classified into five types:

i. Hemorrhagic anemia due to blood loss
ii. Hemolytic anemia due to destruction of large number of red blood cells
iii. Nutrition deficiency anemia due to lack of nutritive substances like iron, protein, and vitamins C and B12
iv. Aplastic anemia due to destruction of bone marrow
v. Anemia of chronic diseases due to sustained diseases.

110. What is sickle cell anemia?

Sickle cell anemia is an inherited blood disorder, characterized by sickle-shaped red blood cells that contain abnormal hemoglobin called hemoglobin S.

111. What is thalassemia? What are its other names?

Thalassemia is an inherited disorder characterized by presence of abnormal hemoglobin in red blood cells. It is also called Cooley's anemia or Mediterranean anemia.

112. What is iron deficiency anemia? What is the morphology of RBCs in this type of anemia?

Iron deficiency anemia is the type of anemia developed due to inadequate deficiency of iron for hemoglobin synthesis. RBCs are microcytic and hypochromic in this anemia.

113. What is the role of intrinsic factor of Castle?

Intrinsic factor of Castle is essential for the absorption of vitamin B12 (extrinsic factor) from the intestine. Vitamin B12 and the intrinsic factor of Castle together form the hematinic principle, which is necessary for the maturation of red blood cells.

114. What is pernicious or Addison's anemia?

Pernicious or Addison's anemia is the anemia due to deficiency of vitamin B12 or intrinsic factor of Castle.

115. What is the morphology of RBC in pernicious anemia? Why?

In pernicious anemia, the RBCs are macrocytic and normochromic. This is because of lack of vitamin B12 and/or intrinsic factor which are necessary for maturation of red blood cells. So, the cells are not matured and remain larger in size.

116. What is megaloblastic anemia?

Megaloblastic anemia is the anemia due to deficiency of folic acid.

117. What is the morphology of RBC in megaloblastic anemia? Why?

Megaloblastic anemia is due to the lack of folic acid, which is essential for the synthesis of DNA in red blood cells. Because of folic acid deficiency, DNA synthesis becomes defective. So, the RBCs are not matured and are macrocytic and hypochromic in nature.

118. What is aplastic anemia?

Aplastic anemia is the anemia due to disorder of bone marrow.

119. What are the symptoms of anemia?

i. Metabolism: Basal metabolic rate increases in severe anemia
ii. Spleen: Spleen enlarges in some type of anemia
iii. Liver: Liver enlargement and liver dysfunction in sickle cell anemia
iv. Digestion: Loss of appetite, nausea, and vomiting
v. Kidney: Disturbed renal functions with albuminuria
vi. Skin and mucous membrane: Color becomes pale
vii. Reproduction: Disturbed menstrual cycle (menorrhagia, oligomenorrhea or amenorrhea) in females
viii. Cardiovascular system: Tachycardia, increased cardiac output, dilatation of heart, cardiac murmur and increased velocity of blood flow
ix. Respiration: Increase in rate and force of respiration and shifting of oxygen hemoglobin dissociation curve to right
x. Neuromuscular system: Increased sensitivity to cold, headache, lack of concentration, restlessness, irritability, drowsiness, fainting sensation, fatigue and muscular weakness.

120. What is hemolysis?

Hemolysis is the rupture of blood cells particularly RBCs with release of hemoglobin.

121. What are the causes of abnormal hemolysis?

i. Hemolysins
ii. Abnormal shape of RBCs
iii. Diseases
iv. Mechanical factors

122. What is fragility? Which RBCs are more fragile?

Fragility refers to tendency of RBCs to break easily or susceptibility of RBCs for hemolysis. Older RBCs (after 120 days of lifespan) are more fragile and are easily broken down.

123. What are hemolysins?

Hemolysins or hemolytic agents are the substances, which cause destruction RBCs.

124. List the hemolysins.

i. Hemolysins of bacterial origin: Toxic substances from gram-positive and gram-negative bacteria
ii. Hemolysins of animal origin: Venom of poisonous snakes like cobra
iii. Hemolysins in the form of chemical substances: Alcohol, benzene, chloroform, acids, alkalis, bile salts and saponin.

125. What are the common differences between the RBC and WBC?

Structural differences: RBC is non-nucleated, biconcave in shape (round in front view) and red in color whereas WBC is nucleated, irregular in shape and colorless.

Functional differences: RBC transports respiratory gases and plays an important role in buffer function. WBC plays important role in defense of the body.

126. Classify WBCs.

WBCs are classified into granulocytes and agranulocytes depending upon the presence or absence of granules in the cytoplasm.

127. Name the granulocytes and describe them briefly.

i. Neutrophil: Has fine granules, which take both acidic and basic stain (violet). It has multilobed nucleus
ii. Eosinophil: Has coarse granules, which stain bright red or orange with eosin. It has bilobed nucleus
iii. Basophil: Has coarse granules, which stain purple with methylene blue. It also has bilobed nucleus.

128. Name the agranulocytes and describe them briefly.

i. Monocytes: Largest of all the WBCs with clear cytoplasm. Nucleus is kidney shaped. It is either in center of the cell or pushed to one side and large amount of cytoplasm is seen

ii. Lymphocytes: Have clear cytoplasm. Nucleus is oval or kidney shaped and occupies the whole of cytoplasm. Depending upon the size, the lymphocytes are classified into small and large lymphocytes.

129. Give the total count and differential count of WBCs.

Total WBC count ranges between 4,000 and 11,000/ cu mm of blood. Differential WBC count:
Neutrophils : 50 to 70 % (3000 to 6000/cu mm)
Eosinophils : 2 to 4 % (150 to 450/cu mm)
Basophils : 0 to 1 % (0 to 100/cu mm)
Monocytes : 2 to 6 % (200 to 600/cu mm)
Lymphocytes : 20 to 30 % (1500 to 2700/cu mm)

130. What is leukocytosis? Name some physiological conditions when leukocytosis occurs.

Leukocytosis is the increase in WBC count. Physiologically, it is found in infants, children and males. It also occurs in high altitudes, during muscular exercise, during emotional conditions and in pregnancy.

131. Name some pathological conditions when leukocytosis occurs.

i. Infections
ii. Allergic conditions
iii. Common cold
iv. Tuberculosis
v. Glandular fever.

132. What is leukopenia? Name some pathological conditions when leukopenia occurs.

Decrease in WBC count is called leukopenia. It occurs in:

i. Anaphylactic shock
ii. Cirrhosis of liver
iii. Disorders of spleen
iv. Pernicious anemia
v. Typhoid and paratyphoid
vi. Viral infections.

133. What is neutrophilia? Name some pathological conditions when it occurs.

Increase in neutrophil count is called neutrophilia. It occurs in:

i. Acute infections
ii. Metabolic disorders
iii. Injections of foreign proteins
iv. Injections of vaccines
v. Poisoning by chemicals and drugs like lead, mercury, camphor, benzene derivatives
vi. Poisoning by insect venom
vii. After acute hemorrhage.

134. What is eosinophilia? Name some pathological conditions when it occurs.

Increase in eosinophil count is called eosinophilia. It occurs in:

i. Asthma and other allergic conditions
ii. Blood parasitism
iii. Intestinal parasitism
iv. Scarlet fever.

135. What is basophilia? Name some pathological conditions when it occurs.

Increase in basophil count is called basophilia. It occurs in:

i. Small pox
ii. Chicken pox
iii. Polycythemia vera.

136. What is monocytosis? Name some pathological conditions when it occurs.

Increase in monocyte count is called monocytosis. It occurs in:

i. Tuberculosis
ii. Syphilis
iii. Malaria
iv. Kala azar
v. Glandular fever.

137. What is lymphocytosis? Name some pathological conditions when it occurs. Increase in lymphocyte count is called lymphocytosis. It occurs in:

i. Diphtheria
ii. Infections
iii. Hepatitis
iv. Mumps
v. Rickets
vi. Syphilis
vii. Thyrotoxicosis
viii. Tuberculosis.

138. What is leukemia? What is its cause?

Leukemia is a type of blood cancer characterized by uncontrolled increase in leukocyte count. Leukemia develops due to production of large number of leukocytes including immature and abnormal leukocytes by blood-forming tissues such as bone marrow and lymphatic system.

139. What are the properties of WBC?

i. Diapedesis: Process of squeezing through the narrow blood vessels
ii. Amoeboid movement: Movement by protruding the cytoplasm
iii. Chemotaxis: Movement due to the attraction by chemical substances called chemoattractants released from the affected tissues
iv. Phagocytosis: Process by which the foreign bodies are engulfed.

140. What are the functions of neutrophils?

Neutrophils provide first line defense along with monocytes. Neutrophils move to the site of infection by diapedesis and engulf the foreign bodies by phagocytosis. Enzymes like proteases, myeloperoxidases, elastases and metalloproteinases present in the neutrophils destroy the foreign invaders. Neutrophils secrete platelet activating factor.

141. What are the chemical substances present in the granules and cell membrane of neutrophils?

In granules: Enzymes like proteases, myeloperoxidases, elastases and metalloproteinases and the antibody like substances called defensins.

In cell membrane: Dihydronicotinamide adenine dinucleotide phosphate oxidase (NADPH oxidase).

All these substances help the neutrophils to destroy the foreign bodies.

142. What is respiratory burst?

Respiratory burst is a rapid increase in oxygen consumption during the process of phagocytosis by neutrophils and other phagocytic cells. During this process nicotinamide adenine dinucleotide phosphate (NADPH) oxidase produces superoxide produces superoxide which is followed by production of other reactive oxygen species (ROS) like hydrogen peroxide. The ROS have potent bactericidal action.

143. What is pus?
Pus is the whitish yellow fluid formed in the area of infected tissue. It consists of dead WBCs, bacteria or foreign bodies, serum and cellular debris.

144. What are pus cells?
Pus cells are the dead WBCs killed by toxins released from bacteria during the battle between WBCs and bacteria.

145. What are the functions of eosinophils?
Eosinophils play an important role in defense mechanism by detoxification, disintegration and removal of foreign proteins. Eosinophils also act against the parasites.

146. Name the chemical substances present in the granules of eosinophils.
Eosinophil peroxidase, major basic protein, eosinophil cationic protein, eosinophil derived neurotoxin and cytokines.

147. What are the functions of basophils?
Basophils prevent intravascular clotting by secreting heparin and play an important role in healing processes after inflammation and allergy.

148. Name the chemical substances present in the granules of basophils.
Histamine, heparin, hyaluronic acid, proteases, myeloperoxidase and cytokine.

149. What are mast cells? What is their function?
Mast cells are large tissue cells resembling the basophils. These cells are present in bone marrow and around the cutaneous blood vessels but do not enter the circulation. Mast cells play an important role during allergy and anaphylaxis.

150. Name the chemical substances secreted by mast cells.
Heparin, histamine, serotonin and hydrolytic enzymes.

151. What are the functions of monocytes?
Monocytes provide first line defense along with neutrophils. These cells wander freely through all the tissues. Matured monocytes move into the tissues and become tissue macrophages. Macrophages engulf the foreign particles by phagocytosis and destroy them.

152. What is the function of lymphocytes?
Lymphocytes protect the body by providing immunity.

153. What are the two types of lymphocytes?
T lymphocytes and B lymphocytes.

154. What is leukopoiesis?
Leukopoiesis is the origin, development and maturation of WBCs.

155. Define immunity.
Immunity is defined as the capacity of the body to resist pathogenic agents. It is the ability of the body to resist the entry of different types of foreign bodies like bacteria, virus, toxic substances, etc.

156. What are the types of immunity?
i. Innate immunity or non-specific immunity: Present from the birth itself like the resistance given by the stomach against the pathogens entering through the food.
ii. Acquired immunity or specific immunity: Developed in the body when exposed to a new invading organism.

157. What are the types of acquired immunity?
Cellular immunity and humoral immunity.

158. Which are the cells responsible for acquired immunity?
Lymphocytes are responsible for acquired immunity. T lymphocytes provide cellular immunity and B lymphocytes provide humoral immunity.

159. What are T lymphocytes?
Lymphocytes which are processed in thymus and taking part in cellular immunity are called T lymphocytes.

160. What are B lymphocytes? Why these cells are called so?
Lymphocytes which are processed in bone marrow and liver and taking part in humoral immunity are called B lymphocytes. These cells were first discovered in the Bursa of Fabricius in birds and hence the name B lymphocytes.

161. Where are the T cells and B cells stored?
After being processed, T cells and B cells migrate and get stored in the lymphoid tissues present in the lymph nodes, spleen, bone marrow and gastrointestinal tract.

162. What are the different types of T cells?
i. Helper T cells
ii. Cytotoxic or killer T cells
iii. Suppressor T cells
iv. Memory T cells.

163. What are the different types of B cells?
Plasma cells and memory B cells.

164. What are antigens? What are the types of antigens?
Antigens are the protein substances, which induce specific immune reactions in the body. Antigens are two types:
i. Autoantigens or self-antigens
ii. non-self-antigens.

165. What are the self-antigens?
Self-antigens are the antigens present on body's own cells.

166. What are the non-self-antigens?
Non-self-antigens are the antigens, which enter the body from outside through some bacteria, virus, fungus, transplanted organs, transfused incompatible blood cells, allergens etc.

167. What are the antigen presenting cells?
Cells, which expose or present the antigen of invading organisms to the lymphocytes are called antigen presenting cells.

Macrophages and dendritic cells are the antigen presenting cells.

168. What are the functions of two types of helper T cells?
Helper–1 cells are concerned with cellular immunity and secrete
i. Interleukin – 2 which activates other T cells
ii. Gamma interferon that stimulates the cytotoxic cells, macrophages and natural killer cells.

Helper–2 cells are concerned with humoral immunity and secrete interleukins 4 and 5 which are concerned with
i. Activation of B cells
ii. Proliferation of plasma cells
iii. Antibody production by plasma cells.

169. What are the functions of cytotoxic T cells?
Cytotoxic T cells:
i. Attack the invading organisms and destroy them by releasing cytotoxic substances like lysosomal enzymes
ii. Destroy cancer cells, transplanted cells and other foreign bodies
iii. Destroy even body's own tissues which are affected by foreign bodies.

170. What are the disadvantages of the actions of cytotoxic T cells?
Cytotoxic T cells are otherwise called killer T cells because these cells destroy the invading organisms. But, at the same time, the cytotoxic T cells may attack the cells in transplanted heart or kidney leading to rejection of the transplanted tissues. These cells may destroy even the tissues affected by the invading organisms.

171. What is the role of suppressor T cells?
Suppressor T cells or regulatory cells suppress the action of killer cells so that, the destruction of body's own tissues is prevented. Suppressor T cells also suppress the activities of helper T cells.

172. What is the importance of memory T cells?
Some of the T cells activated by the antigens of invading organism move to the lymphoid tissues and remain there. These cells are called memory T cells. When the body is attacked by the same organism for the second time, these memory cells recognize the organism and immediately activate the other T cells so that, the invading organism is destroyed quickly and effectively.

173. What is humoral immunity? Which are the cells responsible for it?
Humoral immunity is defined as immunity mediated by antibodies B lymphocytes are responsible for it.

174. What is the role of plasma cells in humoral immunity?
Plasma cells produce antibodies against the antigens of invading organisms. Antibodies which are also called immunoglobulins destroy the invading organisms.

175. Name the immunoglobulins secreted by the plasma cells.
IgA, IgD, IgE, IgG and IgM.

176. What are the mechanisms of action of immunoglobulins? Immunoglobulins destroy the invading organisms by two mechanisms:
i. Direct action
ii. Through complement system.

177. What are the direct actions of immunoglobulins?
Direct actions by which the immunoglobulins destroy the foreign bodies:
i. Agglutination
ii. Precipitation
iii. Neutralization
iv. Lysis.

178. What is complement system?
Complement system is the one that enhances or accelerates various activities during the fight against the invading organisms is called complement system. It is a system of plasma enzymes.

179. What is natural killer cell (NK cell)? What are its functions?
NK cell is a large granular cell that plays an important role in defense mechanism of the body.
Functions of NK cell:
i. Destroys virus
ii. Destroys viral infected or damaged cells, which might form tumors
iii. Destroy the malignant cells
iv. Secretes cytokines: Interleukin-2, interferons, colony stimulating factor and tumor necrosis factor-α.

180. What are cytokines? Name the sources of cytokines?
Cytokines are the hormone-like small proteins which act as cell signaling molecules (intercellular messengers). Major function of cytokines is activation and regulation of general immune system of the body.

Cytokines are secreted by WBCs. platelets and other types of cells like macrophages, mast cells and NK cells.

181. Classify cytokines.
Cytokines are of six types:
i. Interleukins
ii. Interferons
iii. Tumor necrosis factors
iv. Chemokines
v. Defensins
vi. Cathelicidins
vii. Platelet-activating factor

182. Define and classify immunization.
Immunization is defined as the procedure by which the body is prepared to fight against a specific disease.
It is of two types:
i. Passive immunization: Produced by administration of serum or gamma globulins from a person who is already immunized to a non-immune person.
ii. Active immunization: Acquired by activating immune system of the body.

183. What is a vaccine? What are the uses of vaccines?
Vaccine is a substance that is introduced into the body to prevents the diseases produced by certain pathogens. It is produced from dead pathogens or live but attenuated organisms.

184. What are the uses of vaccines?
Vaccines are used to prevent diseases such as measles, mumps, tuberculosis, smallpox, typhoid, influenza, hepatitis B etc.

185. What is a toxoid? What are the uses of toxoids?
Toxoid is a substance which is normally toxic and has been processed to weaken or destroy its toxicity but it retains its capacity to induce antibody production by immune system.

Toxoids are used to develop immunity against diseases such as diphtheria, tetanus, cholera etc.

186. What are immune deficiency diseases?
Immune deficiency diseases are group of diseases in which some components of immune system are missing or defective.

187. What is acquired immune deficiency syndrome (AIDS)?
AIDS is an immune deficiency disease caused by human immune deficiency virus (HIV).

188. What is autoimmune disease? Give examples of autoimmune diseases.
Autoimmune disease is defined as a condition in which the immune system mistakenly attacks body's own cells and tissues and destroy them.
Examples:
i. Insulin dependent diabetes mellitus (IDDM)
ii. Myasthenia gravis
iii. Hashimoto's thyroiditis
iv. Grave's disease
v. Rheumatoid arthritis.

189. What are platelets? What is the normal platelet count?
Platelets or thrombocytes are small, colorless and non-nucleated and moderately refractile formed elements of the blood.

Normal platelet count: 2,50,000/cu mm of blood. It ranges between 2,00,000 and 4,00,000/cu mm of blood.

190. Name the organic substances present in the platelets.
i. Contractile proteins: Actin, myosin and thromobsthenin.
ii. von Willebrand factor
iii. Fibrin stabilizing factor
iv. Platelet derived growth factor
v. Platelet activating factor
vi. Vitronectin
vii. Thrombospondin
viii. Enzymes like ATPase
ix. Hormones: Adrenaline, 5-HT and histamine
x. Other substances such as glycogen, blood group antigens, calcium, copper, magnesium and iron.

191. Name the two types of platelet granules.
Alpha granules and dense granules.

192. Name the properties of platelets.
i. Adhesiveness
ii. Aggregation
iii. Agglutination.

193. What are the functions of platelets?
Platelets:
i. Are responsible for blood clotting
ii. Are responsible for clot retraction
iii. Prevent blood loss during hemorrhage, by causing vasoconstriction and sealing the wound by plug formation
iv. Help in the repair of endothelium of damaged blood vessels
v. Play a role in defense mechanism by agglutination and phagocytosis.

194. What is thrombocytosis? Name some conditions when thrombocytosis occurs.
Thrombocytosis is the increase in platelet count.
It occurs in:
i. Allergic conditions
ii. Asphyxia
iii. Hemorrhage
iv. Bone fractures
v. Surgical operations
vi. Splenectomy
vii. Rheumatic fever
viii. Trauma.

195. What is thrombocythemia? Name some conditions when thrombocythemia occurs.
Thrombocythemia is the condition with persistent and abnormal increase in platelet count.
It occurs in:
i. Carcinoma
ii. Chronic leukemia
iii. Hodgkin's disease.

196. What is thrombocytopenia? Name some conditions when thrombocytopenia occurs.
Thrombocytopenia is the decrease in platelet count.
It occurs in:
i. Acute infections
ii. Acute leukemia
iii. Aplastic anemia and pernicious anemia
iv. Chicken pox
v. Small pox
vi. Splenomegaly
vii. Scarlet fever
viii. Typhoid
ix. Tuberculosis
x. Purpura
xi. Gaucher's disease

197. What is hemostasis?
Hemostasis is defined as arrest or stoppage of bleeding is called hemostasis.

198. Name the stages of hemostasis.
Stage i: Vasoconstriction caused by serotonin secreted by platelets.
Stage ii: Formation of platelet plug caused by ADP and thrombaxne A2 secreted by platelets.
Stage iii: Coagulation of blood.

199. Define coagulation of blood.
Coagulation or clotting is defined as the process in which blood loses its fluidity and becomes a jelly like mass few minutes after it is shed out or collected in a container.

200. Name the clotting factors.
i. Fibrinogen
ii. Prothrombin
iii. Thromboplastin
iv. Calcium
v. Labile factor (proaccelerin or accelerator globulin)
vi. Presence has not been proved
vii. Stable factor
viii. Antihemophilic factor (antihemophilic globulin)
ix. Christmas factor
x. Stuart–Prower factor
xi. Plasma thromboplastin antecedent
xii. Hegman factor (contact factor)
xiii. Fibrin stabilizing factor (fibrinase).

201. Which is the inorganic ion necessary for blood clotting?
Calcium ion (factor IV).

202. Why Christmas factor is called so?
Christmas factor was named after the patient in whom it was discovered.

203. What are the stages of blood clotting?
Stage i: Formation of prothrombin activator
Stage ii: Conversion of prothrombin into thrombin Stage iii: Conversion of fibrinogen into fibrin.

204. How is prothrombin activator formed?
Prothrombin activator is formed by two mechanisms
i. Intrinsic mechanism
ii. Extrinsic mechanism.

205. How is thrombin formed?
Thrombin is formed from prothrombin in the presence of prothrombin activator and calcium.

206. How is fibrin formed?
Fibrin is formed from fibrinogen in the presence of thrombin and calcium.

207. What is blood clot?
Blood clot is defined as the mass of coagulated blood which contains RBCs, WBCs and platelets entrapped in fibrin meshwork.

208. What is clot retraction?
Clot retraction is the process which involves contraction of blood clot 30 to 45 minutes after formation and oozing of a straw-colored fluid called serum.

209. What are the substances necessary for clot retraction?
Contractile protein thrombosthenin present in cytoplasm of platelets is necessary for clot retraction.

210. What is fibrinolysis of clot? What is its significance?
Fibrinolysis is the process which involves breakdown and dissolution of blood clot inside the blood vessel. It helps to remove the clot from lumen of the blood vessel.

211. Which substance is required for fibrinolysis?
Plasmin or fibrinolysin is required for fibrinolysis.

212. Why blood does not clot during circulation?
i. Smooth surface of endothelium of blood vessels prevents activation of clotting factors
ii. Glycocalyx layer on inner surface of endothelium repels platelets and clotting factors and thereby initiation of blood clotting is prevented
iii. Continuous flow of blood does not allow aggregation of platelets and prevents blood clotting
iv. Presence of natural anticoagulants in blood:
a. Heparin
b. Protein C

213. What are anticoagulants?
Anticoagulants are the substances which prevent or postpone blood clotting.

214. Classify anticoagulants?
Anticoagulant is a substance that prevents or prolongs blood clotting.

215. Name some anticoagulants, which can be used *in vivo* (inside the body).
i. Heparin
ii. Dicoumarol
iii. Warfarin
iv. EDTA.

216. What is the mechanism of action of heparin?
Heparin prevents blood clotting by:
i. Suppressing activity of thrombin (antithrombin activity)
ii. Removing thrombin from circulation
iii. Activating antihrombin
iv. Inactivating other clotting factors.

217. Name the anticoagulants, which are used *in vitro*.
Heparin, EDTA, oxalates and citrates.

218. What are procoagulants or hemostatic agents? Give examples.
Procoagulants or hemostatic agents are the substances which accelerate the process of blood coagulation.
Examples: Thrombin, snake venom, extracts of lungs and thymus, sodium or calcium alginate and oxidized cellulose.

219. Define bleeding time.
Bleeding time is the time interval from oozing of blood after injury till the arrest of bleeding.

220. What is the normal bleeding time? In which disease it is prolonged?
Normal bleeding time is 1 to 3 minutes. It is prolonged in purpura.

221. Define clotting time.
Clotting time is the time interval between oozing out of blood after injury and clot formation.

222. What is the normal clotting time? In which disease it is prolonged?
Normal clotting time is 3 to 8 minutes. It is prolonged in hemophilia.

223. What is thrombosis or intravascular blood clotting?
Thrombosis or intravascular blood clotting refers to coagulation of blood inside the blood vessels.

224. Name the causes for thrombosis.
i. Injury to blood vessel
ii. Rough endothelial lining
iii. Sluggish flow of blood
iv. Agglutination of red blood cells
v. Presence of toxic substances like mercury and snake venom
vi. Congenital absence of protein C.

225. What is thrombus? What is agglutinative thrombus?
Thrombus is the solid mass of platelets, red blood cells and/or intravascular clot which occludes lumen of blood vessels during thrombosis.
Agglutinative thrombus is the thrombus formed due to agglutination of red blood cells.

226. What is embolism?
Embolism is the process in which the thrombus or a part of it gets detached, travels in the blood stream, and obstructs the blood flow to any part of the body.

227. What is embolus?
Embolus is the thrombus or a part of it which arrests the blood flow.

228. Name the bleeding disorders.
i. Hemophilia
ii. Purpura and
iii. Von Willebrand disease.

229. What is hemophilia?
Hemophilia is a group of sex-linked inherited blood disorders, characterized by prolonged clotting time and normal bleeding time.

230. What are the types of hemophilia? And what is the cause for each?
Hemophilia is of two types:
i. Hemophilia A or classical hemophilia. It is due to the deficiency of clotting factor VIII (antihemophilic factor).
ii. Hemophilia B or Christmas disease. It is due to the deficiency of clotting factor IX (Christmas factor).

231. What is purpura?
Purpura is a disorder with prolonged bleeding time.

232. How is hemophilia differentiated from purpura by simple laboratory test?
In hemophilia, the clotting time is prolonged whereas in purpura the bleeding time is prolonged.

233. What is von Willebrand disease? What is its cause?
von Willebrand disease is a bleeding disorder, characterized by excess bleeding even with a mild injury. It is due to the deficiency of von Willebrand factor.

234. What is von Willebrand factor?
von Willebrand factor is a protein secreted by endothelium of damaged blood vessel and platelets.

235. What is Landsteiner's law?
Landsteiner's law states that
i. If a particular agglutinogen (antigen) is present in red blood cells of a person, the corresponding agglutinin (antibody) must be absent in the serum
ii. If an agglutinogen is absent in the red blood cells, the corresponding agglutinin will be present in the serum.
Though the second part of Landsteiner's law is a fact, it is not applicable for Rh factor.

236. Classify the blood groups according to Landsteiner's law.
According to Landsteiner's law, blood group is classified as 'A', 'B', 'AB' and 'O' depending upon the presence or absence of agglutinogen (antigen) in the red blood cell. This grouping is also known as ABO system.

237. Name the agglutinogen (antigen) and agglutinin (antibody) present in ABO system.

'A' group : Agglutinogen is 'A' and agglutinin is beta (anti 'B')

'B' group : Agglutinogen is 'B' and agglutinin is alpha (anti 'A')

'AB' group : Both 'A' and 'B' agglutinogens are present but no agglutinin

'O' group : No agglutinogen is present but both alpha and beta agglutinins are present.

238. Who is universal donor? Why?

Person with 'O' group blood is called universal donor because his blood does not contain any agglutinogens in his blood. Usually, during transfusion of blood, the RBCs of the donor (which contains agglutinogen) agglutinate with the agglutinin present in recipient's plasma. Since 'O' group blood does not contain any agglutinogen it can be given to any blood group person without the risk of agglutination. So, he is known as universal donor.

239. Who is universal recipient? Why?

Person with 'AB' blood group is called universal recipient, because, his blood does not contain any agglutinin in his plasma. Usually, during blood transfusion, the donor's agglutinogen will agglutinate with recipient's agglutinin. But, 'AB' group blood does not contain any agglutinin in plasma and, so the person with 'AB' group can receive blood from persons with any other blood group. So, this person is called universal recipient.

240. What is matching? What is cross matching? What is the importance of cross matching?

Matching (or blood typing) is a laboratory test done to determine the blood group of a person. It is done by mixing recipient's RBCs with test sera.

In cross matching, the serum of the recipient and the RBCs of the donor are mixed. Cross matching is always done before blood transfusion. If agglutination of the RBCs from a donor occurs during cross matching, the blood from that person is not used for transfusion.

241. What is H antigen?

H antigen is the precursor of ABO group antigens i.e. antigen A and antigen B. H antigen is present in RBCs of all individuals. If a person has the gene for A antigen or B antigen or both, these antigens are formed from H antigen. If there is no gene for A and B antigens, the person will not have A or B antigen in spite of having H antigen. The blood of this person belongs to O group.

242. What is Rh factor? Why is it called so?

Rh factor is an antigen present in the red blood cell. It was first found in rhesus monkey and hence it is called Rh factor.

243. How is Rh blood type classified?

Rh blood type is classified depending upon the presence or absence of Rh factor (antigen) in the RBCs. If Rh factor is present, the person is called Rh positive and if Rh factor is absent, the person is called Rh negative.

244. In what way Rh type is different from ABO system?

In ABO system of blood grouping, there is natural corresponding antibody (agglutinin) whereas, in Rh typing, there is no natural corresponding antibody.

245. Name the blood groups other than ABO group.

i. Lewis blood group
ii. MNS blood group
iii. Auberger group
iv. Diego group
v. Bombay group
vi. Duffy group
vii. Lutheran group
viii. P group
ix. Kell group
x. I group
xi. Kidd group
xii. Sulter Xg group.

246. What is the importance of determining blood group?

i. For safe blood transfusion and tissue transplants
ii. For donating blood
iii. To prevent complications like erythroblastosis fetalis.

247. What are the complications (transfusion reactions) of mismatched blood transfusion?

i. Jaundice
ii. Cardiac shock
iii. Renal shut down.

248. Why the transfusion reactions do not occur when Rh negative person is given Rh positive blood for the first time? And what happens if the same person is given Rh positive blood for the second time?

There is no antigen in Rh negative blood and there is no antibody in the Rh positive person. So, when Rh positive blood is given to Rh negative person for the first time, there is no reaction. But the Rh antibody develops and remains in his blood. So, when the same person receives Rh positive blood for the second time, the transfusion reactions occur.

249. What is erythroblastosis fetalis?

Erythroblastosis fetalis is a hemolytic disease characterized by the presence of erythroblasts in fetal blood. It occurs due to Rh incompatability.

250. Explain erythroblastosis fetalis briefly.

It is the complication developed in the fetus of Rh negative mother. When the mother is Rh negative and father is Rh positive, the fetus may be Rh positive. The placental barrier does not allow Rh antigen (D antigen) to move from fetal blood into mother's blood. So, there is no complication and the child escapes. But, during delivery of the child, due to the severance of umbilical cord, the Rh antigen from the fetal blood enters the mother's blood. This causes development of antibody in mother's blood.

During second pregnancy, the Rh antibody from mother's blood enters fetus since, the placental barrier permits the Rh antibody. If this fetus also is Rh positive, agglutination occurs in fetal blood leading to complications like severe hemolysis, jaundice and anemia. This condition is called erythroblastosis fetalis.

251. Why erythroblastosis fetalis is called so?

During erythroblastosis fetalis, severe hemolysis occurs. To compensate the destruction of more and more red blood cells, there is rapid production and release of RBCs into the circulation. Now, a large number of immature cells in proerythroblastic stage are released into circulation. Because of the presence of large number of proerythroblastic cells in the blood, the condition is called erythroblastosis fetalis.

252. What are the complications of hemolytic disease in fetus or infant?

i. Severe anemia
ii. Hydrops fetalis
iii. Kernicterus.

253. Name the conditions when blood transfusion is essential.
i. Anemia
ii. Hemorrhage
iii. Trauma
iv. Burns
v. Surgery.

254. What are the precautions to be taken before the transfusion of blood?
i. Donor must be healthy without any diseases like syphilis, hepatitis and AIDS
ii. Only compatible blood must be transfused
iii. Both matching and cross matching must be done
iv. Rh compatibility must be confirmed.

255. What are the precautions to be taken while transfusing blood?
i. Apparatus for transfusion must be sterile
ii. Temperature of the blood must be same as body temperature
iii. Transfusion must be done slowly to avoid the load on the heart.

256. What are the hazards of blood transfusion?
i. Reactions due to mismatched blood transfusion
ii. Reaction due to massive blood transfusion
iii. Reactions due to faulty techniques during blood transfusion
iv. Transmission of infections.

257. What are blood substitutes? Name some commonly used blood substitutes.
Blood substitute are the substances used as a replacement for blood or to expand blood volume.
Commonly used blood substitutes:
i. Human plasma
ii. 0.9% sodium chloride solution
iii. 5% glucose solution
iv. Colloids like gum acacia, isinglass, albumin and animal gelatin.

258. What is exchange transfusion or replacement transfusion? What is its significance?
Exchange transfusion is the procedure which involves the removal of patient's blood and replacing it with fresh donor blood or plasma. It is an important lifesaving procedure usually done to decrease or remove the effects of severe jaundice or changes in the blood like sickle cell anemia.

259. What is autologous blood transfusion? What is allogenic blood transfusion?
Autologous blood transfusion is the collection and reinfusion of patient's own blood. Allogenic blood transfusion is the conventional transfusion of blood that is collected from a person other than the patient.

260. What is the normal blood volume?
5 liters in a young healthy adult weighing about 70 kg.

261. How is blood volume regulated?
Blood volume is regulated by renal mechanism and hormonal mechanism which are controlled by hypothalamus.

262. What is hypervolemia? Name some conditions when it occurs.
Hypervolemia is the increase in blood volume.
It occurs in:
i. Hyperthyroidism
ii. Hyperaldosteronism
iii. Cirrhosis of liver
iv. Congestive heart failure.

263. What is hypovolemia?. Name some conditions when it occurs.
Hypovolemia is decrease in blood volume
It occurs in:
i. Hemorrhage
ii. Fluid loss
iii. Hemolysis
iv. Anemia
v. Obesity
vi. Hypothyroidism.

264. What is reticuloendothelial system or tissue macrophage system?
Reticuloendothelial system or tissue macrophage system is a system of primitive phagocytic cells, which play an important role in defense mechanism of body.

265. What is macrophage?
Macrophage is a large phagocytic cell derived from monocytes.

266. Classify reticuloendothelial cells?
i. Fixed reticuloendothelial cells
Situated in:
a. Connective tissue
b. Endothelium of blood sinusoids
c. Reticulum
d. Central nervous system
e. Lungs
f. Subcutaneous tissue
ii. Wandering reticuloendothelial cells
Two types:
a. Free histiocytes of blood
b. Free histiocytes of solid tissues.

267. What are the tissue macrophages?
Tissue macrophages are the fixed reticuloendothelial cells present in the tissues.

268. What are the functions of reticuloendothelial system?
Most of the functions of reticuloendothelial system are carried out by tissue macrophages. The functions are:
i. Phagocytic function
ii. Secretion of bactericidal agents
iii. Secretion of interleukins
iv. Secretion of tumor necrosis factors
v. Secretion of transforming growth factor
vi. Secretion of colony stimulation factor
vii. Secretion of platelet derived growth factor
viii. Removal of carbon particles and silicon
ix. Destruction of senile RBC
x. Destruction of hemoglobin

269. What are the functions of spleen?
i. Formation of blood cells
ii. Destruction of blood cells
iii. Blood reservoir function
iv. Role in defense mechanism of the body.

270. What is splenomegaly and hypersplenism?
Enlargement of spleen is called splenomegaly and increased activities of spleen is called hypersplenism.

271. Name some causes of splenomegaly.
i. Infectious diseases
ii. Inflammatory diseases
iii. Pernicious anemia
iv. Liver diseases
v. Hematological disorders
vi. Cysts in spleen
vii. Hodgkin's disease
viii. Glandular fever

272. What is asplenia?
Absence of normal functions of spleen is called asplenia.

273. What is lymphatic system?
Lymphatic system is a closed system of lymph channels or lymph vessels. And lymph is a tissue fluid.

274. What are lymph nodes? And mention their situation.
Lymph nodes are small glands or nodes interposed in the course of lymph vessels. Lymph nodes are present in elbow, axilla, knee, groin, abdomen, thorax and neck.

275. What are the functions of lymph nodes?
i. Filtration of lymph
ii. Destruction of bacteria and toxic substances by acting like defense barriers.

276. What is lymph?
Lymph is a clear fluid derived from tissues and passes from tissue space into blood via lymph vessels.

277. What is the composition of lymph?
Lymph contains 96% of water and 4% of solids. Solids are organic and inorganic substances.
Organic substances:
i. Proteins: Albumin, globulin, fibrinogen, prothrombin, clotting factors, antibodies and enzymes
ii. Lipids: Chylomicrons and lipoproteins
iii. Carbohydrate: glucose
iv. Amino acids
v. Nonprotein nitrogenous substances: Urea and creatinine. Inorganic substances: Sodium, calcium, potassium, chlorides and bicarbonates.

278. What are the functions of lymph?
i. Return of proteins from tissue spaces to blood
ii. Redistribution of fluid in the body
iii. Removal of substances like toxins and bacteria
iv. Maintenance of structural and functional integrity of tissues
v. Serves as the route for absorption of fat
vi. Transport of lymphocytes.

279. What is tissue fluid or interstitial fluid?
Tissue fluid is the medium in which cells are bathed. It forms about 20% of the total body water.

280. What are the functions of tissue fluid?
i. It acts as a medium for exchange of various substances between the cells and the blood in capillaries.
ii. It functions as a medium for exchange of respiratory gases.

281. How is tissue fluid formed?
Tissue fluid is formed by means of a process called filtration.

282. How is volume of tissue fluid regulated?
Volume of tissue fluid is regulated by the process of reabsorption.

283. Define edema?
Edema is defined as the swelling caused by excessive accumulation of fluid in the tissues.

284. Name the types of edema.
i. Intracellular edema: Collection of fluid inside the cell
ii. Extracellular edema: Collection of fluid outside the cell.

285. What are the causes for intracellular edema?
i. Malnutrition
ii. Poor metabolism
iii. Inflammation of tissue.

286. What are the causes for extracellular edema?
i. Abnormal leakage of fluid from capillaries into interstitial space
ii. Obstruction of lymphatic vessels that prevents fluid return from interstitium to blood.

287. Name some common clinical conditions when extracellular edema occurs.
i. Heart failure
ii. Renal disease
iii. Hypoproteinemia
iv. Lymphatic obstruction
v. Increased endothelial permeability.

288. What is pitting edema?
When the area of edema is pressed by a finger, displacement of fluid occurs producing a depression or pit. The pit remains for few seconds to one minute till the fluid flows back into that area. This type of edema is called pitting edema.

289. What is nonpitting edema? What is its cause?
When the area of edema is pressed by a finger, there is no displacement of fluid or development of a depression or pit and the area remains hard. This type of edema is called nonpitting edema.

This occurs because the accumulated fluid is bound in a proteoglycan meshwork, which is hard. So, the fluid is not displaced when the area is pressed. The nonpitting edema also occurs due to swelling of the cells or clotting of interstitial fluid in the presence of fibrinogen.

Section 3

Muscle Physiology

1. **Name the methods to classify muscles.**
   i. Depending upon the structure: Striated and non-striated muscles
   ii. Depending upon the control: Voluntary and involuntary muscles
   iii. Depending upon the function: Skeletal muscle, cardiac muscle and smooth muscle.
2. **Which are the striated muscles?**
   Skeletal muscles and cardiac muscles are striated muscles.
3. **What is the nerve supply of different types of muscles?**
   Skeletal muscle: Supplied by somatic nerves.
   Cardiac and smooth muscles: Supplied by autonomic nerve fibers.
4. **What is the other name of muscle cells or fibers?**
   Myocytes.
5. **What is a fasciculus in skeletal muscle?**
   Fasciculus is the group or bundle of muscle fibers.
6. **What is a tendon?**
   Tendon is a tough cord of connective tissue to which muscle fibers are attached.
7. **Name the different connective tissue sheath in skeletal muscle.**
   i. Epimysium which covers the whole muscle
   ii. Perimysium which covers each fasciculus of muscle fibers
   iii. Endomysium which covers each muscle fiber.
8. **What is sarcolemma?**
   It is the cell membrane or plasma membrane of the muscle fiber.
9. **What is sarcoplasm?**
   It is the cytoplasm of the muscle fiber
10. **What are myofibrils?**
    Myofibrils are the thin parallel filaments present in sarcoplasm of the muscle fiber.
11. **What is sarcomere?**
    The structural and functional unit of skeletal muscle is known as sarcomere. It extends between two 'Z' lines.
12. **What is 'A' band in the muscle? Why is it called so?**
    'A' band is the dark band present in the myofibrils of the muscle. It is anisotropic to polarized light; i.e., if polarized light is passed through this area of the muscle, the light rays are refracted at different directions. So this band is called 'A' band.
13. **What is 'I' band in the muscle? Why is it called so?**
    'I' band is the light band present in the myofibrils of the muscle. It is isotropic to polarized light, i.e. when polarized light is passed through this area of the muscle, all the light rays are refracted at the same angle. So this band is called 'I' band.
14. **Define and classify myofilaments.**
    Myofilaments are the thread like protein filaments present in the sarcomere. Myofilaments are of two types—actin filaments and myosin filaments.
15. **Which myofilaments are present in 'A' band?**
    Myosin filaments and part of actin filaments.
16. **Which myofilaments are present in 'I' band?**
    Actin filaments.
17. **Explain the features and situation of myofilaments briefly.**
    Actin filaments are thin filaments with diameter of 20 Å and extend from either side of the 'Z' lines, run across 'I' band and enter into 'A' band up to 'H' zone. Myosin filaments are thick filaments with diameter of 115 Å and are situated in the center of 'A' band.
18. **What are the components of actin and myosin filaments?**
    Actin filament consists of three types of proteins called actin, tropomyosin and troponin.
    Myosin filament consists of myosin molecules.
19. **What are the contractile elements of the skeletal muscle?**
    Contractile elements of the skeletal muscle are the muscle proteins namely myosin, actin, tropomyosin and troponin.
20. **What is 'H' zone? And what is 'M' line?**
    'H' zone is a light area in the middle of 'A' band. 'M' band is the middle part of myosin filaments situated in the middle of 'H' zone.
21. **What are cross-bridges and myosin heads?**
    Cross-bridges are lateral processes or projections arising from each myosin filament. The enlarged structures at the tip of the cross-bridges are called myosin heads.
22. **What is sarcotubular system? What are its components?**
    Sarcotubular system is a system of membranous tubular structures present in the skeletal muscle fiber. The components of this system are 'T' tubules (transverse tubules) and 'L' tubules (longitudinal tubules). 'L' tubule is otherwise called sarcoplasmic reticulum.
23. **What is the functional importance of sarcotubular system?**
    The 'T' tubules are responsible for rapid transmission of action potential through the muscle fiber. The "L" tubules store a large quantity of calcium ions.
24. **What are the organic substances present in skeletal muscle?**
    i. Proteins: Actin, myosin, tropomyosin, troponin, actinin, desmin, mebulin, titin and myoglobulin
    ii. Carbohydrates: Glycogen and hexophosphate
    iii. Lipids: Neutral fat, cholesterol, lecithin and steroids

iv. Nitrogenous substances: ATP, adenylic acid, carnosine, carmitine, creatine, phosphocreatine, urea, uric acid, xanthine and hypoxanthine.

25. Name the properties of skeletal muscle.
Excitability, contractility and muscle tone.

26. Define excitability.
Response of the living tissue to a stimulus in the form of physicochemical change is known as excitability.

27. Define stimulus. What are the types of stimulus?
Stimulus is an agent or influence that brings about the response in an excitable tissue.
Stimulus is of four types, mechanical, electrical, thermal and chemical stimulus.

28. Name the qualities of a stimulus.
i. Intensity or strength
ii. Duration.

29. What is strength duration curve? What is its other name?
Strength duration curve is the curve that demonstrates the relationship between the strength and the duration of stimulus. It is otherwise called excitability curve.

30. What is rheobase?
Rheobase is the minimum strength of the stimulus that is required to excite the tissue.

31. What is utilization time?
Utilization time is the minimum time required to excite the tissue when a stimulus with rheobasic strength (threshold strength of stimulus) is applied.

32. What is chronaxie?
Chronaxie is the minimum time required to excite the tissue when a stimulus with double the rheobasic strength is applied.

33. What is the importance of chronaxie?
Chronaxie helps to determine the excitability of the tissue. Longer the chronaxie, lesser is the excitability.

34. Name some conditions when chronaxie increases.
i. Paralysis of muscles
ii. Neural diseases.

35. Name the types of muscular contractions?
i. Isotonic contraction
ii. Isometric contraction.

36. Define isotonic contraction and give example.
Isotonic contraction is the type of contraction in which the tension remains the same and change occurs only in the length of the muscle fibers.
Example: Contraction of the biceps muscle during simple flexion of arm.

37. Define isometric contraction and give example.
Isometric contraction is the type of contraction in which the length of the muscle fibers remains the same and change occurs only in the tension.
Example: Contraction of arm muscles while pulling any heavy object.

38. What are the different periods in a simple muscle twitch?
i. Latent period: Between point of stimulus and point of contraction
ii. Contraction period: Between point of contraction and point of maximum contraction
iii. Relaxation period: Between point of maximum contraction and point of maximum relaxation.

39. Give the normal duration of different periods of a simple muscle twitch.
Latent period = 0.01 sec
Contraction period = 0.04 sec
Relaxation period = 0.05 sec
Total twitch period = 0.10 sec

40. Why is the contraction period shorter than relaxation period?
Contraction period is shorter than relaxation period because the contraction is an active process and relaxation is a passive process.

41. Define latent period.
Latent period is defined as the time interval between the point of stimulus and point of contraction.

42. What are the causes for latent period?
i. It is the time taken for the impulse to travel along the nerve from the place of stimulation to the muscle
ii. It is the time taken for the initiation of chemical changes
iii. It is the delay in the conduction of impulse at the neuromuscular junction
iv. It is the time taken for the release of neurotransmitter at the neuromuscular junction
v. It is the time taken to overcome the viscosity of the muscle
vi. It is the time taken to overcome the inertia of the instruments in experimental conditions.

43. Name some conditions when the latent period is prolonged.
i. Cold conditions
ii. During onset of fatigue
iii. When the load on the muscle is increased.

44. When does the latent period decrease?
Latent period decreases when temperature is increased.

45. Classify the skeletal muscles depending upon the contraction time. Give examples.
i. Slow or red muscles, which have longer contraction time.
Examples: Back muscles
ii. Fast or pale muscles which have shorter contraction time.
Examples: Hand muscles and ocular muscles.

46. What are the factors affecting the force of contraction of the muscle within physiological limits?
i. Increase in the strength of stimulus
ii. Increase in the number of stimulus
iii. Temperature
iv. Load.

47. Classify the stimulus depending upon the strength.
i. Subminimal stimulus
ii. Minimal stimulus
iii. Submaximal stimulus
iv. Maximal stimulus
v. Supramaximal stimulus.

48. What is threshold stimulus?
Threshold or minimal stimulus is the stimulus with minimum strength required to cause minimum response in the tissues.

49. What are the effects of two successive stimuli on muscle?
i. Beneficial effect
ii. Superposition
iii. Summation.

50. What is beneficial effect?
When two stimuli are applied to a muscle one after another in such a way that the second stimulus falls after the relaxation period of the first twitch, two separate contractions are recorded and the force of second contraction is greater than that of the first contraction. This is known as beneficial effect.

51. What is the cause for beneficial effect?
Increase in the temperature during first contraction decreases the viscosity of muscle. So, the force of second contraction is more.

52. What is superposition or incomplete summation?
While applying two successive stimuli, if the second stimulus falls during relaxation of the first twitch, the first curve is superimposed by the second curve. This is called superposition or incomplete summation.

53. What is summation or complete summation?
When two stimuli are applied one after another and if the second stimulus falls during the contraction period or second half of the latent period, two contractions are summed up, giving single contraction which is bigger and broader than simple muscle curve. This is known as summation or complete summation.

54. Define fatigue.
Fatigue is the decrease in response of the muscle due to repeated stimuli.

55. Name the instrument used to record fatigue in human beings.
Mosso's ergograph.

56. What are the causes of fatigue?
i. Exhaustion of acetylcholine
ii. Accumulation of metabolites like lactic acid and carbon dioxide
iii. Lack of nutrients like glycogen
iv. Lack of oxygen

57. Mention the order of site (seat) of fatigue in the intact body.

First site of fatigue	: Betz cells of cerebral cortex
Second site of fatigue	: Motor neuron in spinal cord
Third site of fatigue	: Neuromuscular junction
Fourth site of fatigue	: Muscle.

58. Mention the order of site of fatigue in frog's muscle nerve preparation.

First site of fatigue	: Neuromuscular junction
Second site of fatigue	: Muscle-nerve preparation.

59. How to prove that the neuromuscular junction is the first site of fatigue in frog's muscle nerve preparation?
In the isolated muscle nerve preparation, nerve is stimulated continuously and the curves are recorded till the fatigue occurs, i.e. till the muscle fails to respond to the stimulus. Then, immediately the muscle is stimulated directly. A response is noticed in the form of curve. This shows that the muscle is not yet fatigued. The nerve cannot be fatigued. So, the site where fatigue must have occurred is the neuromuscular junction.

60. Is fatigue a reversible or irreversible phenomenon?
Fatigue is a reversible phenomenon.

61. What are the causes for recovery from fatigue?
i. Removal of metabolites
ii. Formation of acetylcholine at the neuromuscular junction
iii. Re-establishment of normal polarized state of the muscle
iv. Availability of nutrients
v. Availability of oxygen.

62. What is tetanus?
Tetanus is the sustained contraction of muscle due to repeated stimuli.

63. What is clonus?
incomplete tetanus is called clonus. When the frequency of stimuli is not sufficient to cause tetanus, the fusion of contraction is not complete. This is known as clonus.

64. What is the frequency of stimuli to cause tetanus and clonus?
Frog muscle:
Frequency of stimuli to cause tetanus = 40/sec
Frequency of stimuli to cause clonus = 35/sec
Human muscle:
Frequency of stimuli to cause tetanus = 60/sec
Frequency of stimuli to cause clonus = 55/sec

65. What is physiological tetanus and what pathological tetanus?
Physiological tetanus is the sustained contraction of muscle due to repeated stimuli.
Pathological tetanus is a disease caused by bacillus Clostridium tetani. It affects the nervous system and its common features are muscle spasm and paralysis.

66. What are the effects of pathological tetanus?
Pathological tetanus affects the nervous system and its common features are muscle spasm and paralysis.

67. What lockjaw disease?
It is the locking of jaw due to tightening (spasm) of jaw muscles. It is the first appearing symptom of pathological tetanus.

68. What is the effect of moderate increase in temperature on the muscle? What are the causes for the effect?
Moderate increase in temperature to about 30 to 40° C, increases the force of contraction and decreases all the periods, i.e. the activity is accelerated.
Causes:
i. Increase in excitability of the muscle
ii. Acceleration of chemical processes
iii. Decrease in the viscosity of the muscle.

69. What is the effect of decrease in temperature on the muscle? What are the causes for the effect?
Decrease in temperature to about 10° C, reduces the force of contraction and increases all the periods, i.e. the activity is slowed down.
Causes:
i. Decrease in excitability of the muscle
ii. Slowness of the chemical processes
iii. Increase in the viscosity of the muscle.

70. What is the effect of very high temperature on the muscle?
Heat rigor occurs when the temperature increases above 60° C.

71. What is heat rigor? What is its cause?
Stiffening and shortening of the muscle fibers because of high temperature is called heat rigor. It is due to the coagulation of muscle proteins.

72. Is heat rigor reversible?
Heat rigor is not reversible.

73. What is cold rigor? Is it reversible?
Stiffening and shortening of the muscle fibers due to extreme cold is called cold rigor and it is reversible.

74. What is calcium rigor? Is it reversible?
Rigor due to increased calcium content is known as calcium rigor. It is reversible.

75. What is rigor mortis? What is the cause for it?
Rigidity i.e. the stiffness of muscles and joints that develops after death is called rigor mortis.
Cause: After death there is loss of ATP. Relaxation cannot occur because of lack of ATP and that is the cause of rigor mortis.

76. What is the medicolegal importance of rigor mortis?
Rigor mortis is used to determine the time of death.

77. What is afterload? Give an example.
Afterload is the load, that acts on the muscle after the beginning of the muscular contraction.
Example: Lifting any object from the ground.

78. What is free load? Give an example.
Free load or fore load is the load which acts on the muscle freely even before the onset of contraction of the muscle.
Example: Filling water from a tap by holding the bucket in hand.

79. State whether the muscle works better in after loaded condition or in free loaded condition. Why?
Muscle works better in free loaded condition than in the after loaded condition. Because, in free loaded condition the initial length of the muscle fibers increases even before the onset of muscular contraction. It is according to Frank Starling's law.
And according to Frank Starling's law, the force of contraction of muscle is directly proportional to initial length of the muscle fiber within physiological limits.

80. What is Frank Starling's law?
Frank Starling's law states that the force of contraction of muscle is directly proportional to initial length of the muscle fiber within physiological limits.

81. What is optimum load?
Optimum load is the load at which the work done by the muscle is maximum.

82. Define passive tension, total tension and active tension in skeletal muscle.
Passive tension: Tension developed in muscle during resting condition.
Total tension: Tension developed during contraction of the muscle.
Active tension: Difference between passive tension and total tension at a particular length of the muscle.

83. What is length-duration curve or length-force curve?
It is the curve that shows the relationship between length of the muscle fibers and the tension developed by the muscle.

84. What is refractory period?
Refractory period is the period at which the muscle does not show any response to a stimulus.

85. What are the types of refractory period?
i. Absolute refractory period: Period during which the muscle does not show any response at all, whatever may be the strength of stimulus.
ii. Relative refractory period: Period during which the muscle shows some response if the strength of stimulus is increased to maximum.

86. What is the duration of absolute and relative refractory periods in skeletal muscle?
Absolute refractory period extends for 0.005 sec, i.e. during the first half of latent period.
Relative refractory period extends for 0.005 sec, i.e. during the second half of latent period.
Thus, the duration of refractory period in skeletal muscle is 0.01 sec.

87. What is the duration of absolute and relative refractory periods in cardiac muscle? Absolute refractory period is 0.27 sec, i.e. it extends throughout contraction period.
Relative refractory period is 0.25 sec, i.e. it extends during the first half of relaxation period. Thus, totally the refractory period in cardiac muscle extends for about 0.52 sec. It is very long compared to that of skeletal muscle.

88. What is the significance of long refractory period in cardiac muscle?
Because of long refractory period, fatigue, tetanus and complete summation cannot be produced in cardiac muscle.

89. What is muscle tone?
Muscle fibers always maintain a state of slight contraction with certain degree of vigor and tension. This is known as muscle tone or tonus.

90. How is the tone maintained in skeletal and cardiac muscle?
Skeletal muscle: Maintenance of tone is neurogenic and it is under the influence of gamma motor neuron system.
Cardiac muscle: Maintenance of tone is purely myogenic and it is by the muscle itself.

91. Name the abnormalities of muscle tone.
i. Hypertonia
ii. Hypotonia
iii. Myotonia.

92. Name the changes taking place during muscular contraction.
i. Electrical changes
ii. Physical changes
iii. Histological (molecular) changes
iv. Chemical changes
v. Thermal changes.

93. What is resting membrane potential (RMP)?
Resting membrane potential is defined as the electrical potential difference (voltage) across the cell membrane between inside and outside of the cell under resting conditions is known as RMP. It is negative inside and positive outside.

94. What is polarized state of a cell?
Resting membrane potential is otherwise called polarized state.

95. What are the mechanisms involved in the ionic basis of RMP?
Two transport mechanisms are involved in the ionic basis of RMP.
i. Sodium–Potassium pump
ii. Selective permeability of the cell membrane.

96. How much is the RMP in neuron and different types of muscles?

Neuron	: – 70 mV
Skeletal muscle	: – 90 mV
Cardiac muscle	: – 85 to – 95 mV
Smooth muscle	: – 50 to – 95 mV

97. Define action potential.
Action potential is defined as a series of electrical changes that occur in the membrane potential when the muscle or nerve is stimulated.

98. What are the properties of action potential?
Action potential:
i. Is propagative
ii. Is biphasic
iii. Obeys all or non law
iv. Summation is not possible
v. Shows refractory period.

99. What are the phases of action potential?
i. Depolarization
ii. Repolarization.

100. What is depolarization?
Depolarization is the initial phase of action potential in which inside of the cell (muscle) becomes positive and outside becomes negative. That is polarized state (RMP) is abolished resulting in depolarization.

101. What is the cause for depolarization?
Depolarization is due to opening of sodium channels and rush of sodium ions into the cell.

102. Why the depolarization is short lived?
Because of the rapid inactivation and closure of sodium channels.

103. What is repolarization?
Repolarization is second phase of action potential in which the cell (muscle) reverses back to polarized state (RMP). That is the inside of cell becomes negative and outside becomes positive.

104. What is the cause for repolarization?
Repolarization is due to opening of potassium channels and efflux of potassium ions from inside to outside the cell.

105. What is firing level?
When the cell is stimulated, depolarization starts slowly. After the initial slow depolarization up to – 15 mV, the rate of depolarization increases suddenly. The point at which the rate of depolarization increases suddenly is known as firing level.

106. What is spike potential?
During action potential, the rapid depolarization and rapid repolarization are together called spike potential.

107. What is after depolarization? What is the cause for it?
After rapid repolarization, a slow repolarization takes place and this is known as after depolarization or negative after potential. It is due to decrease in the rate of potassium efflux.

108. What is after hyperpolarization?
More negativity in a cell than normal level during resting membrane is called hyperpolarization.

109. What is after hyperpolarization? What is the cause for it?
When repolarization occurs, it does not stop at the level of resting membrane potential but goes beyond that level causing more negativity inside the cell. This is known as after hyperpolarization or positive after potential. Unlike sodium channels, the potassium channels remain opened for a longer duration allowing large number of potassium ions to move out of the cell. So, the interior of the cell becomes more negative than the resting level.

110. Define different types of action potential.
i. Monophasic action potential
It is the series of electrical changes occurring in a single phase when a muscle or a nerve is stimulated. It is characterized by either positive deflection or negative deflection.
ii. Biphasic action potential
It is the series of electrical changes occurring in two phases when a muscle or a nerve is stimulated. It is characterized by both positive and negative deflections.
iii. Compound action potential
It is the algebraic summation of all the action potentials produced by all fibers of a nerve.

111. What is graded potential, graded membrane potential or graded depolarization)?
Graded potential is a mild local change in the membrane potential that develops in receptor, synapse or neuromuscular junction when stimulated. It is characterized by mild depolarization or hyperpolarization.

112. What are the properties of graded potential?
Graded potential:
i. Is non propagative
ii. Is monophasic
iii. Does not obey all or non law
iv. Summation is possible
v. Has no refractory period.

113. What is patch clamp technique?
Patch clamp technique is a method to measure the ionic currents across the biological membranes.

114. What is actomyosin complex? How is it formed?
Actomyosin complex is the complex of actin and myosin filaments that constitute the muscle fibers and responsible for contraction of muscle. It is formed by gliding of actin filaments over myosin filaments during muscular contraction.

115. What is the molecular basis of muscular contraction?
When muscle is stimulated, action potential develops leading to the development of excitation contraction coupling and formation of actomyosin complex. This makes the actin filaments to slide over the myosin filaments leading to the contraction of the muscle.

116. What is excitation-contraction coupling? What is responsible for it?
Excitation-contraction coupling is a process that occurs in between the excitation and the contraction of the muscle. Calcium is responsible for it.

117. What is sliding theory? What are the other names for it?
Sliding theory explains the mechanism involved in the sliding of actin filaments over the myosin filaments during the muscular contraction. Its other names are ratchet theory and walk along theory.

118. What is power stroke?
Power stroke is the tilting of the head of myosin towards the arm and dragging the active filament along with it.

119. What are the changes taking place in the sarcomere during contraction of muscle?
i. Length of sarcomere decreases and 'Z' limes come close
ii. Length of 'I' band reduces because of overlapping of actin filaments from opposite ends
iii. 'H' zone disappears

iv. Length of 'A' band, actin filaments and myosin filaments remains same.

120. How does the relaxation of muscle take place?
After contraction, the calcium ions are actively pumped back into the sarcotubular reticulum from the sarcoplasm. Decreased calcium content in sarcoplasm leads to detachment of calcium ions from troponin. This causes release of myosin from actin and the relaxation of muscle occurs.

121. What are the chemical changes taking place during muscular contraction?
i. Glycolysis and liberation of energy
ii. Changes in pH.

122. What are the sources of energy for muscular contraction?
The energy for muscular contraction is obtained by the breakdown of adenosine triphosphate (ATP) and resynthesis of ATP from creatine phosphate and glycolytic pathway.

123. What is glycolytic pathway or Embden–Meyerhof pathway? How many molecules of ATP are formed in this pathway?
Breakdown of glycogen into pyruvic acid is called glycolytic pathway or Embden–Meyerhof pathway. Two molecules of ATP are formed in this pathway.

124. Amongst the aerobic glycolysis and anaerobic glycolysis, which one is better and why?
Aerobic glycolysis is better because greater amount of energy is liberated during this process.

125. How many molecules of ATP are formed during carbohydrate metabolism?
Total of 38 molecules of ATP are formed during carbohydrate metabolism

During glycolysis	: 2 molecules of ATP
During Krebs cycle	: 2 molecules of ATP
By utilization of hydrogen	: 34 molecules of ATP

126. Explain the changes in pH of the muscle during contraction.
In resting condition : Muscle is alkaline with a pH of 7.3
During onset of contraction : Muscle becomes acidic due to break down of ATP
During later part of contraction : Muscle becomes alkaline due to resynthesis of ATP from creatine phosphate.
At the end of contraction : Once again it becomes acidic due to the formation of pyruvic acid and lactic acid.

127. Name the different stages of heat production during muscular contraction.
Heat is produced in three stages during muscular contraction,
i. Resting heat
ii. Initial heat
iii. Recovery heat.

128. What is neuromuscular junction?
Neuromuscular junction is the junction between the terminal branch of nerve fiber and muscle fiber.

129. What are the parts of neuromuscular junction?
i. Axon terminal with motor end plate
ii. Presynaptic membrane
iii. Synaptic cleft
iv. Postsynaptic membrane
v. Subneural clefts.

130. What is motor endplate?
Motor endplate in a neuromuscular junction is the terminal portion axon near the muscle fiber. it loses the myelin sheath and expanded like a bulb.

131. What is synaptic cleft?
Synaptic cleft is the space between presynaptic and postsynaptic membranes of a synapse.

132. What are the important structures present in axon terminal?
Mitochondria and synaptic vesicles which contain neurotransmitter.

133. What is the neurotransmitter secreted in neuromuscular junction?
Acetylcholine.

134. Where is acetylcholinesterase present in neuromuscular junction? What is its action?
Acetylcholinesterase is present in the basal lamina of synaptic cleft in the neuromuscular junction. It destroys acetylcholine.

135. Name the important events taking place during neuromuscular transmission.
i. Release of acetylcholine.
ii. Action of acetylcholine
iii. Development of end plate potential
iv. Destruction of acetylcholine.

136. Which ion is responsible for release of acetylcholine during neuromuscular transmission?
Calcium

137. What is end plate potential?
End plate potential is the change in electrical potential in neuromuscular junction. It is a slight depolarization up to – 60 mV.

138. What are the differences between end plate potential and action potential?
End plate potential differs from action potential by its properties viz.
i. It is non-propagative
ii. It is monophasic
iii. It does not obey all or none law.

139. What is the significance of end plate potential?
It causes development of action potential in the muscle fiber.

140. What is miniature end plate potential?
Miniature end plate potential is a weak end plate potential up to – 0.5 mV developed by release of a small quantity of acetylcholine is released from axon terminal.

141. What are neuromuscular blockers? Give examples.
Neuromuscular blockers are the drugs which prevent transmission of impulses from nerve fiber to muscle fiber through neuromuscular junction.
Examples: Bungarotoxin, succinylcholine, carbamylcholine and botulinum toxin.

142. Name some drugs, which can stimulate the neuromuscular junction.
Neostigmine, physostigmine and di-isopropyl fluorophosphate.

143. What is motor unit?
Single motor neuron with its axon terminals and the muscle fibers innervated by it are together called motor unit.

144. What Eaton-Lambert syndrome?
It is also an autoimmune disorder of neuromuscular junction. It is caused by antibodies to calcium channels in axon terminal.

145. What are the smooth muscles?
Smooth muscles are non-striated involuntary muscles, which form the contractile elements of various organs in the body.

146. Name the types of smooth muscle fibers.
i. Multiunit smooth muscle fibers
ii. Visceral smooth muscle fibers.

147. Name the muscle proteins present in the smooth muscles.
Actin, myosin, and tropomyosin. Troponin or troponin like substance is absent in smooth muscles.

148. Name the substance that initiates the contraction of smooth muscles.
Calmodulin initiates the contraction of smooth muscle along with calcium.

149. What are the differences between the electrical activity of smooth muscle and skeletal muscle?
i. In smooth muscle, the resting membrane potential is low ranging between – 50 and – 70 mV whereas in skeletal muscle it is – 90 mV.
ii. Three types of action potential occur in smooth muscle (spike potential, spike potential with slow wave rhythm and action potential with plateau). But in skeletal muscle only one type of action potential occurs.

150. What is tonus or tone in smooth muscles? What is it due to?
Tonus or tone is a state of partial contraction maintained by the smooth muscles of some visceral organs. It is due to the tonic contraction of the smooth muscle without action potential.

151. What is latch-bridge mechanism? What is its significance?
It is the attachment of phosphorylated myosin to actin molecule for a longer period during smooth muscle contraction. It is responsible for sustained contraction of smooth muscle with expenditure of minimum energy.

152. What is plasticity of smooth muscle?
Plasticity is the adaptability of smooth muscle to a wide range of lengths when it is stretched.

153. What is the difference between the nerve supply of smooth muscles and skeletal muscles?
Smooth muscles are supplied by autonomic nerve fibers (sympathetic and parasympathetic fibers) whereas the skeletal muscles are supplied by somatic nerve fibers.

154. Define electromyogram (EMG)? What is its use?
Electromyogram (EMG) is the record of the electrical activity of the muscle. It is useful in the diagnosis of neuromuscular diseases.

155. What is myopathy?
Myopathy is a neuromuscular disease in which progressive dysfunction of muscle fiber occurs leading to muscular weakness.

156. Name the disorders of muscles.
i. Muscular dystrophy
ii. Diseases involving muscle tone: Hypertonia, hypotonia and myotonia
iii. Fibrillation and denervation hypersensitivity
iv. Myasthenia gravis
v. Lambert-Eaton syndrome
vi. McArdle's disease
vii. Mitochondrial myopathy
viii. Nemaline myopathy.

157. What is hypertonia? When does it occur?
Hypertonia is a muscular disease characterized by increased muscle tone and inability of the muscle to stretch. It occurs in upper motor lesion.

158. What is hypotonia? When does it occur?
Hypotonia is a muscular disease characterized by decreased muscle tone. It occurs in lower motor lesion.

159. What is myotonia? What is the cause for it?
Myotonia is a congenital disease characterized continuous contraction of muscle with slow relaxation even after cessation of voluntary act. It is caused by mutation of genes of channel proteins in sarcolemma.

160. What is myasthenia gravis?
Myasthenia gravis is an autoimmune disorder of neuromuscular junction characterized by extreme weakness of muscles due to inability of neuromuscular junction to transmit the impulses from nerve to muscle. It is caused by antibodies against cholinergic receptors.

161. What is the cause for myasthenia gravis?
Myasthenia gravis is caused by development of antibodies against its own acetylcholine receptors. Antibodies destroy the acetylcholine receptors. So even if the acetylcholine is released, it cannot act because of the destruction of the receptors. So the neuromuscular transmission is affected leading to weakness of the muscles.

162. What are the symptoms of myasthenia gravis?
Initially, the muscular contraction is very weak and slow. If patient attempts repeated muscular contractions, fatigue occurs. In severe conditions there is paralysis of muscles. Death occurs due to paralysis of respiratory muscles.

163. What is strength of the muscle?
Maximum force that can be developed during contraction is known as strength of the muscle.

164. What is power of the muscle?
Amount of work done by the muscle in the given unit of time is called power of the muscle.

165. What is gradation of muscle power?
Gradation muscular activity refers to gradual increase in force generated by muscles during any muscular activity.

166. Name some factors influencing gradation of muscle power.
i. Rate of recruitment of motor units.
ii. Strength of stimulus.
iii. Rate of action potential.
iv. Temperature.
v. Length of muscle fibers.
vi. Fatigue.

167. What is endurance of the muscle?
Capacity of the muscle to withstand the power produced during activity is known as endurance.

Section 4 Digestive System

1. **Define digestion.**
   Digestion is the process by which food is broken down into simple chemical substances that are absorbed and used as nutrients by the body.

2. **What are the functions of digestive system?**
   i. Ingestion or consumption of food substances.
   ii. Breaking them into small particles.
   iii. Transport of small particles to different areas of the digestive tract.
   iv. Secretion of necessary enzymes and other substances for digestion.
   v. Digestion of the food particles.
   vi. Absorption of the digestive products (nutrients).
   vii. Removal of unwanted substances from the body.

3. **Name the primary organs of digestive system or Gastrointestinal (GI) tract.**
   i. Mouth
   ii. Pharynx
   iii. Esophagus
   iv. Stomach
   v. Small intestine
   vi. Large intestine.

4. **Name the accessory organs of GI tract.**
   i. Teeth
   ii. Tongue
   iii. Salivary glands
   iv. Exocrine part of pancreas
   v. Liver
   vi. Gallbladder.

5. **Name different layers of GI tract from outside to inside.**
   i. Serous coat
   ii. Muscular coat
   iii. Submucus coat
   iv. Mucus coat.

6. **What are the nerves supplying GI tract?**
   GI tract is supplied by two types of nerve fibers:
   i. Intrinsic nerves:
      a. Auerbach's or myenteric nerve plexus present in the muscular layer
      b. Meissner's plexus or submucus nerve plexus situated in between the muscular and submucus layers.
   ii. Extrinsic nerves:
      a. Sympathetic nerve fibers
      b. Parasympathetic nerve fibers.

7. **What are the functions of sympathetic nerve fibers suppling GI tract?**
   Sympathetic nerve fibers inhibit the movements and decrease the secretions of GI tract by secreting the neurotransmitter noradrenaline. Sympathetic fibers also cause constriction of sphincters.

8. **What are the functions of parasympathetic nerve fibers suppling GI tract?**
   Parasympathetic nerve fibers accelerate movements and secretions of GI tract by secreting the neurotransmitter acetylcholine.

9. **What are the functions of mouth?**
   i. Mastication or chewing and mixing the food with saliva
   ii. Appreciation of taste of the food
   iii. Coordination with other organs like larynx, pharynx, lips and tongue during speech
   iv. Role in appearance of face along with jaws, lips and teeth
   v. Role in facial expressions along with lips and cheeks
   vi. Role in breathing when nasal breathing is inadequate.

10. **Name the major salivary glands in human beings.**
    i. Parotid glands
    ii. Submandibular or submaxillary glands
    iii. Sublingual glands.

11. **What are the properties of saliva?**

Volume	: 1000 to 1500 mL/day
Reaction and pH	: Slightly acidic with a pH of 6.35 to 6.85
Specific gravity	: 1.002 to 1.012
Tonicity	: Hypotonic to plasma

12. **Name the organic substances present in saliva.**
    i. Salivary enzymes:
       a. Amylase (ptyalin), maltase, lingual lipase, lysozyme, phosphatase, carbonic anhydrase and kallikrein.
    ii. Other organic substances:
       a. Proteins: Mucin and albumin
       b. Blood group antigens
       c. Free amino acids
       d. Non-protein nitrogenous substances: Urea, uric acid, creatinine, xanthine and hypoxanthine.

13. **Name the inorganic substances present in saliva.**
    Sodium, potassium, calcium, bicarbonates, bromide, chloride, fluoride and phosphate.

14. **Enumerate the functions of saliva.**
    Saliva:
    i. Prepares the food for swallowing
    ii. Helps in appreciation of taste
    iii. Helps in the digestion of cooked starch
    iv. Keeps the mouth clean and protects it from bacterial growth
    v. Helps in speech
    vi. Excretes certain substances like heavy metals
    vii. Helps in regulation of body temperature in animals but not in humans
    viii. Helps in regulation of water balance via thirst mechanism.

15. **Name the enzymes present in saliva and mention their functions.**
    i. Salivary amylase: Converts starch into maltose
    ii. Maltase: Converts maltose into glucose

iii. Lingual lipase: Converts triglycerides of milk fat into fatty acids and diacylglycerol.

16. What are the nerves supplying the salivary gland?
Salivary glands are supplied by parasympathetic and sympathetic nerves.
Parasympathetic nerves to parotid gland: Arise from the inferior salivatory nucleus and reach the parotid gland by passing through glassopharyngeal nerve.
Parasympathetic nerves to submandibular and sublingual glands: Arise from the superior salivatory nucleus and reach the glands by passing through the facial nerve.
Sympathetic nerves to the salivary glands: Arise from lateral horns of first and second thoracic segments in spinal cord and reach the glands through the postganglionic fibers of superior cervical ganglion.

17. What are the effects of stimulation of parasympathetic nerve fibers to salivary glands?
Vasodilatation and increase in secretion of watery saliva.

18. What are the effects of stimulation of sympathetic nerve fibers to salivary glands?
Vasoconstriction and decrease in secretion of saliva that is thick and rich in mucus.

19. How salivary secretion is regulated?
Salivary secretion is regulated by reflex phenomenon in which both conditioned and unconditioned reflexes are involved.

20. Name some conditions when hyposalivation occurs.
Temporary hyposalivation: Occurs in emotional conditions like fear, fever and dehydration.
Permanent hyposalivation: Occurs in sialolithiasis, congenital absence of salivary glands and Bell's palsy.

21. What is Bell's palsy?
Bell's palsy is the paralysis of facial nerve.

22. What is xerostomia?
Xerostomia is the dryness of the mouth due to hyposalivation or absence of salivary secretion (aptyalism).

23. Name some conditions when hypersalivation occurs.
i. Decay of tooth or neoplasm of mouth or tongue
ii. Diseases of esophagus, stomach and intestine
iii. Neurological disorders like cerebral palsy and mental retardation
iv. Parkinsonism
v. Psychological and psychiatric conditions
vi. Nausea and vomiting.

24. What is drooling?
Drooling is the uncontrolled flow of saliva outside the mouth due to excess production of saliva and inability to retain it within the mouth.

25. What is chorda tympani syndrome?
It is the condition characterized by sweating while eating.

26. What is Sjögren's syndrome?
Sjögren's syndrome is an autoimmune disorder characterized by dryness of mouth due to lack of saliva.

27. Name the parts of stomach.
i. Cardiac region
ii. Fundus
iii. Body or corpus
iv. Pyloric region.

28. What is cardiac sphincter?
It is the circular muscle that surrounds and guards the opening of esophagus into cardiac region (upper part) of stomach. It opens only towards stomach.

29. What is pyloric sphincter?
It is the circular muscle that surrounds and guards the opening of pyloric canal (lower part) of stomach into duodenum. It opens only towards duodenum

30. What are the gastric glands? Mention the types of gastric glands.
Gastric glands are the exocrine glands of the stomach, which secrete gastric juice.
Types of gastric glands:
i. Fundic glands situated in the body and fundus
ii. Pyloric glands situated in pyloric part
iii. Cardiac glands situated in the cardiac region.

31. Name the substances secreted by different cells of gastric gland.
i. Chief or pepsinogen cells: Enzymes pepsinogen, rennin, lipase, gelatinase and urase
ii. Parietal or oxyntic cells: Hydrochloric acid and intrinsic factor of Castle
iii. Mucus neck cells: Mucin
iv. G cells: Gastrin
v. Enterochromaffin (EC) or Kulchitsky cells: Serotonin
vi. Enterochromaffin-like (ECL) cells: Histamine.

32. What are the functions of stomach?
i. Mechanical functions: Storage function and formation of chyme
ii. Digestive function
iii. Protective function
iv. Hemopoietic function
v. Excretory function.

33. What are the properties of gastric juice?

Volume	: 1200 mL/day
Reaction and pH	: Highly acidic with a pH of 0.9 to 1.2
Specific gravity	: 1.002 to 1.004.

34. What is the cause for the high acidy of gastric juice?
It is because of hydrochloric acid.

35. Name the organic substances present in gastric juice.
i. Enzymes: Pepsin, rennin, gastric lipase, gelatinase and urase
ii. Other organic substances: Mucus and intrinsic factor of Castle.

36. What are the functions of gastric mucus?
Mucus:
i. Protects the stomach wall from irritation or mechanical injury
ii. Prevents the digestive action of pepsin on the wall of the stomach
iii. Protects the gastric mucosa from hydrochloric acid of gastric juice.

37. Briefly explain the secretion of hydrochloric acid in stomach.
Hydrochloric acid is formed in the canaliculus of the parietal cells of the gastric glands. In the parietal cell, carbon dioxide combines with water to form carbonic acid. Carbonic acid dissociates into hydrogen and bicarbonate ions immediately. Whole reaction is accelerated by the enzyme carbonic anhydrase. Bicarbonate ion diffuses from the cell to the extracellular fluid in exchange for chloride ions. Hydrogen and chloride ions move from the cell into the canaliculus and combine to form hydrochloric acid.

38. What are the functions of gastric juice?
i. Digestion of proteins and lipids
ii. Hematopoietic function: Intrinsic factor helps in erythropoiesis

iii. Protective function: Mucus protects the wall of stomach from proteolytic enzymes and hydrochloric acid
iv. Antibacterial action: Hydrochloric acid destroys the microorganisms entering the gastrointestinal tract through diet
v. Activator function: Hydrochloric acid activates pepsinogen into pepsin. It also provides acid medium for actions of hormones

39. Name the enzymes present in gastric juice and mention their functions.
i. Pepsin: Converts proteins into proteoses, peptones and polypeptides. It also causes curdling and digestion of milk (casein
ii. Gastric lipase: Converts triglycerides of butter into fatty acids and glycerides
iii. Gastric amylase: Converts starch into dextrin and maltose (negligible action)
iv. Rennin: Curdles milk (present only in animals)

40. How is pepsinogen converted into pepsin?
Pepsinogen is converted into pepsin by acid medium provided by hydrochloric acid.

41. What is rennin?
Rennin is a milk curdling enzyme present in animals.

42. What is Devenport theory?
According to Davenport theory, hydrochloric acid secretion is an active process that takes place in the canaliculi of parietal cells in gastric glands.

43. Name the factors regulating the secretion of hydrochloric acid in stomach.
Gastrin, histamine and vagal stimulation increase the secretion of hydrochloric acid. Secretin, gastric inhibitory polypeptide and peptide YY inhibit the acid secretion.

44. Briefly explain Pavlov pouch. What is its use?
It is a small part of stomach that is incompletely separated from the main portion and made into a bag like pouch. Russian scientist Pavlov devised it. This pouch is fully innervated with both sympathetic and parasympathetic nerve supply intact.

Pavlov pouch is useful to study the hormonal and nervous regulation of gastric juice.

45. What is Heidenhain pouch? What is its use?
It is a modified Pavlov's pouch without parasympathetic nerve supply. Its blood vessels are intact. It has only sympathetic nerve supply.

Heidenhain pouch is useful to study the hormonal regulation of gastric secretion.

46. What is Bickel pouch? What is its use?
It is a modified Pavlov's pouch. It is totally denervated.

Bickel pouch is useful to study the hormonal regulation of gastric secretion.

47. What is Farrel and Ivy pouch? What is its use?
It is modified Pavlov pouch. The pouch is completely separated from the main portion of the stomach and transplanted in subcutaneous tissue of abdominal wall. It is totally denervated.

Farrel and Ivy is useful to study the hormonal regulation of gastric secretion.

48. What is sham feeding? What is its use?
Sham feeding means false feeding, i.e. the animal eats the food but the food does not reach the stomach. This is done by cutting the esophagus transversely and the cut ends are brought out by making a hole in the neck. So, when the animal swallows the food, it comes out.

Sham feeding is useful to demonstrate the unconditioned reflex during cephalic phase of gastric secretion.

49. Name the phases of gastric secretion.
i. Cephalic phase
ii. Gastric phase
iii. Intestinal phase.

50. What is cephalic phase of gastric secretion?
Cephalic phase of gastric secretion is the secretion of gastric juice by the stimuli arising from head region (cephalus) such as sight, smell or thought of food or the presence of food in the mouth.

51. What are the reflex actions of cephalic phase of gastric secretion?
i. Unconditioned reflex: The inborn reflex when food is placed in the mouth, salivary secretion is induced. Simultaneously, gastric secretion also occurs.
ii. Conditioned reflex: It is the reflex response acquired by previous experience. Presence of food in the mouth is not necessary to elicit this reflex. Sight, smell, hearing or thought of food, which induce salivary secretion induce gastric secretion also.

52. What is appetite juice?
Gastric juice secreted during cephalic phase is called appetite juice.

53. What are the experimental evidences to prove cephalic phase of gastric secretion?
Unconditioned reflex: Proved by sham feeding with Pavlov pouch
Conditioned reflex: Proved by Pavlov pouch and bell dog experiment.

54. What is gastric phase of gastric secretion.
Gastric phase of gastric secretion is the secretion of gastric juice when food enters the stomach.

55. What are the mechanisms involved in gastric phase of gastric secretion.
Nervous control: Operated through local myenteric reflex and vagovagal reflex.
Hormonal control: Operated through secretion of gastrin.

56. What is local myenteric reflex?
It is the reflex elicited by stimulation of myenteric nerve plexus in stomach wall. After entering stomach, the food particles stimulate the local nerve plexus present in the wall of the stomach. These nerve fibers release acetylcholine, which stimulates gastric glands to secrete a large quantity of gastric juice. Acetylcholine also stimulates G cells to secrete gastrin.

57. What is vagovagal reflex? Why is it called vagovagal reflex.
Vagovagal reflex is the reflex in which entrance of bolus into the stomach causes secretion of gastric juice. It involves both afferent and efferent vagal fibers. Since, both afferent and efferent impulses pass through vagus, this reflex is called vagovagal reflex.

58. What is gastrin? What is its action?
Gastrin is the G.I hormone secreted by the G cells present in pyloric glands of stomach. It is also secreted in mucosa of upper small intestine and islets of Langerhans in pancreas (of fetus).

Gastrin stimulates secretion of pepsinogen and hydrochloric acid by gastric glands.

59. What are the experimental evidences to prove gastric phase of gastric secretion?
Nervous mechanism: Proved by Pavlov pouch.

Hormonal mechanism: Proved by Heidenhain pouch, Bickel pouch and Farrel and Ivy pouch.

60. Briefly explain intestinal phase of gastric secretion.
When chyme enters the intestine, initially, the gastric secretion increases but later it stops. Intestinal phase of gastric secretion is regulated by nervous and hormonal control.

61. What are the mechanisms involved in intestinal phase of gastric secretion.
Initial stage of intestinal phase: Initial secretion of gastric secretion due to gastrin.

Latter stage of intestinal phase: Inhibition of gastric secretion in later phase is due to enterogastric reflex and GI hormones like secretin, cholecystokinin, gastric inhibitory polypeptide (GIP), vasoactive intestinal polypeptide (VIP), polypeptide YY and somatostatin.

62. What is enterogastric reflex?
It is the reflex which inhibits the gastric secretion and motility due to the distention of intestinal mucosa by chyme or chemical or osmotic irritation of intestinal mucosa by chemical substances in the chyme. It is mediated by myenteric nerve (Auerbach) plexus and vagus.

63. What are the effects of alcohol and caffeine on gastric secretion?
Alcohol and caffeine stimulate gastric secretion.

64. What are the experimental evidences to prove intestinal phase of gastric secretion?
Intestinal phase is proved by Bickel pouch and Farrel and Ivy pouch.

65. How is gastric juice collected in human beings?
By using Ryle's tube.

66. How is gastric juice collected in human beings?
By using Ryle's tube.

67. What is gastric analysis? What are its uses?
Gastric analysis is analysis of gastric juice. It is done for diagnosis of peptic ulcer and other disorders of stomach.

68. What are the methods of gastric analysis?
i. Measurement of peptic activity.
ii. Measurement of gastric acidity: Total acid, free acid (hydrochloric acid) and combined acid.

69. What is fractional test meal (FTM)?
It is one of the methods of gastric analysis. After overnight fasting, a sample of gastric juice is collected. Then a test meal is given and the samples of gastric juice are collected at the interval of 15 minutes for about 2½ hours. All the samples are analyzed for peptic activity and gastric acidity.

70. What is gastritis? What are its types?
Inflammation of gastric mucosa is called gastritis. It may be acute or chronic.

Acute gastritis: It is characterized by inflammation of superficial layers of mucus membrane and infiltration with leukocytes, mostly neutrophils.

Chronic gastritis: It involves inflammation of even the deeper layers and infiltration with more lymphocytes. It results in the atrophy of the gastric mucosa, with loss of chief cells and parietal cells of glands. Therefore, the secretion of gastric juice decreases.

71. List the causes of gastritis.
i. Infection with bacterium *Helicobacter pylori*
ii. Excess consumption of alcohol
iii. Excess administration of Aspirin and other non-steroidal anti-inflammatory drugs (NSAIDs)
iv. Trauma by nasogastric tubes
v. Repeated exposure to radiation (rare)
vi. Autoimmune diseases

72. What is gastric atrophy? What are its causes?
It is the condition in which the muscles of the stomach shrink and become weak. It is caused by chronic gastritis called chronic atrophic gastritis. It is also caused autoimmune gastritis.

73. What is peptic ulcer? What are its causes?
Peptic ulcer is the injury or damage of gastrointestinal mucosa. Causes for peptic ulcer:
i. Increased peptic activity in gastric juice
ii. Hyperacidity of gastric juice
iii. Reduced alkalinity of duodenal content
iv. Decreased mucin content in gastric juice or decreased protective activity in stomach or duodenum
v. Constant physical or emotional stress
vi. Food with excess spices
vii. Smoking
viii. Long term use of nonsteroidal anti-inflammatory drugs like aspirin, ibuprofen, and naproxen
ix. Chronic inflammation due to *Helicobacter pylori.*

74. What is Zollinger-Ellison syndrome?
It is the condition characterized by secretion of excess hydrochloric acid in stomach.

75. Why pancreas is called a dual organ?
Pancreas is called a dual organ because it has two functions, namely endocrine function and exocrine function.

76. What are the basic structures of exocrine part of pancreas?
Alveoli or acini are the basic structures of exocrine part of pancreas.

77. Name the pancreatic duct. How does it open into the intestine?
Pancreatic duct is called Wirsung's duct. It joins the common bile duct and forms ampulla of Vater that opens into the duodenum.

78. What are the properties of pancreatic juice?

Volume	: 500 to 800 mL/day
Reaction and pH	: Highly alkaline with a pH of 8 to 8.3
Specific gravity	: 1.010 to 1.018.

79. What is the cause for high alkalinity of pancreatic juice?
Presence of large quantity of bicarbonate (110 to 150 mEq/L) is responsible for the high alkalinity of pancreatic juice.

80. Name the enzymes present in pancreatic juice.
i. Proteolytic enzymes: Trypsin, chymotrypsin, carboxypeptidases, nuclease, elastase and collagenase
ii. Lipolytic enzymes: Pancreatic lipase, cholesterol ester hydrolase, phospholipases A and B, colipase and bile salt-activated lipase
iii. Amylolytic enzyme: Pancreatic amylase.

81. What are the functions of pancreatic juice?
i. Digestive functions: Digestion of proteins, lipids and carbohydrates
ii. Neutralizing action: Neutralization of acidity of chyme in intestine.

82. How is trypsinogen converted into trypsin?
Trypsinogen is converted into active trypsin by the enzyme enterokinase. Once formed trypsin also converts trypsinogen into trypsin by means of autocatalytic action.

83. What are the actions of trypsin?
i. Digestion of proteins: It converts proteins into proteoses and polypeptides
ii. Curdling of milk: It converts caseinogens in the milk into casein
iii. Acceleration of blood clotting
iv. Activation of other enzymes of pancreatic juice: It converts chymotrypsinogen into chymotrypsin and procarboxypeptidases into carboxypeptidases.

84. What is endopeptidase? Which is the powerful endopeptidase?
Endopeptidase is the enzyme that breaks the interior bonds of protein molecules and converts protein into proteoses and polypeptides. Trypsin is the most powerful endopeptidase.

85. What are the actions of chymotrypsin?
Chymotrypsin:
i. Hydrolyses the proteins into polypeptides
ii. Digests milk.

86. What is the action of carboxypeptidase?
Carboxypeptidase converts polypeptides into amino acids.

87. What is the importance of pancreatic lipase?
Pancreatic lipase is the strongest lipolytic enzyme in the gastrointestinal tract. 80% of the fat is digested by this enzyme. Absence of pancreatic lipase leads to steatorrhea.

88. What is bile salt-activated lipase? What is its action?
Bile salt-activated lipase is the lipolytic enzyme activated by bile salt. It is also called carboxyl ester lipase or cholesterol esterase. It hydrolyses a variety of lipids such as phospholipids, cholesterol esters and triglycerides.

89. How neutralizing action of pancreatic juice is performed? What is its significance?
When acid chyme enters intestine from stomach, pancreatic juice is released into intestine. Presence of large quantity of bicarbonate ions makes the pancreatic juice highly alkaline. This alkaline pancreatic juice neutralizes acidity of chyme in the intestine.

Neutralizing action of pancreatic juice because protects the intestine from destructive action of acid in the chyme.

90. Name the phases of pancreatic secretion.
i. Cephalic phase
ii. Gastric phase
iii. Intestinal phase.

91. Name the hormones, which increase the secretion of pancreatic juice.
Gastrin, secretin and cholecystokinin.

92. What is the effect of secretin on pancreatic juice?
Secretin causes secretion of watery juice which is rich in bicarbonate ions. Volume of pancreatic juice is large.

93. What is the effect of cholecystokinin on pancreatic juice?
Cholecystokinin causes secretion of pancreatic juice which is rich in enzymes. Volume of juice is low.

94. How is pancreatic juice collected in human beings?
By using a multilumen tube.

95. What is steatorrhea?
Steatorrhea is the condition in which large quantity of undigested fat is excreted in feces. It is due to the lack of pancreatic lipase.

96. What is pancreatitis? What are its types?
Inflammation of pancreatic acini is called pancreatitis. It may be acute or chronic.

Acute pancreatitis: It is more severe and it occurs due to heavy alcohol intake or gallstones.
Chronic pancreatitis: It develops due to repeated acute inflammation or chronic damage of pancreas.

97. What are hepatocytes? Explain the arrangement of hepatocytes.
Hepatocytes are liver cells arranged in columns, which form the hepatic plates. Each plate is made up of 2 columns of hepatocytes.

98. What is bile canaliculus?
Space between two columns of hepatocytes is called bile canaliculus.

99. Explain the flow of bile.
Bile is secreted by liver cells and emptied into bile canaliculus. From canaliculus, bile enters the tributary of bile duct. Tributaries of bile duct from canaliculi of neighboring lobules unite to form small bile ducts. These small bile ducts join together and finally form left and right hepatic ducts, which emerge out of liver.

100. What is biliary system or extrahepatic biliary apparatus? How is it formed?
Biliary system or extrahepatic biliary apparatus is formed by gallbladder and extrahepatic bile ducts (bile ducts outside the liver). Right and left hepatic bile ducts which come out of liver join to form common hepatic duct. It unites with the cystic duct from gallbladder to form common bile duct. All these ducts have similar structures.

Common bile duct unites with pancreatic duct to form the common hepatopancreatic duct or ampulla of Vater, which opens into the duodenum.

101. What is sphincter of Oddi? What is its function?
Sphincter of Oddi is the sphincter present at the lower part of common bile duct, before it joins the pancreatic duct. This sphincter is formed by smooth muscle fibers of common bile duct. It is normally kept closed. So, bile secreted from liver enters gallbladder and it is stored there. Upon appropriate stimulation, the sphincter of Oddi opens and allows flow of bile from gallbladder into the intestine.

102. What are portal triads or portal canals in liver? What are the vessels present in each portal triad?
Portal triad or canals are the canals surrounding each hepatic lobule. The triads are lined by perivascular fibrous capsule.
Each portal triad consists of three vessels:
i. A branch of hepatic artery.
ii. A branch of hepatic portal vein.
iii. A tributary of bile duct.

103. What are the sources of blood supply to liver?
Liver has dual blood supply i.e., it receives blood from two sources.
i. Hepatic artery: Arises directly from aorta and supply oxygenated blood to liver
ii. Hepatic portal vein: Formed by superior mesenteric vein and splenic vein. It supplies deoxygenated blood from stomach, intestine, spleen and pancreas.

104. What is the importance of deoxygenated blood flowing through hepatic portal vein?
Deoxygenated blood flowing through hepatic portal vein contains large amount of monosaccharides and amino acids. It also contains bile salts, bilirubin, urobilinogen and GI hormones. However, oxygen content is less in portal blood.

105. What is bile?
Bile is a golden yellow or greenish fluid produced by liver.

106. How is bile stored?
Most of the bile secreted by liver is stored in gallbladder. It is released from gallbladder into intestine whenever it is required.

107. What are the changes that occur in bile when it is stored in gallbladder?
When bile is stored in gallbladder, it undergoes many changes both in quality and quantity such as:
i. Volume is decreased because of absorption of a large amount of water and electrolytes (except calcium and potassium)
ii. Concentration of bile salts, bile pigments, cholesterol, fatty acids and lecithin is increased because of absorption of water and electrolytes
iii. The pH is decreased slightly
iv. Specific gravity is increased
v. Mucin is added to bile

108. What are the properties of bile?

Volume	: 1200 mL/day
Reaction and pH	: Alkaline with pH of 8 to 8.6
Specific gravity	: 1.010 to 1.011.

109. Name the organic substances present in bile.
i. Bile salts
ii. Bile pigments
iii. Cholesterol
iv. Fatty acids
v. Lecithin
vi. Mucin.

110. What are the bile salts?
Bile salts are the sodium and potassium salts of primary bile acids which are conjugated with glycine or taurine. Bile acids are cholic acid and chenodeoxycholic acid.

111. Name the bile acids?
Bile acids are cholic acid and chenodeoxycholic acid.

112. Explain briefly the formation of bile salts.
Primary bile acids, cholic acid and chenodeoxycholic acids are formed in liver and enter the intestine. Due to the bacterial action in intestine, cholic acid is converted into deoxycholic acid and chenodeoxycholic acid is converted into lithocholic acid.

Deoxycholic acid and lithocholic acid are called secondary bile acids. Now, these two acids from intestine enter the liver through enterohepatic circulation. In liver, the secondary bile acids are conjugated with glycine and taurine forming glycocholic acid and taurocholic acid. These two conjugated bile acids combine with sodium or potassium salt to form bile salts.

113. Name the functions of bile salts.
i. Emulsification of fat
ii. Absorption of fats
iii. Choleretic action
iv. Cholagogue action
v. Laxative action
vi. Prevention of gallstone formation.

114. What are the bile pigments?
Bile pigments are bilirubin and biliverdin and these pigments are the excretory products of bile.

115. How are the bile pigments formed?
When senile red blood cells are destroyed in the reticuloendothelial system, hemoglobin is released. It is broken into globin and heme. Heme is split into iron and the pigment biliverdin. Biliverdin is reduced to bilirubin.

116. Explain briefly the circulation of bile pigments.
Bilirubin formed in reticuloendothelial system is released into blood. It is called free bilirubin. Through blood it reaches the liver. There, the free bilirubin is conjugated by glucuronic acid to form conjugated bilirubin. Conjugated bilirubin is excreted through bile into the intestine.

From intestine, 50% of conjugated bilirubin enters the liver via enterohepatic circulation and excreted through bile. Remaining 50% of conjugated bilirubin is converted into urobilinogen. Urobilinogen is excreted through urine as urobilin and through feces as stercobilinogen.

117. What is enterohepatic circulation?
Flow of blood from intestine to liver through portal vein is known as enterohepatic circulation. Bile salts and bile pigments are transported through enterohepatic circulation.

118. Name the functions of bile.
i. Digestive function
ii. Absorptive function
iii. Excretory function
iv. Laxative action
v. Antiseptic action
vi. Choleretic action
vii. Maintenance of pH in GI tract
viii. Prevention of gallstone formation
ix. Lubrication function
x. Cholagogue action.

119. Name the functions of liver.
i. Storage function
ii. Synthetic function
iii. Secretion of bile
iv. Metabolic function
v. Excretory function
vi. Heat production
vii. Hemopoietic function
viii. Hemolytic function
ix. Inactivation of hormones and drugs
x. Defensive and detoxification functions.

120. What are the functions of gallbladder?
i. Storage of bile
ii. Concentration of bile
iii. Reduction of pH of bile
iv. Secretion of mucin
v. Maintenance of pressure in biliary system.

121. What are the differences between liver bile and gallbladder bile?
i. Liver bile is dilute and gallbladder is concentrated
ii. The pH of liver bile (8 to 8.6) is more than the pH in gallbladder bile (7 to 7.6)
iii. Concentration of bile salts, bile pigments, cholesterol, fatty acids and lecithin is less in liver bile and more in gallbladder bile
iv. Mucin is absent in liver bile and present in gallbladder bile
v. Sodium, chloride, and bicarbonate are more in liver bile than in gallbladder bile
vi. Calcium and potassium are less in liver bile than in gallbladder bile.

122. What is jaundice or icterus?
Jaundice or icterus is the yellow pigmentation of the skin, mucous membrane and deeper tissues due to increased bilirubin content in blood.

123. What is the normal bilirubin content in blood and at what level jaundice occurs?
Normal bilirubin content in blood is 0.5 to 1.5 mg%. When it exceeds 2 mg% jaundice occurs.

124. What are direct and indirect bilirubin?
Direct bilirubin is the conjugated bilirubin. It is water soluble.
Indirect bilirubin is the unconjugated bilirubin. It is fat soluble and transported in blood by albumin.

125. What are the common causes of jaundice?
i. Excessive destruction of red blood cells
ii. Liver damage
iii. Obstruction of bile duct

126. What are the types of jaundice?
Jaundice is classified into 3 types depending upon the causes.
i. Prehepatic or hemolytic jaundice : Caused by excess destruction of red blood cells
ii. Hepatic or hepatocellular jaundice : Caused by damage of hepatic cells
iii. Posthepatic or obstructive jaundice : Caused by obstruction of bile duct.

127. What are the causes for prehepatic jaundice?
i. Liver failure
ii. Renal disorder
iii. Hypersplenism
iv. Burns
v. Infections like malaria
vi. Hemoglobin abnormalities like sickle cell anemia or thalassemia
vii. Drugs or chemical substances causing red cell destruction

128. What are the causes for hepatic jaundice?
i. Infection (infective jaundice) by virus resulting in hepatitis (viral hepatitis)
ii. Alcoholic hepatitis
iii. Cirrhosis of liver
iv. Exposure to toxic materials.

129. What are the causes for posthepatic jaundice?
i. Gallstones
ii. Cancer of biliary system or pancreas.

130. What is hepatitis?
Hepatitis is the inflammation of liver characterized by swelling and inadequate functioning of liver. Hepatitis may be acute or chronic. In severe conditions, it may lead to liver failure and death.

131. What is viral hepatitis?
Viral hepatitis is the type of hepatitis caused by viruses. It is caused by two types of viruses, hepatitis A and B.
Hepatitis caused by hepatitis B virus is more common and considered more serious because it may lead to cirrhosis and cancer of liver.

132. What is cirrhosis of liver?
Cirrhosis of liver is the inflammation and damage of parenchyma of liver. It results in degeneration of hepatic cells and dysfunction of liver.

133. What is cholelithiasis?
Formation of gallstone is called cholelithiasis.

134. How is gallstone formed?
Gallstone is formed by the precipitation of cholesterol. Cholesterol in gallbladder bile combines with bile salts and lecithin. Now, cholesterol becomes soluble in water and it is precipitated forming crystals. To these crystals, bile pigments and calcium ions get attached forming gallstones.

135. What are the causes for gallstone formation?
i. Reduction in bile salts and/or lecithin
ii. Excess of cholesterol
iii. Disturbed cholesterol metabolism
iv. Excess of calcium ions due to increased concentration of bile
v. Damage or infection of gallbladder epithelium
vi. Obstruction of bile flow from the gallbladder.

136. What are parts of small intestine?
Small intestine consists of three parts:
i. Proximal part : Duodenum
ii. Middle part : Jejunum
iii. Distal part : Ileum.

137. What are crypts of Lieberkuhn?
Crypts of Lieberkuhn are the intestinal glands.

138. What are the cells present in the intestinal glands?
i. Columnar epithelial cells called enteroctyes, which secrete enzymes
ii. Argentaffin or enterochromaffin cells which secrete intrinsic factor of Castle
iii. Goblet cells which secrete mucus
iv. Paneth cells which secrete defensins (cytokines).

139. What are Brunner's glands?
Brunner's glands are the mucus glands present in the first part of duodenum.

140. What is succus entericus?
Digestive juice secreted by small intestine is called succus entericus or small intestinal juice.

141. What are the properties of succus entericus?
Volume : 1800 mL/day
Reaction and pH : Alkaline with a pH of 8.3

142. Mention the composition of succus entericus.
Succus entericus contains water, organic and inorganic substances
i. Organic substances are enzymes, mucus, intrinsic factor and defensins
ii. Inorganic substances are sodium, calcium, potassium, bicarbonate, chloride, phosphate and sulfate.

143. What are the enzymes present in succus entericus?
i. Proteolytic enzymes: Peptidases, namely amino peptidase, dipeptidase and tripeptidase
ii. Lypolytic enzyme: Intestinal lipase
iii. Amylolytic enzymes: Sucrase, maltase, lactase, dextrinase, trehalase
iv. Enterokinase.

144. What are the functions of succus entericus?
i. Digestive function by enzymes
ii. Protective function by mucus
iii. Activator function by enterokinase
iv. Hemopoietic function by intrinsic factor
v. Hydrolytic function by water.

145. What are the functions of small intestine?
i. Mechanical function
ii. Secretory function
iii. Hormonal function
iv. Digestive function
v. Activator function
vi. Hemopoietic function
vii. Hydrolytic function
viii. Absorptive function.

146. How is succus entericus collected?
Succus entericus is collected by using multilumen tube.

147. What is malabsorption? What are the effects of malabsorption?
Malabsorption is the failure to absorb nutrients such as proteins, carbohydrates, fats and vitamins. Malabsorption affects growth and development of the body.

148. What is malabsorption syndrome? What are the causes for it?
Malabsorption syndrome is the condition characterized by the failure of digestion and absorption in small intestine.
It is caused by Crohn's disease, tropical sprue, steatorrhea and celiac disease.

149. What is Crohn's disease or enteritis?
Crohn's disease is an inflammatory bowel disease (IBD) characterized by inflammation of small intestine. Inflammation causes malabsorption and diarrhea.

150. What is tropical sprue?
It is a malabsorption syndrome, affecting the residents of or the visitors to tropical areas where the disease is epidemic.

151. What is celiac disease?
Celiac disease is an autoimmune disorder characterized by the damage of mucosa and atrophy of villi in small intestine, resulting in impaired digestion and absorption. It is also known as gluten-sensitive enteropathy, celiac sprue and non-tropical sprue.

152. What are the parts of large intestine or colon?
i. Cecum with appendix.
ii. Ascending colon.
iii. Transverse colon.
iv. Descending colon.
v. Sigmoid colon or pelvic colon.
vi. Rectum.
vii. Anal canal.

153. What are the properties of large intestinal juice?
Large intestinal juice is a watery fluid and highly alkaline with the pH of 8.0.

154. What is the composition of large intestinal juice?
Large intestinal juice contains water and solids. Solids are organic and inorganic substances.
Organic substances: Albumin, globulin, mucin, urea and debris of epithelial cells.
Inorganic substances: Sodium, calcium, potassium, bicarbonate, chloride, phosphate and sulfate.

155. What are the functions of large intestinal juice?
i. Neutralization of acids
ii. Lubrication activity.

156. What are the functions of large intestine?
i. Absorptive function: Absorption of water, electrolytes, glucose, alcohol and drugs like anesthetic agents, sedatives and steroids
ii. Formation of feces
iii. Excretory function: Excretion of mercury, lead, bismuth and arsenic
iv. Secretory function: Secretion of mucin, chloride and bicarbonate
v. Synthetic function: Synthesis of folic acid, vitamin B12 and vitamin K.

157. What is dietary fiber or roughage?
Dietary fiber or roughage is a group of food particles which pass through stomach and small intestine without being digested and reach the large intestine unchanged. Other nutritive substances of food are digested and absorbed before reaching large intestine.

158. What is the characteristic feature of dietary fiber?
Characteristic feature of dietary fiber is that it is not hydrolyzed by digestive enzymes. So, it escapes digestion in small intestine and passes to large intestine. It provides substrate for microflora of large intestine and increases the bacterial mass.

159. What is the significance of dietary fiber?
Diet with high-dietary fiber has the following health benefits:
i. Dietary fiber delays emptying of stomach and gives the person a sense of fullness of stomach. Also, diet with high-fiber content tends to be low in energy and it may be useful in reducing the body weight.
ii. It contains substances such as antioxidants and other useful substances.
iii. Intake of high-dietary fiber food may reduce quantity some disease-producing food substances or such food substances may be completely excluded in diet.
iv. Some components of dietary fiber also reduce blood cholesterol level and thereby decrease the risk for **coronary heart disease and gallstones**.
v. Dietary fiber is useful for treating or to prevent constipation and bowel syndrome.
vi. It is also useful in treatment of some disorders such as diabetics, cancer, ulcer, etc.
Dietary fiber increases the formation of bulk and soft feces and eases defecation.

160. What is diarrhea?
Diarrhea is the frequent and profuse discharge of intestinal contents in loose and fluid form. It occurs due to the increased movement of intestine. It may be acute or chronic.

161. What are the causes of diarrhea?
i. Dietary abuse: Intake of contaminated food or water, or very spicy food
ii. Food intolerance: Indigestion of food substances such as lactose
iii. Infections by bacteria or viruses
iv. Reaction to medicines such as antibiotics, antihypertensive drugs, antacids containing magnesium and laxatives.
v. Intestinal disorders such as inflammation, irritable bowel syndrome and abnormal motility.

162. What is constipation?
Failure of voiding of feces which produces discomfort is known as constipation.

163. What are the causes of constipation?
i. Dietary causes such as lack of fiber or water
ii. Irregular bowel habits
iii. Spasm of sigmoid colon
iv. Many types of diseases
v. Megacolon
vi. Drugs such as diuretics, pain relievers (narcotics), antihypertensive drugs (calcium channel blockers), antiparkinsonian drugs, antidepressants and anticonvulsants.

164. What is megacolon or Hirschsprung's disease? What is its cause?
Megacolon is the condition characterized by distension and hypertrophy of colon, associated with constipation.
Megacolon is caused by:
i. Dysfunction of myenteric plexus in colon due to absence or damage of ganglionic cells in myenteric plexus.
ii. Inflammatory bowel disease or bacterial infection of colon causes megacolon which is associated with amebic dysentery. Such type of megacolon is called toxic megacolon.

165. What is appendicitis? What is its cause?
Appendicitis is the inflammation of appendix. It may occur due to infection due to bacteria or viruses and blockage of connection between appendix and large intestine by faces, foreign body or tumor.

166. Define mastication or chewing.
Cutting the food substances into small particles and grinding them into a soft bolus is known mastication or chewing.

167. What are the significances of mastication?
i. Breakdown of foodstuffs into smaller particles
ii. Mixing of saliva with food substances
iii. Lubrication and moistening of dry food by saliva so that, the bolus can be easily swallowed
iv. Appreciation of taste of the food.

168. Name the muscles of mastication?
i. Masseter muscle
ii. Temporal muscle
iii. Pterygoid muscle
iv. Buccinator muscle.

169. What is deglutition?
Swallowing of food is known as deglutition. It is the process, by which the masticated food moves from mouth into stomach via pharynx and esophagus.

170. What are the stages of deglutition?
i. Oral stage : Entrance of food into pharynx from mouth.
ii. Pharyngeal stage : Entrance of food into esophagus from pharynx.
iii. Esophageal stage : Entrance of food into stomach from esophagus.

171. What is the nature of different stages of deglutition?
Oral stage of deglutition is a voluntary process. Pharyngeal and esophageal stages are involuntary processes.

172. What are the possible passages for bolus from pharynx?
From pharynx, the bolus can enter into four paths:
i. Backward into mouth
ii. Upward into nasopharynx
iii. Forward into larynx
iv. Downward into esophagus.

173. Explain in brief how the entrance of bolus through different passages other than esophagus is prevented.
i. Return of bolus back into the mouth is prevented by the position of tongue against the roof of the mouth and the high intraoral pressure
ii. Movement of bolus into nasopharynx is prevented by elevation of soft palate
iii. Movement of bolus into the larynx is prevented by:
   a. Approximation of vocal cords
   b. Forward and upward movement of larynx
   c. Backward movement of epiglottis to close the larynx causing deglutition apnea.

174. What is deglutition apnea or swallowing apnea?
Deglutition apnea or swallowing apnea is the temporary arrest of breathing during pharyngeal stage of deglutition.

175. What is the significance of deglutition apnea?
Deglutition apnea prevents entrance of bolus into larynx during swallowing.

176. What are the movements of esophagus during deglutition?
Movements of esophagus during deglutition are the primary and secondary peristaltic contractions. Sometimes tertiary contraction may also occur.

177. Define peristalsis.
Peristalsis is the wave of contraction followed by wave of relaxation that travels in aboral direction.

178. What is the significance of peristalsis?
By peristalsis, the contents are propelled along the gastrointestinal tract.

179. Trace the pathway for deglutition reflex.
Receptors: Present in the pharynx
Afferent fibers: Fibers of glossopharyngeal nerve
Center: In medulla oblongata
Efferent fibers: Fibers of glossopharyngeal and vagus nerves.
Glossopharyngeal nerve: Concerned with pharyngeal stage of deglutition
Vagus nerve: Concerned with esophageal stage of deglutition
Effectors: Muscles of pharynx and esophagus.

180. What is gag or pharyngeal reflex? What is its significance in babies?
Gag reflex or pharyngeal reflex is the elevation of soft palate and retching (strong involuntary effort to vomit) or gagging (opening of mouth). It is initiated by touch of a wisp of cotton or any other object at roof of mouth, back of tongue, uvula, tonsils or back of throat.

Gag reflex is very active in babies below 6 months. Forceful gag makes the baby to vomit. Thus, in babies, the gag reflex prevents swallowing of hard and solid food and its entry into respiratory passage.

181. What is choking? How it is prevented naturally?
Choking is the inability to breathe due to obstruction or compression of respiratory passage. It may happen sometimes when food particles enter larynx from mouth during swallowing.
It is prevented by gag reflex. Gag reflex is a normal protective reflex and prevents choking by thrusting the objects from throat towards opened mouth.

182. What is dysphagia? What are its causes?
Dysphagia means difficulty in swallowing.
Causes:
i. Mechanical obstruction of esophagus
ii. Decreased movement of esophagus
iii. Muscular disorders.

183. What is esophageal achalasia or achalasia cardia? What is it due to?
It is a neuromuscular disease characterized by accumulation of food in esophagus preventing normal swallowing. It is due the failure of lower esophageal (cardiac) sphincter to relax during swallowing.

184. What is gastroesophageal reflux disease (GERD)? What is it due to?
GERD is a disorder characterized by regurgitation of acidic gastric content into esophagus. It is due to the weakness or incompetence of cardiac sphincter.

185. What is tracheoesophageal fistula?
Tracheoesophageal fistula or TE fistula or TEF is a congenital defect characterized by abnormal connection between trachea and esophagus. Air can pass through the fistula and enter gastrointestinal tract resulting in distension of intestine. Also, liquids taken by the baby may enter lungs causing pneumonia and breathing problems.

186. What is esophageal atresia?
Esophageal atresia is another congenital defect in which the esophagus is shortened and closed off forming a blind pouch at any level along its length. As it develops mostly along with tracheoesophageal fistula, one or more fistulae may be formed between the defected esophagus and trachea resulting in feeding and swallowing difficulties.

When the baby tries to swallow there is regurgitation because of the blind pouch of esophagus leading to choking. Entry of mucus and saliva into trachea causes breathing difficulty and pneumonia.

187. What are the types of movements of stomach?
i. Hunger contractions
ii. Receptive relaxation
iii. Peristalsis when the stomach is filled with food.

188. What are hunger contractions?
Hunger contractions are movements of empty stomach.

189. What is receptive relaxation?
Receptive relaxation is the relaxation of the upper part of the stomach when bolus enters the stomach from esophagus.

190. What is digestive peristalsis?
Digestive peristalsis is the peristaltic contraction that starts from lower part of body of stomach and passes through pylorus till pyloric sphincter. It is called digestive peristalsis because it is responsible for the grinding of food particles and mixing them with gastric juice for digestive activities.

191. What are the factors influencing emptying of stomach?
i. Volume of gastric content
ii. Consistency of gastric content
iii. Chemical composition of gastric content
iv. pH of gastric content
v. Osmolar concentration of gastric contents.

192. What are the factors, which inhibit gastric emptying?
i. Nervous factor: Enterogastric reflex
ii. Hormonal factors: Hormones VIP, GIP, secretin and cholecystokinin.

193. What is enterogastric reflex?
Enterogastric reflex is the reflex that inhibits gastric emptying. When the chyme enters the intestine, the gastric muscle is inhibited and the gastric movements are reduced or stopped. It causes stoppage of gastric emptying.

194. What is gastric dumping syndrome?
Gastric dumping syndrome or rapid gastric emptying is the condition characterized by series of upper abdominal symptoms. It is due to the rapid or quick dumping of undigested food from stomach into the jejunum.

195. What are the causes of dumping syndrome?
i. Gastric surgery.
ii. Zollinger-Ellison syndrome (rare disorder due to severe peptic ulcer and gastrin-secreting tumor in pancreas).

196. What is gastroparesis?
Gastroparesis is a chronic disorder characterized by delayed gastric emptying.

197. Define vomiting or emesis.
Vomiting or emesis is the abnormal emptying of stomach and upper part of intestine through mouth.

198. What are the causes for vomiting?
i. Presence of irritating contents in GI tract
ii. Mechanical stimulation of pharynx
iii. Pregnancy
iv. Excess intake of alcohol
v. Nauseating sight, odor or taste
vi. Unusual stimulation of labyrinthine apparatus
vii. Abnormal stimulation of sensory receptors in other organs like kidney, heart, semicircular canals or uterus
viii. Drugs like antibiotics, opiates, etc.
ix. Any GI disorder
x. Acute infection like urinary tract infection, influenza, etc.
xi. Metabolic disturbances like carbohydrate starvation and ketosis (pregnancy), uremia, ketoacidosis (diabetes) and hypercalcemia.

199. What is the cause for vomiting during pregnancy?
During pregnancy, vomiting occurs because of metabolic disturbances such as carbohydrate starvation and ketosis.

200. What is nausea?
Nausea is an unpleasant sensation that occurs before vomiting. It is characterized by secretion of large amount of saliva with more amount of mucus along with some disagreeable sensations.

201. What is retching?
Retching is the condition characterized by spasmodic respiratory movements and reverse movements in the GI tract without vomiting. The word retching means 'try to vomit' or 'effort to vomit'. The movements of retching start before actual vomiting and intensify the feeling of vomiting. And vomiting occurs few minutes after this.

202. What are the movements involved in vomiting?
Vomiting involves:
i. Antiperistalsis from ileum towards mouth through intestine, stomach and esophagus
ii. Relaxation of lower and upper esophageal sphincters
iii. Closure of glottis
iv. Contraction of abdominal muscles.

203. Trace the pathway for vomiting reflex.
Receptors: Mostly in gastrointestinal tract
Afferent fibers: Fibers of vagus and sympathetic afferent nerves
Center: In medulla oblongata near tractus solitarius
Efferent fibers: Fibers of V, VII, IX, X and XII cranial nerves and spinal nerves.
Effectors: Muscles of gastrointestinal tract and abdominal muscles.

204. What are the movements of small intestine?
i. Mixing movements: Segmentation movements and pendular movements
ii. Propulsive movements: Peristaltic movements and peristaltic rush
iii. Peristalsis in fasting (migrating motor complex)
iv. Movements of villi.

205. What is peristaltic rush? What is its cause?
Peristaltic rush is a powerful peristaltic contraction in small intestine that begins in duodenum, passes through entire length of small intestine and reaches ileocecal valve. It is by excessive irritation of intestinal mucus membrane or extreme distention of intestine.

206. What is the significance of peristaltic rush?
Peristaltic rush sweeps the contents of small intestine into colon and thus it relieves the small intestine off irritant substances or excessive distention.

207. What is migrating motor complex or peristalsis in fasting?
It is the most powerful peristaltic contraction involving a large portion of stomach or intestine during the period of fasting or several hours after the meals. It starts in stomach and runs through the entire length of small intestine.

208. What is the significance of migrating motor complex?
It sweeps the excessive digestive secretions into the colon and prevents the accumulation of secretions in stomach and small intestine.

209. What are the movements of large intestine?
i. Mixing movements: Segmentation contractions
ii. Propulsive movements: Mass peristalsis.

210. What is the significance of mass peristalsis or mass movement?
It propels the feces from colon towards anus.

211. Define defecation.
Defecation is the voiding of feces.

212. What is gastrocolic reflex?
Gastrocolic reflex is the contraction of rectum, followed by desire for defecation caused by distention of stomach by entrance of food.

213. What is the nerve supply to internal and external anal sphincters?
Internal anal sphincter that is formed by smooth muscle fibers is innervated by parasympathetic fibers via pelvic nerve.

External anal sphincter that is formed by skeletal muscle fibers is innervated by somatic nerve fibers via pudendal nerve.

214. Trace the pathway for defecation reflex.

Receptors	: In rectum
Afferent fibers	: Fibers of pelvic nerve
Center	: In sacral segment of spinal cord
Efferent fibers	: Fibers of pelvic nerve
Effectors	: Muscles of rectum and internal sphincter.

215. What is the importance of pudendal nerve?
Pudendal nerve always keeps the external anal sphincter constricted. During defecation reflex, the pudendal nerve is inhibited by impulses arising from cerebral cortex and this causes relaxation of external anal sphincter and defecation.

216. What is belching or burping?
It is the process by which the gas accumulated in stomach is expelled through mouth.

217. What is flatulence?
Flatulence is the mixture of intestinal gases (flatus) that is released through anus.

218. What are the gastrointestinal hormones?
Gastrointestinal hormones are the local hormones secreted in GI tract.

219. What are enteroendocrine cells?
Enteroendocrine cells are the hormone-secreting cells present in GI tract.

220. What is the name given to enteroendocrine cells which secrete gastrointestinal hormones?
Enteroendocrine cells which secrete gastrointestinal hormones are called APUD (amine precursor uptake and decarboxylation) cells.

221. Name the hormones secreted by stomach.
i. Gastrin
ii. GIP
iii. Somatostatin
iv. Motilin.

222. Name the hormones secreted by small intestine.
i. Gastrin
ii. Secretin
iii. Cholecystokinin
iv. GIP (glucose dependent insulinotropic hormone or gastric inhibitory peptide)
v. VIP (vasoactive intestinal peptide)
vi. Glucagon,
vii. Glicentine
viii. GLP-1 (glucagon like polypeptide)
ix. GLP-2
x. Somatostatin
xi. Pancreatic polypeptide
xii. Peptide YY
xiii. Neuropeptide Y
xiv. Motilin
xv. Substance P
xvi. Ghrelin

223. What are the actions of gastrin?
Gastrin:
i. Stimulates gastric secretion and motility
ii. Promotes growth of gastric mucosa
iii. Stimulates release of pancreatic hormones
iv. Stimulates secretion of pancreatic juice
v. Stimulates secretion of pancreatic hormones

224. What are the actions of secretin?
Secretin:
i. Causes secretion of large amount of watery juice with high content of bicarbonate ions
ii. Inhibits secretion of gastric juice
iii. Inhibits motility of stomach
iv. Causes constriction of pyloric sphincter
v. Increases the potency of action of cholecystokinin on pancreatic secretion.

225. What are the actions of cholecystokinin?
Cholecystokinin:
i. Contracts gallbladder
ii. Causes secretion of pancreatic juice with large amount of enzymes
iii. Accelerates the activity of secretin
iv. Increases the secretion of enterokinase
v. Inhibits the gastric motility
vi. Increases the motility of intestine and colon
vii. Augments contraction of pyloric sphincter
viii. Plays an important role in satiety by suppressing hunger
ix. Induces drug tolerance to opioids.

226. What are the actions GIP?
GIP:
i. Stimulates insulin secretion
ii. Inhibits gastric secretion and motility

227. What are the actions VIP?
VIP:
i. Dilates splanchnic (peripheral) blood vessels
ii. Inhibits HCl secretion in gastric juice
iii. Stimulates secretion of succus entericus
iv. Relaxes smooth muscles of intestine
v. Augments acetylcholine action on salivary glands
vi. Stimulates insulin secretion.

228. What are the actions of glucagon?
Glucagon increases blood sugar level

229. What are the actions of Glicentin?
Glicentin increases blood sugar level

230. What are the actions of GLP-1?
GLP-1:
i. Stimulates insulin secretion
ii. Inhibits gastric motility

231. What are the actions of GLP-2?
GLP-2 suppresses appetite.

232. What are the actions of somatostatin?
Somatostatin:
i. Inhibits secretion of growth hormone
ii. Inhibits gastric secretion and motility
iii. Inhibits secretion of pancreatic juice
iv. Inhibits secretion of GI hormones.

233. What are the actions of pancreatic polypeptide?
Pancreatic polypeptide:
i. Increases secretion of glucagon
ii. Decreases pancreatic secretion.

234. What are the actions of peptide YY?
Peptide YY:
i. Inhibits gastric secretion and motility
ii. Reduces secretion of pancreatic juice
iii. Inhibits intestinal motility and bowel passage
iv. Suppresses appetite and food intake.

235. What is the action of neuropeptide Y?
Neuropeptide Y increases blood flow in enteric blood vessels.

236. What are the actions of motilin?
Motilin:
i. Accelerates gastric emptying
ii. Increases movements of small intestine
iii. Increases peristalsis in colon.

237. What is the action of substance P?
Substance P increases movements of small intestine.

238. What are the actions of ghrelin?
Ghrelin:
i. Promotes growth hormone (GH) release
ii. Induces appetite and food intake
iii. Stimulates gastric emptying.

239. What are the carbohydrates present in diet?
Carbohydrates in human diet are of three types
i. Polysaccharides: Glycogen, amylose and amylopectin
ii. Disaccharides: Sucrose and lactose
iii. Monosaccharides: Glucose and fructose.

240. How is carbohydrate digested?
Carbohydrate digestion starts in the mouth by ptyalin and continues in the stomach where gastric amylase also acts.

Final digestion occurs in small intestine by pancreatic amylase, sucrase, maltase, lactase, dextrinase and trehalase.

241. What are the final products of carbohydrate digestion?
Final products of carbohydrate digestion are monosaccharides namely glucose, galactose and fructose.
i. Glucose: Represents 80% of final products
ii. Galactose and fructose: Represent 20% if final products.

242. How is carbohydrate absorbed from small intestine?
Carbohydrate is absorbed from small intestine mainly as monosaccharides (glucose, galactose and fructose).

243. What are the proteins present in common food stuffs?
i. Wheat: Glutenin and gliadin, which constitute gluten
ii. Milk: Casein, lactalbumin, albumin and myosin.
iii. Egg: Albumin and vitellin.
iv. Meat: Collagen, albumin and myosin.

244. How is protein digested?
Protein digestion starts only in the stomach. Pepsin breaks proteins into proteoses, peptones and large polypeptides.

In small intestine, final digestion of proteins occurs because of proteolytic enzymes in pancreatic juice and succus entericus.

245. How is protein absorbed from small intestine?
Protein is absorbed from small intestine mainly as amino acids.

246. What are the lipids present in human diet?
Lipids present in human diet are triglycerides (neutral fats), Cholesterol and cholesterol esters. Triglycerides form major portion of lipids in diet.

247. How is lipid digested?
Lipid digestion starts in the stomach by gastric lipase. But it is a very weak lipolytic enzyme.

In small intestine, most of the lipid is digested by pancreatic lipase. Succus entericus also contains lipase but it is very weak and its action is negligible.

248. What is the role of bile salts in lipid digestion?
Lipid molecules are not soluble in water due to the surface tension. So, the lipids cannot be digested by any lipolytic enzymes. Due to the detergent action of bile salts in small intestine, the lipid molecules become water soluble. This action of bile salts is known as emulsification. During this, the bile salts convert the lipid substances into micelles. The emulsified fat molecules in micelles are easily digested by lipolytic enzymes.

249. How is lipid absorbed from small intestine?
Lipid is absorbed from small intestine in two forms:
i. In the form of fatty acids which are absorbed into blood by diffusion.
ii. In the form of chylomicrons, which contain triglycerides, and cholesterol esters. Because of the larger size, chylomicrons cannot pass through membrane of blood capillaries. And, these lipid materials are absorbed into lymph vessels and transferred into blood from lymph.

250. What are lipoproteins?
Lipoproteins are the small particles in blood which contain cholesterol, phospholipids, triglycerides and proteins (beta globulins called apoproteins).

251. Classify lipoproteins?
i. Very low-density lipoproteins (VLDL)
ii. Intermediate low-density lipoproteins (IDL)
iii. Low density lipoproteins (LDL)
iv. high density lipoproteins (HDL).

252. What are the importance of HDL and LDL?
HDL (good cholesterol) carries cholesterol and phospholipids from tissues and organs back to the liver for degradation and elimination. It prevents the deposition of cholesterol on the walls of arteries by carrying cholesterol away from arteries to liver. High level of HDL indicates a healthy heart, because it reduces the blood cholesterol level.

LDL (bad cholesterol) carries cholesterol and phospholipids from the liver to muscles, other tissues and organs such as heart. It is responsible for deposition of cholesterol on walls of arteries causing atherosclerosis. High level of LDL increases the risk of heart disease.

253. What is lipid profile?
Lipid profile is a group of blood tests which are carried out to determine the risk of coronary artery diseases (CAD).

254. What are the tests involved in lipid profile? Give the normal values.
i. Total cholesterol (200 to 240 mg%)
ii. Triglyceride (150 to 200 mg%)
iii. HDL (40 to 60 mg%)
iv. LDL (60 to 100 mg%)
v. Total cholesterol – HDL ratio (2 to 6).

Section 5 Renal Physiology and Skin

1. **Define excretion.**
   Excretion is the process by which the unwanted substances and metabolic wastes are eliminated from the body.
2. **What are the systems / organs involved in excretory function?**
   i. Renal system: Has maximum excretory capacity. Excretes water and waste products
   ii. Digestive system: Excretes food residues in the form of feces. Some bacteria and toxic substances are also excreted through feces
   iii. Lungs: Excretes carbon dioxide and water vapor
   iv. Skin: Excretes water, salts and some wastes. It also removes heat from the body
   v. Liver: Excretes many substances like bile pigments, heavy metals, drugs, toxins, bacteria, etc. through bile.
3. **What are the functions of kidney?**
   Primary function of kidney is homeostasis, i.e. the maintenance of internal environment. Various functions of kidney:
   i. Role in homeostasis: By the formation of urine and excretion of water, electrolytes and waste products through urine
   ii. Hemopoietic function
   iii. Endocrine function
   iv. Regulation of blood pressure
   v. Regulation of blood calcium level.
4. **Name the components of renal system.**
   i. A pair of kidneys
   ii. Ureters
   iii. Urinary bladder
   iv. Urethra.
5. **Name the layers of kidney.**
   i. Outer cortex containing renal corpuscles and convoluted tubules
   ii. Inner medulla containing tubular and vascular structures arranged in the form of medullary pyramids
   iii. Renal sinus containing renal pelvis, major calyces, minor calyces, branches of nerves and arteries, tributaries of veins, loose connective tissue and fat.
6. **What are uriniferous tubules? Name their parts.**
   Uriniferous tubules are the tubular structures forming the parenchyma of kidney.
   Uriniferous tubules include nephrons and collecting ducts.
7. **What are papillary ducts of Bellini?**
   Papillary ducts or papillary ducts of Bellini are short ducts formed by union of straight collecting ducts. Papillary ducts open into minor calyces through papilla.
8. **Define nephron.**
   Nephron is defined as structural and functional unit of kidney.
9. **How many nephrons are present in each kidney?**
   1 to 1.3 million nephrons are present in each kidney.
10. **What are the two types of nephrons?**
    i. Cortical or superficial nephrons whose renal corpuscles are situated in the outer part of cortex
    ii. Juxtamedullary nephrons whose renal corpuscles are situated in the inner part of cortex near medulla.
11. **What are the parts of nephron?**
    i. Renal corpuscle or Malpighian corpuscle
    ii. Tubular portion or renal tubule.
12. **What are the structures of renal corpuscle?**
    i. Glomerulus
    ii. Bowman's capsule that encloses the glomerulus.
13. **What is glomerulus?**
    Glomerulus is a tuft of capillaries formed from the afferent arteriole and drained by efferent arteriole.
14. **What are the layers of Bowman's capsule?**
    i. Inner visceral layer
    ii. Outer parietal layer.
15. **What are fenestrae or filtration pores?**
    Fenestrae are minute pores present in endothelial cells of glomerular capillaries. .
16. **What are podocytes?**
    Podocytes are the epithelial cells of visceral layer of Bowman's capsule, which are connected to basement membrane by means of foot like projections called pedicles.
17. **What is filtering membrane of glomerulus?**
    It is the membrane in glomerulus formed by capillary endothelial layer, basement membrane and epithelium of visceral layer of Bowman's capsule.
18. **What are the parts of renal tubule?**
    i. Proximal convoluted tubule
    ii. Loop of Henle that includes the thick descending limb, thin descending limb, hairpin bend, thin ascending limb and thick ascending limb
    iii. Distal convoluted tubule.
19. **What is the unique feature of the wall of proximal convoluted tubule?**
    Wall of proximal convoluted tubule is formed by brush bordered cuboidal epithelial cells.
20. **What is the advantage of brush bordered cuboidal epithelial cells in proximal convoluted tubule?**
    Brush bordered cuboidal epithelial cells increase the surface area for reabsorption.
21. **Name the type of epithelial lining in different parts of nephron and collecting duct.**
    Bowman's capsule: Flattened epithelium
    Proximal convoluted tubule: Cuboidal cells with brush border

Thin descending segment: Flattened epithelium
Hairpin bend: Flattened epithelium
Thin ascending segment: Flattened epithelium
Thick ascending segment: Cuboidal cells without brush border
Distal convoluted tubule: Cuboidal cells without brush border
Collecting duct: Cuboidal cells without brush border.

22. What is the other name for cuboidal epithelial cells in distal convoluted tubule?
Intercalated cells (I cells).

23. What are the two types of cuboidal epithelial cells present in collecting duct?
i. Principal cells or P cells
ii. Intercalated cells or I cells.

24. What is juxtaglomerular apparatus?
It is a specialized organ situated near the glomerulus of each nephron.

25. Name the parts of juxtaglomerular apparatus.
i. Macula densa
ii. Extraglomerular mesangial cells
iii. Juxtaglomerular cells.

26. What is macula densa? What is its importance?
Macula densa is the part of distal convoluted tubule near the afferent arteriole, which is formed by tightly packed cuboidal epithelial cells.
Macula densa plays an important role in tubuloglomerular feedback?

27. What are extraglomerular mesangial cells? What are the other names for these cells?
Extraglomerular mesangial cells are the special type of agranular or lasis cells situated in the triangular region bound by afferent arteriole, efferent arteriole and macula densa.
These cells are also called agranular cells, lacis cells or Goormaghtigh cells.

28. What is the function of extraglomerular mesangial cells?
Extraglomerular mesangial cells secrete prostaglandin and cytokines.

29. What are intraglomerular or glomerular mesangial cells?
Intraglomerular or glomerular mesangial cells mesangial cells situated in between glomerular capillaries.

30. What are functions of glomerular mesangial cells?
i. Support the glomerular capillary loops
ii. Play an important role in regulating the glomerular filtration
iii. Phagocytic in nature
iv. Secrete glomerular interstitial matrix, prostaglandins and cytokines.

31. What are juxtaglomerular cells or agranular cells?
Juxtaglomerular cells or agranular are the specialized type of smooth muscle cells present in the afferent arteriole before it enters the Bowman's capsule.

32. What is polar cushion or polkissen?
Juxtaglomerular cells form a thick cuff called polar cushion or polkissen around afferent arteriole enters Bowman' capsule.

33. What are the functions of juxtaglomerular apparatus?
i. Secretion of hormones: Renin and prostaglandin
ii. Secretion of other substances: Cytokines, interlukin-2 and thromboxane A_2
iii. Regulation of glomerular blood flow and glomerular filtration rate by means of tubuloglomerular feedback.

34. What is the role of renin in the body?
i. Renin converts inactive angiotensinogen into angiotensin I
ii. Angiotensin I is converted into angiotensin II by the converting enzyme
iii. Angiotensin II is converted into angiotensin III by angiotensinases
iv. Angiotensin III is converted into angiotensin IV.

35. Name the factors which stimulate renin secretion.
i. Decreased arterial blood pressure
ii. Reduction in ECF volume
iii. Increased sympathetic activity
iv. Decreased load of sodium and chloride in macula densa.

36. What are the functions of angiotensins?
Angiotensin I: It is physiologically inactive
Angiotensin II:
i. Increases blood pressure
ii. Increases aldosterone secretion
iii. Regulates glomerular filtration rate
iv. Inhibits response of baroreceptor reflex
Angiotensins III and IV:
i. Increase blood pressure
ii. Increase the aldosterone secretion.

37. How much of blood is supplied to both the kidneys?
1300 mL/minute. It forms 26% of cardiac output.

38. What are the blood vessels forming arterial system and capillary system in kidney?
i. Renal artery arising from aorta
ii. Segmental arteries
iii. Interlobar arteries
iv. Arcuate arteries
v. Interlobular arteries
vi. Afferent arterioles
vii. Glomerular capillaries
viii. Efferent arterioles
ix. Peritubular capillaries
x. Vasa recta (singular = vas rectum)

39. What are the blood vessels forming venous system?
i. Peritubular venules
ii. Interlobular veins
iii. Arcuate veins
iv. Interlobar veins
v. Segmental veins
vi. Renal vein which drains into inferior vena cava

40. How is renal blood flow measured?
By renal clearance test using para aminohippuric acid.

41. What is autoregulation? What are the mechanisms involved in renal autoregulation?
The intrinsic ability of an organ to regulate its own blood flow is called autoregulation. Renal autoregulation involves myogenic response and tubuloglomerular feedback.

42. What are the special features (peculiarities) of renal circulation?
i. Renal arteries arise directly from aorta
ii. Kidneys receive maximum amount of blood (1,300 mL/minute) next to liver (1,500 mL/minute)
iii. Whole blood passes through glomerulus
iv. Renal circulation has a portal system
v. Capillary pressure in glomerulus is very high (60 mm Hg). It forms high pressure bed
vi. Peritubular capillaries form low pressure bed
vii. Autoregulation is well established in kidney.

43. What is the normal urinary output?
1 to 1.5 L/day.

44. Name the processes involved in urine formation.
i. Glomerular filtration
ii. Tubular reabsorption
iii. Tubular secretion or excretion.

45. Define glomerular filtration. What is glomerular filtrate?
It is the process by which blood is filtered while passing through glomerular capillaries by filtration membrane. The filtered fluid is called glomerular filtrate.

46. What is the composition of glomerular filtrate?
Glomerular filtrate is the plasma without plasma proteins, i.e. all the substances present in the plasma are present in glomerular filtrate also except plasma proteins.

47. Why glomerular filtration is called ultrafiltration?
Glomerular filtration is called ultrafiltration because even the minute particles are filtered from glomerular capillary into Bowman's capsule.

48. Define glomerular filtration rate (GFR).
Glomerular filtration rate (GFR) is defined as total amount of filtrate formed in all the nephrons of both the kidneys per unit time.

49. What is the normal value of GFR?
125 mL/minute or 180 L/day.

50. What is filtration fraction?
Filtration fraction if the fraction (portion) renal plasma that becomes the filtrate. Or, it is the ratio of renal plasma flow and glomerular filtration rate. It is expressed in percentage.

51. What is the normal filtration fraction?
15 to 20%.

52. Name the pressures, which determine the GFR.
i. Glomerular capillary pressure (60 mm Hg)
ii. Colloidal osmotic pressure in the glomeruli (25 mm Hg)
iii. Hydrostatic pressure in the Bowman's capsule (15 mm Hg).
Glomerular capillary pressure favors filtration. Colloidal osmotic pressure and hydrostatic pressure oppose or prevent filtration.

53. What is net or effective filtration pressure? How much is it?
Net or effective filtration pressure is the balance between the pressure favoring filtration and pressures opposing filtration.
Effective filtration pressure = 60 – (25 + 15) mm Hg
Normally it is 15 to 20 mm Hg.

54. What is Starling's hypothesis?
Starling's hypothesis states that the net filtration through capillary membrane is proportional to the hydrostatic pressure difference across the membrane minus the oncotic pressure difference.

55. What are Starling forces of glomerular filtration?
Starling forcers of glomerular are the pressures involved in determination of glomerular filtration.

56. What is filtration coefficient?
Filtration coefficient is the GFR in terms of net filtration pressure. It is the glomerular filtration rate per mm Hg of effective filtration pressure.

57. Name the factors affecting GFR.
i. Renal blood flow
ii. Tubuloglomerular feedback
iii. Glomerular capillary pressure
iv. Colloidal osmotic pressure
v. Hydrostatic pressure in Bowman's capsule
vi. Constriction of afferent arteriole
vii. Constriction of efferent arteriole
viii. Systemic arterial pressure
ix. Sympathetic stimulation
x. Surface area of capillary membrane
xi. Permeability of capillary membrane
xii. Contraction of glomerular mesangial cells
xiii. Hormonal and other factors.

58. What is tubuloglomerular feedback?
Tubuloglomerular feedback is the mechanism that regulates GFR through renal tubule and macula densa.

59. What is macula densa? What is its function?
Macula densa of juxtaglomerular apparatus in the terminal portion of thick ascending limb.
It is sensitive to the sodium chloride in the tubular fluid. When the glomerular filtrate passes through the terminal portion of thick ascending segment, macula densa acts like a sensor. It detects the concentration of sodium chloride in the tubular fluid and accordingly alters the glomerular blood flow and GFR.

60. What is tubular reabsorption?
Tubular reabsorption is the process by which water, electrolytes and other substances are transported from renal tubule into the blood in peritubular capillaries.

61. Why the tubular reabsorption is called selective reabsorption?
Tubular reabsorption is called selective reabsorption because tubular cells reabsorb only the substances necessary to the body.

62. Why is tubular reabsorption called selective reabsorption?
Tubular reabsorption is called selective reabsorption because tubular cells reabsorb only the substances necessary to the body.

63. What are the mechanisms involved in tubular reabsorption?
i. Active Reabsorption: Movement of molecules against the electrochemical (uphill) gradient. It needs liberation of energy, which is derived from ATP.
ii. Passive Reabsorption: Movement of molecules along the electrochemical (downhill) gradient. This process does not need energy.

64. Name the substances reabsorbed actively from renal tubules.
Sodium, calcium, potassium, phosphates, sulfates, bicarbonates, glucose, amino acids, ascorbic acid, uric acid and ketone bodies.

65. Name the substances reabsorbed passively from renal tubules.
Chloride, urea and water.

66. What are the routes of tubular reabsorption tubular reabsorption?
i. Transcellular Route: In this route, the substances move through the cell
ii. Paracellular Route: In this route, the substances move through the intercellular space.

67. Name the substances reabsorbed in proximal convoluted tubule.
Glucose, amino acids, sodium, potassium, calcium, bicarbonates, chlorides, phosphates, uric acid and water.

68. Name the substances reabsorbed in loop of Henle.
Sodium and chloride.

69. Name the substances reabsorbed in distal convoluted tubule.
Sodium, calcium, bicarbonate and water.

70. What is glomerulotubular balance?
It is the balance between filtration and reabsorption of solutes and water in kidney. When GFR increases, the tubular load of solutes and water in the proximal convoluted tubule is increased. It is followed by increase in the reabsorption of solutes and water.

71. What is the significance of glomerulotubular balance?
This process helps constant reabsorption of sodium and water from renal tubule.

72. What are high threshold substances? Give examples.
High-threshold substances are those substances, which do not appear in urine under normal conditions. Food substances like glucose, amino acids, acetoacetate ions and vitamins are completely reabsorbed from renal tubules and do not appear in urine under normal conditions.

Such substances appear in urine, only if their concentration in plasma is abnormally high or in renal diseases when reabsorption is affected. Hence, these substances are called high- threshold substances.

73. What are low threshold substances? Give examples.
Low-threshold substances are the substances, which appear in urine even under normal conditions. The substances such as urea, uric acid and phosphate are reabsorbed to a little extent. So, these substances appear in urine even under normal conditions.

74. What are non-threshold substances?
Non-threshold substances are those substances, which are not at all reabsorbed and are excreted in urine irrespective of their plasma level. Metabolic end products such as creatinine are the non-threshold substances.

75. What is tubular maximum (Tm)?
Maximum rate at which a substance is reabsorbed from the renal tubule is called tubular maximum (Tm).

76. What is TmG? What is its normal value?
TmG means tubular maximum for glucose, i.e. the maximum rate at which glucose is reabsorbed from renal tubule is called TmG. It is about 375 mg/minute in adult males and 300 mg/minute in adult females.

77. What is threshold value?
Blood level of a substance below which it is completely reabsorbed and does not appear in urine is known as the threshold value for that substance. When the concentration increases above that level in blood, the excess amount is excreted through urine.

78. What is the renal threshold for glucose?
180 mg%.

79. How is water reabsorbed from renal tubules?
By two ways:
i. Obligatory water reabsorption in proximal convoluted tubule
ii. Facultative water reabsorption in distal convoluted tubule.

80. What is obligatory reabsorption of water reabsorbed from renal tubules?
Obligatory reabsorption is the type of water reabsorption in proximal convoluted tubule, which is secondary (obligatory) to sodium reabsorption. When sodium is reabsorbed from the tubule, the osmotic pressure decreases. It causes osmosis of water from renal tubule.

81. What is obligatory reabsorption of water reabsorbed from renal tubules?
Facultative reabsorption is the type of water reabsorption in distal convoluted tubule and collecting duct that occurs by the activity of antidiuretic hormone

82. What are aquaporins?
Aquaporins are membrane proteins which function as water channels.

83. What are the carrier proteins for glucose in renal tubules?
Carrier protein called sodium-dependent glucose cotransporter 2 (SGLT2) transports glucose from lumen of renal tubule into tubular epithelial cell. From tubular cell, glucose is transported into medullary interstitium by another carrier protein called glucose transporter 2 (GLUT2).

84. What is renal threshold curve?
It is the curve used to determine renal threshold of a substance. It is drawn by using the values of transport maximum and blood level of that substance.

85. Explain splay in renal threshold curve for glucose? What is the cause for it?
Splay in renal threshold curve is referred to deviation of the curve from ideal shape.

With normal GFR of 125 mL/ min and TmG of 375 mg/min in an adult male the predicted (expected) renal threshold for glucose should be 300 mg/dL. But actually, it is only 180 mg/dL.

When the renal threshold curves are drawn by using these values, the actual curve deviates from the 'should be' or predicted or ideal curve. This type of deviation is called splay. Splay is because of the fact that all the nephrons do not have the same filtering and reabsorbing capacities.

86. What are the substances secreted into renal tubules?
Potassium is secreted in distal convoluted tubule and collecting duct. Ammonia is secreted in proximal convoluted tubule. Hydrogen ions are secreted in proximal and distal convoluted tubules.

87. What are the factors determining concentration of urine?
i. Medullary gradient
ii. ADH mechanism.

88. What is medullary gradient?
Medullary gradient is the gradual increase in the osmolarity of medullary interstitial fluid from 300 milliosmoles/L near the cortex up to 1,200 milliosmoles/ L at the innermost part of medulla.

89. How is medullary gradient developed and maintained?
Medullary gradient is developed and maintained by counter current mechanism. Development of medullary gradient is because of counter current multiplier and the maintenance of medullary gradient is because of counter current exchanger.

90. What is counter current system?
Flow of fluid in opposite directions through 'U' shaped tubules is known as counter current system.

91. Name the divisions of counter current system in kidney.
i. Counter current multiplier that is formed by loop of Henle
ii. Counter current exchanger that is formed by vasa recta.

92. Why the loop of Henle is called counter current multiplier?
Loop of Henle is called counter current multiplier because it is responsible for the increase or multiplication of osmolarity in medullary interstitium.

93. Why vas rectum is called counter current exchanger?
Vas rectum is called counter current exchanger because it helps to exchange the sodium ions between the ascending limb and descending limb of loop of Henle by which the hyperosmolarity of medullary interstitium and medullary gradient are maintained.

94. What are the special features of vasa recta, which help it to act as counter current exchanger?
i. Each vas rectum has got an ascending limb and a descending limb
ii. Only 5% blood flowing to kidney passes through vasa recta
iii. The velocity of blood flow through vasa recta is very less.

95. How does the final concentration of urine occur?
Final concentration of urine occurs under the influence of antidiuretic hormone (ADH). ADH increases the water reabsorption in distal convoluted tubule and collecting duct and causes concentration of urine.

96. What is the importance of acid-base balance?
Acid-base balance is very important for the homeostasis of the body and almost all the physiological activities depend upon the acid-base status of the body.

97. What is pH?
The pH is the expression of hydrogen ion concentration.

98. What is the normal pH of ECF?
Normal pH of ECF is 7.4. It varies between 7.38 and 7.42 in physiological conditions.

99. How is the pH of ECF and plasma determined?
The pH is of ECF is calculated by means of Henderson-Hasselbalch equation by using concentrations of bicarbonate ions and carbon dioxide dissolved in the fluid.

The pH of plasma is determined by pH meter.

100. What are the mechanisms which regulate acid base balance?
i. Blood buffer system
ii. Respiratory mechanism
iii. Renal mechanism.

101. What are the buffer systems in the body?
i. Bicarbonate buffer system
ii. Phosphate buffer system
iii. Protein buffer system.

102. What is basic mechanism involved in the regulation of acid base balance by respiratory system?
Respiratory system regulates acid base balance by regulating carbon dioxide content in the blood.

103. What is basic mechanism involved in the regulation of acid base balance by kidney?
Kidney regulates acid base balance by secretion of hydrogen ions and retention of bicarbonate ions.

104. What are the disturbances of acid base status?
i. Acidosis: When hydrogen ion concentration increases, it leads to reduction in pH. It is called acidosis.
ii. Alkalosis: When hydrogen ion concentration decreases, it leads to increase in pH. It is known as alkalosis.

105. Classify acidosis. Explain briefly.
i. Respiratory acidosis that occurs during respiratory disturbances. This is due to the increase in the partial pressure of carbon dioxide above 60 mm Hg in the arterial blood.
ii. Metabolic acidosis that occurs during metabolic disturbances. It is due to the excessive accumulation of organic acids like lactic acid, acetoacetic acid and beta hydroxyl butyric acid.

106. Name some conditions when respiratory acidosis occurs.
Respiratory acidosis occurs in conditions leading to hypoventilation like:
i. Airway obstruction (as in bronchitis)
ii. Lung diseases (like fibrosis)
iii. Respiratory center depression (by anesthetics, sedatives etc.)
iv. Extrapulmonary thoracic diseases (like kyphosis and scoliosis)
v. Neural diseases (poliomyelitis)
vi. Paralysis of respiratory muscles.

107. Name some conditions when metabolic acidosis occurs.
i. Lactic acidosis (as in circulatory shock)
ii. Ketoacidosis (as in diabetes mellitus)
iii. Uric acidosis (as in renal failure)
iv. Acid poisoning
v. Renal tubular acidosis
vi. Loss of excess of bicarbonate ions (as in diarrhea).

108. What are the types of alkalosis? Explain briefly.
i. Respiratory alkalosis that occurs during respiratory disturbances. It is due to the reduction in the partial pressure of carbon dioxide (< 20 mm Hg) in arterial blood
ii. Metabolic alkalosis that occurs during metabolic disturbances. It is due to the excessive loss of hydrogen ions from the body.

109. Name some conditions when respiratory alkalosis occurs.
Hyperventilation is the primary cause for loss of excess carbon dioxide from the body leading to respiratory alkalosis. Hyperventilation occurs in hypoxic conditions, anemia, cerebral disturbances, pulmonary diseases like edema and embolism and psychological and emotional trauma.

110. Name some conditions when metabolic alkalosis occurs.
Metabolic alkalosis is due to loss of excess hydrogen ions that occurs in:
i. Vomiting and diarrhea
ii. Endocrine disorders (Cushing's syndrome, Conn's syndrome)
iii. Diuretic therapy.

111. What is role of kidneys in maintaining acid-base balance?
Kidney plays an important role in maintenance of acid-base balance by excreting hydrogen ions and retaining bicarbonate ions.

112. How is urine acidified?
Urine is acidified by the excretion of hydrogen ions.

113. Name the mechanisms involved in excretion of hydrogen ions.
i. Bicarbonate mechanism
ii. Phosphate mechanism
iii. Ammonia mechanism.

114. What are the properties of urine?
Volume: 1,000 to 1,500 mL/day
Reaction: Slightly acidic with pH of 4.5 to 6
Specific gravity: 1.010 to 1.025
Osmolarity: 1,200 mOsm/L
Color: Normally, straw colored
Odor: Fresh urine has light aromatic odor. Odor becomes stronger in stored urine due to bacterial decomposition.

115. Name the renal function tests.
i. Examination of urine alone
ii. Examination of blood alone
iii. Examination of urine and blood.

116. Name the blood test to determine renal functions.
i. Estimation of plasma proteins
ii. Estimation of urea, uric acid and creatine.

117. Give normal blood level of urea, uric acid and creatine. When does the blood level of these substances increase?
Urea : 25 to 40 mg/dL
Uric acid: 2.5 mg/dL
Creatinine: 0.5 to 1.5 mg/dL
Blood level of these substances increases in renal failure.

118. Define plasma clearance.
Plasma clearance is the amount of plasma that is cleared off a substance in a given unit of time.

119. What are the advantages of determining plasma clearance?
Determination of plasma clearance helps to measure:
i. Glomerular filtration rate
ii. Renal plasma flow
iii. Renal blood flow.

120. Name the substances used to measure glomerular filtration rate and renal plasma flow by plasma clearance.
Inulin is used to measure glomerular filtration rate.
Para aminohippuric acid is used to measure renal plasma flow.

121. Classify renal disorders.
i. Acute renal failure
ii. Chronic renal failure.

122. What is renal failure?
Renal failure refers to failure of excretory functions of kidney. It is usually characterized by decrease in glomerular filtration rate.

123. What are the causes of acute renal failure?
i. Acute nephritis
ii. Damage of renal tissues by poisons
iii. Renal ischemia
iv. Acute tubular necrosis in kidney
v. Severe transfusion reactions
vi. Sudden fall in blood pressure
vii. Blockage of ureter.

124. What are the causes of chronic renal failure?
i. Chronic nephritis
ii. Polycystic kidney disease
iii. Renal stones
iv. Urethral constriction
v. Hypertension
vi. Atherosclerosis
vii. Tuberculosis
viii. Slow poisoning by drugs or metals.

125. What is uremia?
Excessive accumulation of metabolic end products like urea and creatinine in blood is called uremia. It is the most characteristic feature of chronic renal failure.

126. What is micturition?
Micturition is the process by which urine is voided from urinary bladder.

127. What is detrusor muscle?
It is the smooth muscle forming the body of urinary bladder.

128. Mention the differences between the internal and external urethral sphincters.
i. Internal urethral sphincter is formed by smooth muscle but the external urethral sphincter is formed by skeletal muscle
ii. Internal sphincter is innervated by sympathetic and parasympathetic fibers of autonomic nervous system, whereas, the external sphincter is innervated by somatic nerve fibers
iii. Internal sphincter functions under reflex control and the external sphincter is under voluntary control.

129. What is the functional difference between male urethra and female urethra?
Male urethra has both urinary function and reproductive function. It carries urine and semen.
Female urethra has only urinary function and it carries only urine.

130. What are the parts of male urethra?
i. Prostatic urethra
ii. Membranous urethra
iii. Spongy urethra.

131. Name the nerves supplying urinary bladder and sphincters.
Detrusor muscle and internal sphincter are supplied by:
i. Parasympathetic fibers (pelvic nerve)
ii. sympathetic fibers (hypogastric nerve)
External sphincter is supplied by:
i. Somatic nerve fibers (pudendal nerve).

132. What is the action of parasympathetic nerve on urinary bladder and internal sphincter?
Parasympathetic (pelvic) nerve causes contraction of detrusor muscle and relaxation of internal sphincter leading to micturition. Hence it is called the nerve of micturition or nerve of emptying.

133. What is the action of sympathetic nerve on urinary bladder and internal sphincter?
Sympathetic (hypogastric) nerve causes relaxation of detrusor muscle and constriction of internal sphincter. This helps in filling of urinary bladder and so it is called the nerve of filling.

134. What is the action of pudendal (somatic) nerve on external sphincter?
Pudendal (somatic) nerve is always active and keeps the external sphincter constricted. When urine enters the urethra from bladder, the pudendal nerve is inhibited and the external sphincter relaxes leading to micturition. Thus, the pudendal nerve is responsible for voluntary control of micturition.

135. What is cystometrogram?
Cystometrogram is the graphical recording of pressure changes in relation to volume changes in the urinary bladder while filling.

136. What is intravesical pressure?
It is the pressure in the urinary bladder.

137. When does the desire for micturition arise?
Desire for micturition arises when about 300 mL of urine is collected in urinary bladder and the intravesical pressure increases to about 10 to 15 cm H_2O.

138. What is the maximum amount of urine collected in the bladder and intravesical pressure up to which the voluntary control of micturition is possible?
Voluntary control of micturition is possible up to 600 to 700 mL of urine collection in the urinary bladder at which the intravesical pressure is about 35 to 40 cm H_2O.

When the volume of urine in the bladder increases beyond 700 mL, the pressure rises to 40 cm H_2O. Now, the voluntary control of micturition fails.

139. Explain briefly the micturition reflex.
Micturition reflex occurs in two phases.
Initially, when 300 to 400 mL of urine is collected in the urinary bladder, the stretch receptors in the wall of the bladder are stimulated. This leads to contraction of detrusor muscles and relaxation of internal sphincter and urine flows into the urethra from the urinary bladder.

In the second phase, when urine flows through urethra, the stretch receptors present in urethra are stimulated. This leads to inhibition of pudendal nerve, relaxation of external sphincter causing voiding of urine.

140. Trace the pathway for first phase micturition reflex.
Receptors: Stretch receptors in the wall of urinary bladder
Afferent fibers: Pass through pelvic nerve
Center: Sacral segments of spinal cord
Efferent fibers: Pass through pelvic nerve
Response: Contraction of detrusor muscles and relaxation of internal sphincter.

141. Where are the centers for micturition
In sacral segments of spinal cord.

142. What are the higher centers for micturition?
Spinal centers for micturition are regulated by two types of higher centers in brain.
Inhibitory centers: Centers in midbrain and cerebral cortex inhibit the micturition by suppressing spinal micturition centers.
Facilitatory centers for micturition: Centers in pons and some centers in cerebral cortex facilitate micturition.

143. What is atonic bladder? What are the other names for it?
Atonic bladder is the urinary bladder with loss of tone in detrusor muscle. Due to loss of tone in bladder, micturition contraction is lost and there is overflow dribbling. It occurs in conditions like syphilis, tabs dorsalis or injury to sacral segments of spinal cord.

Atonic bladder is also called flaccid neurogenic bladder or hypoactive neurogenic bladder

144. What is overflow incontinence or overflow dribbling?
In atonic bladder, due to loss of tone in detrusor muscle and absence of micturition contraction, the bladder is completely filled with urine. Later there is overflow of urine in drops as and when urine enters the bladder. This is called overflow incontinence or overflow dribbling.

145. What is automatic bladder?
Bladder with automatic emptying of urine is called automatic bladder. During the stage of recovery after spinal transection, the voluntary control of urinary bladder is lost. Whenever, some amount of urine reaches the bladder, there is automatic emptying of bladder.

146. What is uninhibited neurogenic bladder? What are the other names for it?
In brainstem lesion, the higher centers continuously excite the spinal micturition centers causing uncontrollable micturition. Even a small quantity of urine collected in the bladder elicits the micturition reflex. This type of bladder is known as uninhibited neurogenic bladder.

It is also called spastic neurogenic bladder or hyperactive neurogenic bladder.

147. What is nocturnal micturition?
Bedwetting is called nocturnal micturition or enuresis. It is due to the loss of voluntary control of micturition. It is common in children below 3 years due to incomplete myelination of motor nerve fibers of urinary bladder. In adults it occurs in neurological or psychological disorders.

148. What is dialysis?
Dialysis means diffusion of solutes from an area of higher concentration to the area of lower concentration through a semipermeable membrane. And, this is the principle of artificial kidney.

149. What is artificial kidney?
Artificial kidney is a machine that is used to carry out dialysis during renal failure.

150. What is dialysate?
Diialysate is the dialyzing fluid that is used in artificial kidney. Through this fluid, the blood is purified during dialysis.

151. What is the composition of dialysate?
Dialyzing fluid contains more quantity of glucose, bicarbonate and calcium. It contains less quantity of sodium, potassium and chloride than in patient's blood. It does not contain urea, uric acid, sulfate, phosphate and creatinine.

152. What is peritoneal dialysis?
It is the technique in which peritoneal membrane is used as a semipermeable membrane to remove waste materials and toxic substances from body fluid.

153. What are the complications of dialysis?
i. Sleep disorders
ii. Anxiety
iii. Depression.

154. Define diuretics?
Diuretics are the substances that increase the urine output.

155. What are the general uses of diuretics?
Diuretics are generally used for the treatment of disorders involving increase in extracellular fluid volume like:
i. Hypertension
ii. Congestive cardiac failure
iii. Edema.
Diuretic agents prevent these disorders, by increasing the urinary output and reducing extracellular fluid (ECF) volume.

156. What is syndrome of diuretic-dependent sodium retention? What is the cause for it?
It is a disorder characterized by edema. It is caused by prolonged use of diuretics.

157. What are adverse effects of diuretics?
i. Dehydration
ii. Electrolyte imbalance
iii. Potassium deficiency

iv. Headache
v. Dizziness
vi. Renal damage
vii. Cardiac arrhythmia
viii. Heart palpitations.

158. What are types of diuretics?
i. Diuretics which increase osmotic pressure in renal tubules (osmotic diuretics)
ii. Diuretics which inhibit active reabsorption of electrolytes
iii. Diuretics which inhibit action of aldosterone
iv. Diuretics which inhibit activity of carbonic anhydrase
v. Diuretics which increase glomerular filtration rate
vi. Diuretics which inhibit secretion of ADH
vii. Diuretics which inhibit ADH receptors

159. What are osmotic diuretics? Give examples.
Some of the osmotically active substances which are not reabsorbed from renal tubules can increase the osmotic pressure in the tubules and thereby increase the urine output. Such substances are called osmotic diuretics.

Examples: Urea, mannitol, sucrose and glucose.

160. What are loop diuretics? Give examples.
Substances, which inhibit the reabsorption of electrolytes in the ascending limb of loop of Henle and thereby increase the urine output, are known as loop diuretics.

Examples: Furosemide, torasemide and bumetanide.

161. Name some diuretics, which act on distal convoluted tubule.
Chlorothiazide, metolazone and chlortalidone inhibit reabsorption of sodium and potassium from proximal part of distal convoluted tubule.

Triamterene and amiloride inhibit reabsorption of electrolytes from distal part of distal convoluted tubule.

162. Name the diuretics inhibiting action of aldosterone on renal tubule.
Spironolactone and eplerenone.

163. Name the diuretics which inhibit the secretion of antidiuretic hormone.
Water and ethanol.

164. Name some diuretics, which increase glomerular filtration rate.
Xanthines such as caffeine and theophylline.

165. What are the layers of skin?
i. Epidermis: Formed by stratified epithelium
ii. Dermis: Connective tissue layer formed by collagen fibers, fibroblasts and histiocytes.

166. What are the layers epidermis?
i. Stratum corneum: Formed by dead cells
ii. Stratum lucidum: Formed by flattened epithelial cells
iii. Stratum granulosum: Formed by flattened rhomboid cells
iv. Stratum spinosum: Formed by epithelial cells with spine-like protoplasmic projections
v. Stratum germinativum: Formed by polygonal cells superficially and columnar or cuboidal cells in deeper layers. Contains keratinocytes, melanocytes and Langerhans cells.

167. What are the layers dermis?
i. Stratum corneum: Formed by dead cells
ii. Stratum lucidum: Formed by flattened epithelial cells
iii. Stratum granulosum: Formed by flattened rhomboid cells.

168. What are the appendages of skin?
i. Hair follicles with hair
ii. Nails
iii. Sweat glands
iv. Sebaceous glands
v. Mammary glands.

169. What is melanin?
Melanin is the skin pigment and it forms the major color determinant of human skin. Skin becomes dark when melanin content increases.

170. Which is the source of melanin?
Melanin is synthesized by melanocytes, which are present mainly in the stratum germinativum and stratum spinosum of epidermis. After synthesis, this pigment spreads to the cells of the other layers.

171. What are the glands present in skin?
i. Sebaceous glands which secrete sebum
ii. Sweat glands which secrete sweat.

172. What is the function of sebaceous glands?
Sebaceous glands secrete an oily substance called sebum that has antibacterial action, antifungal action and protective function. Sebum also prevents heat loss.

173. What is the composition of sebum?
Sebum contains free fatty acids, triglycerides, squalene, sterols, waxes and paraffin.

174. What are the types of sweat glands? Name them.
Sweat glands are of two types, eccrine glands and apocrine glands.

175. What are the functional differences between eccrine and apocrine glands?
Eccrine glands function throughout life since birth and secrete clear watery sweat. These glands play major role in temperature regulation.

Apocrine glands start functioning only during puberty and secrete thick and milky sweat. These glands do not play any role in temperature regulation.

176. Name the nerves supplying the sweat glands.
Eccrine glands are supplied by sympathetic cholinergic fibers whereas, apocrine glands are supplied by sympathetic adrenergic fibers.

177. What are pheromones or vomeropherins?
Pheromones or vomeropherins are a group of chemical substances that are secreted by apocrine glands. When secreted into environment by an organism, pheromones produce some behavioral or physiological changes in other members of the same species.

Pheromones are mostly present in urine, vaginal fluid and other secretions of mammals and influence the behavior and reproductive cycle in these animals.

178. What are the functions of skin?
i. Protective function: Protection from bacteria, toxic substances, mechanical blow and ultraviolet rays
ii. Sensory function
iii. Storage function: Storage of substances like fat and water
iv. Synthetic function: Synthesis of vitamin D
v. Regulation of body temperature
vi. Regulation of water and electrolyte balance
vii. Excretory function: Excretion of urea, salts and fatty substances
viii. Absorptive function: Absorption of fat soluble substances and some ointments
ix. Secretory function: Secretion of sweat and sebum.

179. What are homeothermic or warm-blooded animals?
Homeothermic or warm-blooded animals are the animals in whom the body temperature is maintained at a constant level, irrespective of the environmental temperature. Birds and mammals including man belong to this category.

180. What are poikilothermic or cold-blooded animals?
Poikilothermic or cold-blooded animals are the animals in whom the body temperature is not constant. It varies according to the environmental temperature. Amphibians and reptiles are the poikilothermic animals.

181. How body temperature is measured?
Body temperature is measured by placing the clinical thermometer in different parts of the body such as:
i. Mouth (oral temperature).
ii. Axilla (axillary temperature).
iii. Rectum (rectal temperature).
iv. Over the skin (superficial or surface temperature)

182. What is the normal body temperature?
37°C (98.6°F).

183. What is the temperature at different parts of the body?
Oral temperature: 37°C (98.6°F)
Axillary temperature: 0.3 to 0.6°C (0.5 to 1°F) lower than the oral temperature
Rectal temperature: 0.3 to 0.6°C (0.5 to 1°F) higher than oral temperature
Surface temperature: 29.5 to 33.9°C (85.1 and 93°F).

184. What is core temperature?
Core temperature is the average temperature in deeper tissues of the body. It is always more than the oral or rectal temperature. It is about 37.8°C (100°F).

185. Name the physiological factors affecting body temperature.
i. Age
ii. Sex
iii. Diurnal variation
iv. Meals
v. Exercise
vi. Sleep
vii. Emotion
viii. Menstrual cycle

186. What are the pathological variations of body temperature?
i. Hyperthermia: Abnormal increase in body temperature
ii. Hypothermia: Decrease in body temperature.

187. Name some conditions when hyperthermia or fever occurs.
i. Infection
ii. Hyperthyroidism
iii. Brain lesions
iv. Diabetes insipidus.

188. Name some conditions when hypothermia occurs.
i. Exposure to cold
ii. Immersion in cold water
iii. Drug abuse
iv. Hypothyroidism
v. Hypopituitarism
vi. Hypothalamic lesions
vii. Hemorrhage in brainstem.

189. What is heat balance?
Difference between heat produced in the body and the heat lost from the body is called heat balance.

190. How is heat produced in the body?
By:
i. Metabolic activities
ii. Muscular activity
iii. The actions of hormones
iv. Radiation of heat from environment
v. Shivering
vi. Brown fat tissue.

191. What is heat of metabolism?
Heat produced by metabolism of foodstuffs. It is the major portion of heat produced in the body.

192. What is heat of activity?
Heat produced during muscular activity. 80% of heat is produced by skeletal muscles.

193. What is heat brown fat tissue? What is its importance?
It is one of the two types of adipose tissues, the other being white fat tissue. Brown fat tissue produces enormous body heat particularly in infants.

194. How is heat lost from the body?
By:
i. Conduction
ii. Radiation
iii. Convection
iv. Evaporation
v. Panting.

195. What is insensible perspiration or insensible water loss?
It is the amount of water evaporated from skin and lungs continuously which we are not aware of it. It is about 400 to 600 mL/day.

196. Where are centers for temperature regulation in hypothalamus.
i. Heat loss center in the preoptic nucleus of hypothalamus
ii. Heat gain center in the posterior hypothalamic nucleus.

Section 6 Endocrinology

1. **What is a cell-to-cell signaling? What are the other names for it?**
   Cell-to-cell signaling refers to transfer of information from one cell to another cell. It is also called cell signaling or intercellular communication.
2. **Define chemical messengers.**
   Chemical messengers are the substances through which the cells of the body communicate with each other.
3. **Classify the chemical messengers.**
   i. Endocrine messengers: Classical hormones secreted by endocrine glands
   ii. Paracrine messengers: Which diffuse from control cells to target cells
   iii. Autocrine messengers: Which control the source cells which secrete them.
   iv. Neurocirne messengers: Neurotransmitters released from nerve endings.
4. **What is a hormone?**
   Hormone is a chemical messenger that is secreted ductless (endocrine) gland and other organs like kidney and heart.
5. **What is a classical hormone? Give examples.**
   Classical hormone is the chemical messenger synthesized by endocrine glands and transported by blood to target organs or tissues (site of action).
   Examples: Growth hormone and insulin.
6. **What are paracrine messengers?**
   Paracrine messengers are the chemical messengers, which diffuse from the control cells to the target cells through the interstitial fluid.
7. **What are juxtacrine messengers or local hormones? Give examples.**
   Juxtacrine messengers or local hormones are some of the paracrine messengers which directly enter the neighboring target cells through gap junctions.
   Examples: Prostaglandins and histamine.
8. **What are autocrine messengers or intracellular chemical mediators? Give examples.**
   Autocrine messengers or intracellular chemical mediators are the chemical messengers, which control the source cells which secrete them.
   Examples: Leukotrienes.
9. **What are neurocrine or neural messengers?**
   Neurocrine or neural messengers are neurotransmitters and neurohormones.
   Neurotransmitter: Neurotransmitter is an endogenous signaling molecule that carries information form one nerve cell to another nerve cell or muscle or another tissue.
   Examples: Acetylcholine and dopamine.
   Neurohormone: Neurohormone is a chemical substance that is released by the nerve cell directly into the blood and transported to the distant target cells.
   Examples: Oxytocin, antidiuretic hormone and hypothalamic releasing hormones.
10. **What are endocrine glands? Why the name ductless glands for them?**
    Endocrine glands are the glands which synthesize and release the classical hormones into the blood.
    Endocrine glands are called ductless glands, because the hormones secreted by them are released directly into the blood without any duct.
11. **Define sign and symptom. Give examples.**
    Sign: It is the feature of a disease as detected by the doctor during the physical examination. So, it is the objective physical evidence of disease found by the examiner
    Examples: Yellow coloration of skin and mucous membrane in jaundice, paleness in anemia, enlargement of liver, etc.
    Symptom: It is the feature of a disease felt by the patient. So, it is the subjective evidence perceived by the patient. In simple words, it is a noticeable change in the body, experienced by the patient
    Examples: Fever, itching, swelling, tremor etc.
12. **Define syndrome. Give example**
    Syndrome is the combination of signs and symptoms (associated with a disease), which occur together and suggest the presence of a certain disease or the possibility of developing the disease.
    Examples: Stoke-Adams syndrome and syndrome of inappropriate antidiuretic hormone hypersecretion (SIADH).
13. **Classify the classical hormones.**
    Classical hormones are classified by their chemical nature:
    i. Steroid hormones
    ii. Protein hormones
    iii. Hormones derived from the amino acid tyrosine.
14. **What are the steroid hormones?**
    Steroid hormones are the hormones synthesized from cholesterol or its derivatives. Steroid hormones are secreted by adrenal cortex, gonads and placenta.
15. **What are the proteins hormones?**
    Protein hormones are large or small peptides. Protein hormones are secreted by pituitary gland, parathyroid glands, pancreas and placenta ('P's).
16. **What are the hormones derived from tyrosine?**
    Two types of hormones, namely thyroid hormones and adrenal medullary hormones are derived from the amino acid tyrosine.
17. **What are hormones receptors?**
    Hormone receptors are the large proteins present in target cells to which the hormones bind to execute the hormonal actions.

18. Where are the hormonal receptors situated in the target cell?
i. Cell membrane: Receptors of catecholamines and protein hormones are situated in the cell membrane
ii. Cytoplasm: Receptors of steroid hormones are in the cytoplasm
iii. Nucleus: Receptors of thyroid hormones are situated in nucleus.

19. What is hormone-receptor complex?
It is the complex formed when a hormone combines with its receptor on the target cells.

20. Name the mechanism of action of different types of hormones.
Hormones act by any of the following mechanisms:
i. By altering the permeability of cell membrane: Neurotransmitters
ii. By activating the intracellular enzymes and formation of second messenger: Protein hormones and catecholamines
iii. By activating the genes: Thyroid and steroid hormones.

21. What is second messenger?
Substance through which the hormonal actions are executed is known as second messenger, the hormone being the first messenger.

22. Name some second messengers.
Cyclic AMP, calcium, calmoduline, inositol triphosphate (IP_3), diacylglycerol (DAG) and cyclic GMP are second messengers.

23. What are G proteins? What is their significance?
G proteins or guanosine nucleotide binding proteins are the membrane proteins to which the receptor proteins are attached in most of the target cells. G proteins play important role in the formation of cyclic AMP.

24. What are the actions of cyclic AMP?
Cyclic AMP executes the actions of hormone inside the cell by stimulating the enzymes like protein kinase A. Cyclic AMP produces the response, depending upon the function of the target cells through these enzymes.

25. Name the major endocrine glands in the body.
Pituitary gland, thyroid gland, parathyroid gland, adrenal glands, islets of Langerhans in pancreas and gonads (ovaries in females and testes in males).

26. Where is pituitary gland (hypophysis) situated?
Pituitary gland (hypophysis) is situated at the base of the brain in sella turcica of sphenoid bone.

27. What are the two parts of pituitary gland?
i. Anterior pituitary or adenohypophysis
ii. Posterior pituitary or neurohypophysis.

28. Briefly explain development of pituitary gland.
Anterior pituitary is ectodermal in origin and arises from pharyngeal epithelium as an upward growth as Rathke pouch.

Posterior pituitary is neuroectodermal in origin and arises from hypothalamus as a downward diverticulum.

29. Name the parts of anterior pituitary.
i. Pars distalis
ii. Pars tuberalis
iii. Pars intermedia.

30. Name the types of cells in anterior pituitary.
i. Somatotrophs: Secrete growth hormone
ii. Corticotropes: Secrete adrenocorticotropic hormone
iii. Thyrotropes: Secrete thyroid stimulating hormone
iv. Gonadotrophs: Secrete gonadotropic hormones
v. Lactotrophs: Secrete prolactin.

31. Enumerate the hormones secreted by anterior pituitary.
i. Growth hormone
ii. Thyroid stimulating hormone
iii. Adrenocorticotropic hormone
iv. Follicle stimulating hormone
v. Luteinizing hormone
vi. Prolactin.

32. What are the gonadotropic hormones?
Follicle stimulating hormone and luteinizing hormone are together called gonadotropic hormones or gonadotropins because of their action on gonads.

33. What is hypothalamo-hypophyseal system?
Hypothalamo-hypophyseal system is the connection between the pituitary gland and hypothalamus through which hypothalamus controls pituitary gland.

34. Name the parts of hypothalamo-hypophyseal system.
i. Hypothalamo-hypophyseal portal system which connects the hypothalamus with anterior pituitary through blood vessels
ii. Hypothalamo-hypophyseal tract which connects the hypothalamus with posterior pituitary through nerves.

35. How is anterior pituitary regulated?
Anterior pituitary is regulated by hypothalamus by the secretion of releasing and inhibitory hormones, which reach the anterior pituitary through hypothalamo- hypophyseal portal vessels.

36. Name the releasing hormones, which regulate anterior pituitary.
i. Growth hormone releasing hormone
ii. Growth hormone releasing polypeptide
iii. Thyrotrophic releasing hormone
iv. Corticotropin releasing hormone
v. Gonadotropin releasing hormone.

37. Name the inhibitory hormones, which control anterior pituitary.
i. Growth hormone inhibitory hormone or somatostatin
ii. Prolactin inhibitory hormone.

38. What are the metabolic effects of growth hormone?
Growth hormone acts on protein, carbohydrate and fat metabolism.
i. On protein metabolism: It increases protein synthesis
ii. On carbohydrate metabolism: It increases conservation of sugar
iii. On fat metabolism: It increases mobilization of fat from fat depots and utilization of fat.

39. How does growth hormone increase protein synthesis?
Growth hormone increases the protein synthesis by:
i. Increasing amino acid transport through cell membrane
ii. Increasing RNA translation
iii. Increasing transcription of DNA to RNA
iv. Decreasing the catabolism of proteins.
v. By promoting anabolism of protein indirectly via insulin

40. How does growth hormone act as protein sparer?
Growth hormone acts as protein sparer by mobilizing fats from fat depots and making them available for energy production so that the proteins are spared and not broken down.

41. How does growth hormone increase the blood sugar level?

Growth hormone increases the blood sugar level by:

i. Decreasing the peripheral utilization of glucose
ii. Increasing the deposition of glycogen in the cells and saturating the cells with glycogen
iii. Decreasing the uptake of glucose by the cells.

42. What is diabetogenic effect of growth hormone?

Hypersecretion of GH increases blood glucose level enormously. It causes continuous stimulation of the β-cells in the islets of Langerhans in pancreas and increase in secretion of insulin. In addition to this, the GH also stimulates β-cells directly and causes secretion of insulin. Because of the excess stimulation, β-cells are burnt out at one stage. This causes deficiency of insulin, leading to true diabetes mellitus or full-blown diabetes mellitus. This effect of GH is called the diabetogenic effect.

43. What is the effect of growth hormone on bones?

In fetus: Growth hormone is responsible for the differentiation and development of bone cells.

During childhood till puberty: Growth hormone increases the length and thickness of bone.

After puberty: When the head of the bone fuses with shaft, the growth hormone increases the thickness of bones.

44. What is the mode of action of growth hormone on bones?

Growth hormone does not act directly on the bones. Instead, it acts on liver and causes secretion of a substance called somatomedin. The somatomedin acts on the bones and causes increase in the length and thickness of bones.

45. What is somatomedin?

Somatomedin is a polypeptide secreted in liver under the influence of growth hormone.

46. What are the types of somatomedin? Mention their actions.

i. Insulin like growth factor I (IGF – I) or somatomedin C: Acts on bones and protein metabolism
ii. Insulin like growth factor II (IGF – II): Promotes growth of fetus.

47. Which is the receptor for growth hormone?

Growth hormone receptor is called growth hormone secretagogue (GHS) receptor which is a transmembrane receptor belonging to cytokine family.

48. How is secretion of growth hormone regulated?

Growth hormone secretion is regulated by hormones secreted by hypothalamus:

i. Growth hormone releasing hormone
ii. Growth hormone releasing polypeptide
iii. Growth hormone inhibitory hormone (somatostatin).

Whenever the blood level of growth hormone decreases, hypothalamus secretes growth hormone releasing hormone, and growth hormone releasing polypeptide which in turn act on pituitary and increase the secretion of growth hormone.

When blood level of growth hormone increases, it is controlled by negative feedback mechanism. Hypothalamus secretes growth hormone inhibitory hormone which decreases or stops the secretion of growth hormone.

49. Explain feedback control of GH secretion.

Hypothalamus releases GHRH and GHRP, which in turn promote the release of GH from anterior pituitary. GH acts on various tissues. It also activates the liver cells to secrete somatomedin C (IGFI).

Now, the somatomedin C increases the release of GHIH from hypothalamus. GHIH, in turn inhibits the release of GH from pituitary. Somatomedin also inhibits release of GHRP from hypothalamus. It acts on pituitary directly and inhibits the secretion of GH.

50. Explain short-loop feedback control.

GH inhibits its own secretion by stimulating the release of GHIH from hypothalamus. This type of feedback is called short-loop feedback control. Similarly, GHRH inhibits its own release by shortloop feedback control.

51. What is ghrelin? What is its role of ghrelin in secretion of GH?

Ghrelin is a peptide hormone synthesized mainly by epithelial cells in the fundus of stomach. It promotes secretion of GH by stimulating somatotrophs directly.

52. What are the actions of follicle stimulating hormone (FSH) in females?

In females, FSH:

i. Causes the development of Graafian follicle from primordial follicle.
ii. Stimulates the theca cells of Graafian follicle and causes secretion of estrogen
iii. Promotes the aromatase activity in granulosa cells, resulting in conversion of androgens into estrogen.

53. What are the actions of follicle stimulating hormone (FSH) in males?

In males, FSH acts along with testosterone to accelerate the process of spermiogenesis.

54. What are the actions of luteinizing hormone (LH) in females?

In females, LH:

i. Causes maturation of vesicular follicle into Graafian follicle along with follicle stimulating hormone
ii. Induces synthesis of androgens from theca cells of growing follicle
iii. Is responsible for ovulation
iv. Is necessary for the formation of corpus luteum
v. Activates the secretory functions of corpus luteum.

55. What is the name of LH in males? What is its action?

In males, this hormone is known as interstitial cell stimulating hormone (ICSH). It stimulates the interstitial cells of Leydig in testes to secrete testosterone.

56. What are the actions of prolactin?

Prolactin acts on the mammary glands and prepares it for production and secretion of milk by causing localized alveolar hyperplasia.

57. What is β-lipotropin? What is its action?

It is a polypeptide hormone secreted from anterior pituitary. It also forms the precursor of endorphins. It mobilizes fat from adipose tissue and promotes lipolysis.

58. What are the parts of posterior pituitary.

i. Pars nervosa or infundibular process
ii. Neural stalk or infundibular stem
iii. Median eminence.

59. What is hypophyseal stalk?

It is the connection between pituitary and hypothalamus.

60. Name the hormones of posterior pituitary.

i. Antidiuretic hormone (ADH)
ii. Oxytocin.

61. Which is the source of secretion of posterior pituitary hormones?

Posterior pituitary hormones are secreted from hypothalamus. ADH is secreted mainly from supraoptic

nucleus and oxytocin is secreted mainly from paraventricular nucleus of hypothalamus.

62. How do ADH and oxytocin reach the posterior pituitary from hypothalamus?
ADH and oxytocin, which are secreted from hypothalamic nuclei, reach the posterior pituitary through the nerve fibers of hypothalamo hypophyseal tract.

63. What is hypophyseal stalk?
It is the connection between pituitary and hypothalamus.

64. What are neurophysins? Mention their actions.
Neurophysins are the binding proteins which transport ADH and oxytocin from hypothalamus to posterior pituitary via hypothalamohypophyseal tract.

65. What are the two types of neurophysins?
Neurophysin I or oxytocin-neurophysin: Binding protein for oxytocin

Neurophysin II or ADH-neurophysin: Binding protein for ADH.

66. What are the actions of ADH?
i. Retention of water: Major function of ADH is retention of water by acting on kidneys. It increases the facultative reabsorption of water from distal convoluted tubule and collecting duct in the kidneys
ii. Vasopresor action: In large amount, ADH increases blood pressure by constriction of the arteries in all parts of the body.

67. Why ADH is called so?
Since this hormone prevents diuresis by reabsorption of water from distal convoluted tubule and collecting duct, it is called antidiuretic hormone (ADH).

68. How is ADH secretion regulated?
ADH secretion is regulated by the volume and osmolar concentration of ECF. ADH secretion is stimulated by decrease in ECF volume and increase in the osmolar concentration of ECF.

69. What are osmoreceptors? Mention their situation.
Osmoreceptors are the receptors which give response to change in the osmolar concentration of the blood. These receptors are situated near supraoptic and paraventricular nuclei of hypothalamus.

70. What is the function of osmoreceptors?
When osmolar concentration of blood increases, the osmoreceptors are activated and stimulate the supraoptic and paraventricular nuclei. These nuclei send motor impulses to posterior pituitary through the nerve fibers and cause release of ADH.

ADH causes reabsorption of water from the renal tubules. This increases ECF volume and restores the normal osmolarity.

71. What is the mode of action of ADH?
ADH increases water reabsorption in tubular epithelial membrane by regulating the water channel proteins called aquaporins through V2 receptors.

72. Mention the sites of action of oxytocin.
Mammary glands and uterus.

73. What is the action of oxytocin on mammary glands?
Oxytocin causes ejection of milk by contracting the myoepithelial cells of mammary glands.

74. What is milk ejection reflex? Why is it called neuroendocrine reflex?
When the infant suckles mother's nipple, the impulses produced from the touch receptors on and around the nipple pass through somatic afferent nerve fibers and reach the paraventricular and supraoptic nuclei of hypothalamus via cerebral cortex.

Now, oxytocin is released into the blood. When the hormone reaches the mammary glands, it causes ejection of milk. As this reflex is initiated by nervous factors and completed through hormonal action, it is called neuroendocrine reflex.

During this reflex, large quantity of oxytocin is secreted by positive feedback mechanism.

75. What is the action of oxytocin on pregnant uterus?
Oxytocin causes contraction of uterus and helps in the expulsion of fetus during labor. Due to the movement of fetus through cervix during the onset of labor, the receptors on the cervix are stimulated and discharge the impulses. These impulses are carried to cerebral cortex by somatic nerve fibers. Cerebral cortex sends impulses to hypothalamus causing the release of oxytocin into blood.

And oxytocin enhances labor by causing contraction of uterus. This is a neuroendocrine reflex.

During labor a large quantity of oxytocin is released by means of positive feedback mechanism.

76. What is the action of oxytocin on non-pregnant uterus?
On non-pregnant uterus, oxytocin increases the uterine contractions during sexual intercourse and facilitates the transport of sperms through uterine cavity towards the fallopian tube.

77. What is the mode of action of oxytocin?
Oxytocin acts on mammary glands and uterus by activating G-protein coupled oxytocin receptor.

78. What are the disorders of pituitary gland?
Hyperactivity of anterior pituitary:
i. Gigantism
ii. Acromegaly
iii. Acromegalic gigantism

Hypoactivity of anterior pituitary:
i. Dwarfism
ii. Acromicria
iii. Simmond's disease

Hyperactivity of posterior pituitary
Syndrome of inappropriate hypersecretion of ADH (SIADH)

Hypoactivity of posterior pituitary:
Diabetes insipidus

Hypoactivity of anterior and posterior pituitary:
Dystrophia adiposogenitalis.

79. What is gigantism?
Gigantism is the pituitary disorder characterized by excess growth of the body.

80. What is cause for gigantism?
Gigantism is due to hypersecretion of GH in childhood or in preadult life before the fusion of epiphysis of bone with shaft. Hypersecretion of GH is because of tumor of acidophil cells in the anterior pituitary.

81. What are the important features of gigantism?
i. Increase in height of the person to 7 or 8 feet
ii. Hyperglycemia leading to diabetes mellitus and glycosuria
iii. Constant headache
iv. Visual disturbances (bitemporal hemianopia).

82. What is acromegaly?
Acromegaly is the pituitary disorder characterized by enlargement, thickening and broadening of bones particularly in extremities of the body.

83. What is the cause for acromegaly?
Acromegaly is due to hypersecretion of GH in adults after the closure of epiphysis. Hypersecretion of GH is because of tumor of acidophil cells in anterior pituitary.

84. What are the important features of acromegaly?
i. Facial features: Acromegalic face or guerrilla face with protrusion of supraorbital ridges, broadening of nose, thickening of lips, wrinkles on forehead and protrusion of lower jaw (prognathism)
ii. Enlargement of hands and feet with kyphosis
iii. Kyphosis
iv. Bulldog scalp
v. Overgrowth of body hair
vi. Enlargement of visceral organs like lungs, thymus, heart, liver and spleen
vii. Hyperactivity of other endocrine glands
viii. Hyperglycemia and glycosuria resulting in diabetes mellitus
ix. Hypertension.
x. Headache
xi. Visual disturbance (bitemporal hemianopia).

85. What is acromegalic gigantism?
It is a rare disorder with symptoms of both gigantism and acromegaly.

86. What is the cause for acromegalic gigantism?
Hypersecretion of GH in children, before the fusion of epiphysis with shaft of the bones causes gigantism and if hypersecretion of GH is continued even after the fusion of epiphysis, the symptoms of acromegaly also appear.

87. What is Cushing's disease?
It is a disease characterized by obesity. It is due to hypersecretion of glucocorticoids.

88. What are the features of Cushing's disease?
Refer Q 254.

89. What is dwarfism?
Dwarfism is a pituitary disorder in children characterized by stunted growth.

90. What is the cause for dwarfism?
Dwarfism is due to hyposecretion of growth hormone in infancy or early childhood. Hyposecretion of GH occurs due to:
i. Tumor of chromophobes
ii. Deficiency of GH-releasing hormone secreted by hypothalamus
iii. Deficiency of somatomedin
iv. Atrophy or degeneration of acidophilic cells in the anterior pituitary
v. Panhypopituitarism.

91. What is panhypopituitarism?
It is the condition characterized by hyposecretion of all hormones of anterior pituitary.

92. What are the important features of dwarfism?
i. Stunted growth is the prominent feature of dwarfism
ii. Different parts of the body are almost proportionate. Only the head becomes slightly longer.
iii. No other deformity and mental activity is normal
iv. Reproductive function is normal if there is only GH deficiency.

93. List different types of dwarfism?
i. Pituitary dwarfism
ii. Growth hormone insensitivity: Laron dwarfism
iii. Psychosocial dwarfism or Kasper Hauser syndrome
iv. Dwarfism in dystrophia adiposogenitalis
v. Dwarfism in panhypopituitarism
vi. Cretinism

94. What is growth hormone insensitivity?
Growth hormone insensitivity (GHI) is a group of rare genetic disorders characterized by dwarfism caused by mutations in genes of growth hormone receptors (GHR) or mutations in IGF-1.

95. What is Laron dwarfism or Laron syndrome?
Laron dwarfism or Laron syndrome is one of GHI that occurs due to mutations in genes of GHR. GH secretion is normal or high. Since, the hormone cannot stimulate growth because of abnormal GHR, dwarfism occurs.

96. What is psychogenic dwarfism or Kasper Hauser syndrome?
Psychosocial or stress dwarfism is a pituitary disorder that occurs due to deficiency of GH caused by exposure of the child to extreme emotional deprivation or stress.
It is also called Kasper Hauser syndrome since it was noticed first in a patient called Kasper Hauser.

97. What is dystrophia adiposogenitalis or Fröhlich syndrome?
Dystrophia adiposogenitalis or Fröhlich syndrome is a pituitary disorder caused by hypoactivity of both anterior and posterior pituitary. It results in dwarfism if it affects children.

98. What is acromicria?
This is a rare condition in adults characterized by atrophy of extremities of the body.

99. What is the cause for acromicria?
Deficiency of GH in adults causes acromicria.
Hyposecretion of GH occurs in the following conditions:
i. Deficiency of GH-releasing hormone from hypothalamus
ii. Atrophy or degeneration of acidophilic cells in the anterior pituitary
iii. Tumor of chromophobes
iv. Panhypopituitarism.

100. What are the important features of acromicria?
i. Atrophy and thinning of hands and feet
ii. Hypothyroidism
iii. Hyposecretion of adrenocortical hormones
iv. Lethargy and obesity
v. Loss of sexual functions.

101. What is Simmond's disease or pituitary cachexia?
It is a pituitary disease that occurs mostly in panhypopituitarism due to atrophy or degeneration of the gland.

102. What are the features of Simmond's disease?
i. Rapid development of senile decay and appearance of old age
ii. Loss of hair and teeth
iii. The skin over the face becomes dry and wrinkled.

103. What is syndrome of inappropriate hypersecretion of antidiuretic hormone (SIADH)?
SIADH is the disease due to the excessive secretion of ADH.

104. What are the features of SIADH?
i. Loss of appetite.
ii. Weight loss.
iii. Nausea and vomiting.
iv. Headache.
v. Muscle weakness, spasm and cramps.

vi. Fatigue.
vii. Restlessness and irritability.
viii. In severe conditions: Convulsions, coma and death.

105. What is diabetes insipidus?
It is a posterior pituitary disorder characterized by excessive excretion of water through urine.

106. What are the causes of diabetes insipidus?
Diabetes insipidus is due to the deficiency of ADH, which occurs in the following conditions:
i. Lesion (injury) or degeneration of supraoptic and paraventricular nuclei of hypothalamus
ii. Lesion in hypothalamohypophyseal tract
iii. Atrophy of posterior pituitary
iv. Inability of renal tubules to give response to ADH hormone.

107. What are the important features of diabetes insipidus?
i. Polyuria: Excretion of large quantity of dilute urine
ii. Polydipsia: Excessive thirst inducing intake of large quantity of water
iii. Dehydration: If thirst is also affected.

108. What is nephrogenic diabetes insipidus?
Nephrogenic diabetes insipidus is a genetic disorder due to inability of renal tubules to give response to ADH. It is caused by mutations of genes of V2 receptors or aquaporin 2.

109. What is dystrophia adiposogenitalis? What are its other names?
It is a disease characterized by obesity and hypogonadism, affecting mainly the adolescent boys. It is also called Fröhlich syndrome or hypothalamic eunuchism.

110. What are causes of dystrophia adiposogenitalis?
Dystrophia adiposogenitalis is due to hypoactivity of both anterior pituitary and posterior pituitary.
Causes:
i. Tumor in pituitary gland and hypothalamic regions
ii. Injury or atrophy of pituitary gland
iii. Genetic inability of hypothalamus to secrete luteinizing hormone releasing hormone

111. What are the important features of dystrophia adiposogenitalis?
In children: Obesity, dwarfism and sexual infantilism
In adults: Obesity and atrophy of sex organs.

112. What are the cells present in follicles of thyroid gland?
i. Follicular cells: Secrete tetraiodothyronine (thyroxine) and triiodothyronine
ii. Parafollicular cells: Secrete calcitonin.

113. Name the hormones secreted by thyroid gland.
i. Triiodothyronine (T_3)
ii. Tetraiodothyronine (T_4 or thyroxine)
iii. Calcitonin.

114. Which is more potent amongst T_3 and T_4? Why it is so?
T_3 is more potent than T_4 because T_3 is found freely in the plasma and can act immediately. But T_4 is bound with plasma proteins, so it takes time for it to be released and then to act.

115. What are the substances necessary for the synthesis of thyroid hormones?
i. Amino acid tyrosine
ii. Inorganic ion iodine.

116. How much of iodine is required for the synthesis of normal quantity of thyroid hormones?
One mg of iodine per week or 50 mg per year.

117. Name the stages in the synthesis of thyroid hormones.
i. Thyroglobulin synthesis
ii. Iodide trapping and iodide pump
iii. Oxidation of iodide into elemental iodine
iv. Transport of iodine into follicular cavity
v. Iodination of tyrosine
vi. Coupling reactions.

118. What are the enzymes involved in the synthesis of thyroid hormones?
i. Peroxidase that converts iodide into elemental iodine
ii. Iodinase that accelerates the iodination of tyrosine.

119. What is pendrin?
Pendrin is an iodide-chloride pump which transports iodine from follicular cells into follicular cavity of thyroid gland.

120. What is thyroglobulin? What is its importance?
Thyroglobulin is a large glycoprotein secreted by the endoplasmic reticulum and Golgi apparatus of follicular cells and stored in the follicles of thyroid gland.
Thyroid hormones are secreted in thyroglobulin.

121. How are thyroid hormones released from thyroglobulin?
Follicular cells form pinocytic vesicles around thyroglobulin–hormone complex. Then the digestive enzymes like proteinase present in lysosomes of the follicular cells digest the thyroglobulin and release the hormones.

122. How are the thyroid hormones transported in the blood?
Thyroid hormones are transported in the blood in combination with plasma proteins:
i. Thyroxine binding globulin (TBG)
ii. Thyroxine binding prealbumin (TBPA)
iii. Albumin.

123. What is the normal plasma level of T_3 and T_4?
T_3 = 0.12 µg/dL
T_4 = 8 µg/dL.

124. What is the action of thyroxine on basal metabolic rate (BMR)?
Thyroxine increases BMR by increasing metabolic activities in most of the body tissues, except brain, retina, spleen, testes and lungs. This action is called calorigenic action.

125. What are the actions of thyroxine on protein metabolism?
Thyroxine increases:
i. Translation of RNA
ii. Transcription of DNA into RNA
iii. Mitochondrial activity
iv. Activity of cellular enzymes.

126. What are the actions of thyroxine on carbohydrate metabolism?
Thyroxine is a diabetogenic hormone. It increases:
i. Glucose absorption from gastrointestinal tract
ii. Transport of glucose into the cells
iii. Breakdown of glycogen (glycogenolysis) into glucose
iv. Gluconeogenesis.

127. What are the actions of thyroxine on fat metabolism?
i. Mobilizes fat from fat depots and increases free fatty acids in the blood
ii. Decreases the level of cholesterol and triglycerides in plasma.

128. What is the action of thyroxine on vitamins?
Thyroxine increases the formation of many enzymes by utilizing. Hence, vitamin deficiency is possible during hypersecretion of thyroxine.

129. What is the action of thyroxine on body temperature?
Thyroid hormone increases the heat production in the body, by accelerating various cellular metabolic processes and increasing BMR. It is called thyroid hormone-induced thermogenesis.

130. What is the action of thyroxine on growth?
Thyroid hormones have general and specific effects on growth. It accelerates the growth of the body, especially in growing children. Thyroxine is more important to promote growth and development of brain during fetal life and first few years of postnatal life.

131. What is the action of thyroxine on blood?
Thyroxine accelerates erythropoietic activity and increases blood volume. It is one of the important general factors necessary for erythropoiesis.

132. What are the actions of thyroxine on cardiovascular system?
Thyroxine increases overall activity of cardiovascular system. It:
i. Increases the heart rate
ii. Increases force of contractions of the heart
iii. Causes vasodilatation and increases blood flow
iv. Increases systolic blood pressure and decreases diastolic pressure leading to increase in pulse pressure.

133. What is the action of thyroxine on respiratory system?
Thyroxine increases the rate and force of respiration.

134. What are the actions of thyroxine on GI tract?
Thyroxine increases:
i. Appetite and intake of food
ii. Secretions and movements of GI tract.

135. What are the actions of thyroxine on central nervous system (CNS)?
Thyroxine is necessary for the development of CNS during fetal life. In adult life, it stimulates and maintains the normal function of CNS.

136. What are the effects of thyroxine on sleep?
Hypersecretion of thyroxine causes excessive stimulation of muscles leading to exhaustion and sleepiness. But the person cannot sleep because of the stimulatory effect of thyroxine on CNS. On the other hand, hyposecretion of thyroxine causes lethargy and somnolence (excessive sleep).

137. What is the mode of action of thyroid hormones?
Thyroid hormones act by activating the genes and increasing the genetic transcription. Thyroid hormones also act at mitochondrial level by stimulating the synthesis of proteins and RNA.

138. Name the factors increasing the secretion of thyroid hormones.
i. Low basal metabolic rate
ii. Leptin
iii. Alpha melanocyte stimulating hormone.

139. Name the factors decreasing the secretion of thyroid hormones.
i. Excess iodide intake
ii. Stress
iii. Somatostatin
iv. Glucocorticoids
v. Dopamine.

140. What are the actions of thyroid stimulating hormone (TSH)?
TSH increases:
i. Number of follicular cells of thyroid
ii. Development of follicles by converting cuboidal cells into columnar cells
iii. Size and secretory activity of follicular cells
iv. Iodide pump and iodide trapping in follicles
v. Secretion of thyroglobulin into follicles
vi. Iodination of tyrosine and coupling to form thyroid hormones
vii. Proteolysis of the thyroglobulin by which the thyroid hormones are released into the blood.

141. What is Wolff-Chaikoff effect?
Wolff-Chaikoff effect is the suppression of synthesis of thyroid hormones by high intake of dietary iodine.

142. Define hyperthyroidism and thyrotoxicosis.
Hyperthyroidism refers to excess synthesis and release of thyroid hormones by thyroid gland resulting in increased level of hormones in blood.

Thyrotoxicosis is defined as high level of thyroid hormones in blood is the condition caused by not only excess secretion by thyroid glands, but also release of stored hormones.

143. What are the causes for hyperthyroidism?
i. Grave's disease
ii. Thyroid adenoma.

144. What is Grave's disease? How it causes hyperthyroidism?
Graves' disease is an autoimmune disease. In Graves' disease, B lymphocytes (plasma cells) produce autoimmune antibodies called thyroid-stimulating autoantibodies (TSAbs). These antibodies act like TSH by binding with membrane receptors of TSH and activating cAMP system of the thyroid follicular cells. This results in hypersecretion of thyroid hormones.

145. What is thyroid adenoma?
It is a localized tumor developed in thyroid tissue. It secretes large quantities of thyroid hormones.

146. What are the important features of hyperthyroidism?
i. Intolerance to heat
ii. Increased sweating
iii. Loss of weight
iv. Diarrhea
v. Muscular weakness
vi. Nervousness
vii. Toxic goiter
viii. Oligomenorrhea or amenorrhea
ix. Exophthalmos
x. Polycythemia
xi. Tachycardia and atrial fibrillation
xii. Systolic hypertension
xiii. Cardiac failure.

147. What is exophthalmos?
Protrusion of eyeballs is known as exophthalmos.

148. What are the causes for exophthalmos in hyperthyroidism?
Exophthalmos in hyperthyroidism is due to the edematous swelling of retro-orbital tissues and degenerative changes in the extraocular muscles.

149. Why does exophthalmos lead to blindness if left untreated?
If left untreated, exophthalmos leads to blindness because of two reasons:
i. Protrusion of eyeball stretches the optic nerve causing damage to it and blindness
ii. Due to protrusion of eyeball, the eyelids cannot be closed fully even during sleep. So, the constant

exposure of eyeball to atmosphere causes dryness of the cornea leading to irritation and infection. This finally results in ulceration of cornea and blindness.

150. What are the effects of hypothyroidism?
In adults : Myxedema
In Children : Cretinism.

151. What is myxedema?
Myxedema is the hypothyroidism in adults, characterized by generalized edematous appearance.

152. What are the causes of myxedema?
i. Diseases of thyroid gland
ii. Genetic disorder
iii. Iodine deficiency
iv. Deficiency of thyroid-stimulating hormone
v. Deficiency of thyrotropin-releasing hormone.
vi. Hashimoto's thyroiditis.

153. What Hashimoto's thyroiditis?
It is an autoimmune disease characterized by inflammation and destruction of thyroid gland. It is the common cause of myxedema late middle-aged women.

154. What are the features of myxedema?
i. Swelling of the face
ii. Bagginess under the eyes
iii. Nonpitting edema
iv. Atherosclerosis leading to arteriosclerosis and hypertension
v. Anemia
vi. Fatigue and muscular sluggishness
vii. Somnolence
viii. Menorrhagia and polymenorrhea in females
ix. Decreased cardiovascular functions
x. Increased body weight
xi. Constipation
xii. Mental sluggishness
xiii. Depressed hair growth
xiv. Scaliness of the skin
xv. Frog like husky voice
xvi. Cold intolerance.

155. What is cretinism?
Cretinism is a congenital hypothyroidism characterized by stunted growth, physical deformity and mental retardation.

156. What are the causes of cretinism?
i. Congenital hyposecretion or absence of thyroid gland
ii. Genetic disorder affecting synthesis of thyroid hormones
iii. Lack of iodine in mother's diet during pregnancy
iv. Use of antithyroid drugs during pregnancy
v. Failure of pituitary to stimulate thyroid gland

157. What are the features of cretinism?
i. Sluggish movements
ii. Croaking sound while crying
iii. Mental retardation
iv. Stunted growth
v. Bloated body
vi. Protrusion of tongue with dripping of saliva
vii. Pot belly.
All these symptoms give idiotic look to the baby.

158. What are the major differences between cretinism and pituitary dwarfism?
i. In cretinism, there is mental retardation and in dwarfism, the development and functions of nervous system are normal
ii. The different parts of the body are disproportionate in cretinism but, in dwarfism, the different parts of the body are proportionate
iii. In cretinism, the reproductive function is abnormal whereas, it may be normal in dwarfism.

159. What is goiter?
Goiter is the enlargement of thyroid gland which occurs in hyperthyroidism and hypothyroidism.

160. What is toxic goiter?
Toxic goiter is the enlargement of thyroid gland with hypersecretion of hormones caused by thyroid tumor.

161. What is nontoxic goiter and what are the types of nontoxic goiter?
Nontoxic goiter is the enlargement of the thyroid gland with hyposecretion of hormones
It is of two types:
i. Endemic colloidal goiter that is due to lack of iodine
ii. Idiopathic nontoxic goiter that is due to thyroiditis or presence of goitrogenic factors in foodstuffs.

162. Name some antithyroid substances.
i. Thiocyanate
ii. Thyourylenes
iii. Inorganic iodides in high concentration.

163. What is thyroidectomy? When it is done?
Thyroidectomy is the surgical removal of thyroid gland. It is done in advance cases of hyperthyroidism when treatment with antithyroid substances is not possible.

164. Name the thyroid function tests.
i. Measurement of T_3 and T_4 in blood
ii. Measurement of basal metabolic rate
iii. Measurement of TRH and TSH in blood.

165. How many parathyroid glands are present in human beings? Mention their location.
Human beings have four parathyroid glands situated on posterior surface of upper and lower poles of thyroid gland.

166. Name the types of cells present in parathyroid glands and mention their functions.
i. Chief cells: Secrete parathormone
ii. Oxyphill cells: Degenerated chief cells and secrete parathormone only in pathological conditions like adenoma.

167. What is the important function of parathyroid glands in the body?
Parathyroid glands secrete parathormone that is very essential to maintain the blood calcium level.

168. What are the actions of parathormone (PTH)?
PTH:
i. Increases blood calcium level
ii. Decreases blood phosphate level.

169. Name the hormones involved in the regulation of blood calcium level.
i. Parathormone secreted from parathyroid glands
ii. 1, 25 dihydroxy cholecalciferol synthesized in kidney from vitamin D that is released from the liver
iii. Calcitonin secreted from parafollicular cells of thyroid gland.

170. How does PTH increase blood calcium level?
PTH increases the blood calcium level by increasing:
i. Resorption of calcium from bones
ii. Reabsorption of calcium from renal tubules
iii. Absorption of calcium from intestine by activating vitamin D.

171. How does PTH decrease blood phosphate level?
PTH decreases blood phosphate level by increasing urinary excretion of phosphate (phosphaturic action). PTH increases urinary excretion of phosphate by inhibiting reabsorption from renal tubules.

172. What is the action of PTH on bone?
i. PTH increases resorption of calcium from bones (osteoclastic activity) by acting on osteoclasts
ii. It stimulates proliferation of osteoclasts
iii. PTH also increases absorption of phosphate from bones.

173. What is the action of PTH on kidney?
i. PTH decreases urinary excretion of calcium by increasing reabsorption of calcium from renal tubules
ii. PTH increases urinary excretion of phosphate by inhibition tubular reabsorption of phosphate.

174. What is the action of PTH on GI tract?
i. PTH increases absorption of calcium from GI tract indirectly through 1, 25 dihydroxycholecalciferol
ii. PTH also increases absorption of phosphate from GI tract through calcitriol.

175. How is 1, 25 dihydroxycholecalciferol (active form of vitamin D) formed?
1, 25 dihydroxycholecalciferol (active form of vitamin D) is formed from vitamin D_3 (inactive form of vitamin D). Vitamin D_3 is converted into 25 hydroxycholecalciferol in liver and this is converted into 1, 25 dihydroxycholecalciferol in kidney in the presence of parathormone.

176. What are the actions of 1, 25 dihydroxycholecalciferol?
It increases:
i. Absorption of calcium from intestine
ii. Synthesis of ATPase in intestinal epithelium
iii. Alkaline phosphatase in intestinal epithelium.

177. How is secretion of PTH regulated?
i. Increase in blood calcium level decreases secretion of PTH. Thus, PTH secretion is inversely proportional to blood calcium level.
ii. Increase in blood phosphate level increases secretion of PTH. Thus, PTH secretion is directly proportional to blood phosphate level.

178. What is the effect of hyposecretion of parathormone?
Hyposecretion of parathormone leads to reduction in blood calcium level (hypocalcemia).

179. What are the causes of hyposecretion of parathormone leading to hypocalcemia?
i. Surgical removal of parathyroid glands (parathyroidectomy).
ii. Removal of parathyroid glands during surgical removal of thyroid gland (thyroidectomy).
iii. Autoimmune disease.
iv. Deficiency of receptors for PTH in the target cells. In this, the PTH secretion is normal or increased but the hormone cannot act on the target cells. This condition is called pseudohypoparathyroidism.

180. What is tetany?
Tetany is an abnormal condition characterized by violent and painful muscular spasm, particularly in feet and hand.

181. What is the cause for tetany?
Tetany is because of hyperexcitability of nerves and skeletal muscles due to hypocalcemia caused by hypoparathyroidism.

182. What are the important features of tetany?
i. Hyperreflexia and convulsions
ii. Carpopedal spasm
iii. Laryngeal stridor
iv. Cardiovascular changes.

183. What is muscular spasm?
Muscular spasm refers to involuntary muscular contraction.

184. What is carpopedal spasm?
Carpopedal spasm is the spasm in hand and feet that occurs in hypocalcemic tetany. During spasm, the hand shows a peculiar attitude as follows:
i. Flexion at wrist joint
ii. Flexion at metacarpophalangeal joints
iii. Extension at interphalangeal joints
iv. Adduction of thumb.

185. What is laryngeal stridor?
Stridor means noisy breathing. Laryngeal stridor means a loud crowing sound during inspiration, which occurs mainly due to laryngospasm.

186. What is latent tetany or subclinical tetany? What are its signs?
Latent tetany is the neuromuscular hyperexcitability due to hypocalcemia that develops before the onset of tetany. It is characterized by general weakness and cramps in feet and hand. Hyperexcitability in these patients is detected by some signs, which do not appear in normal persons.
i. Trousseau's sign
ii. Chvostek's sign
iii. Erb-Westphal sign.

187. What is Trousseau's sign?
Trousseau's sign is the spasm of the hand that is developed after 3 minutes of arresting the blood flow to lower arm and hand. The blood flow to lower arm and hand is arrested by inflating the blood pressure cuff 20 mm Hg above the patient's systolic pressure.

188. What is Chvostek's sign?
Chvostek's sign is the twitch of the facial muscles, caused by a gentle tap over the facial nerve in front of the ear. It is due to the hyperirritability of facial nerve.

189. What is Erb's sign?
Hyperexcitability of the skeletal muscles even to a mild electrical stimulus is called Erb's sign. It is also called Erb-Westphal sign.

190. What are the important features of hypercalcemia?
i. Depression of neuronal activities
ii. Sluggishness of reflex activities
iii. Reduction in the duration of ST segment and QT interval in ECG
iv. Lack of appetite
v. Constipation.

191. What are the actions of calcitonin?
Calcitonin decreases blood calcium level and blood phosphate level.

192. How does calcitonin decrease blood calcium level?
Calcitonin decreases blood calcium level by:
i. Increasing deposition of calcium in bones
ii. Increasing excretion of calcium through urine
iii. Decreasing the absorption of calcium from intestine.

193. Why should the blood calcium level be maintained?
Because, calcium is very essential for many important activities in the body such as:

i. Neuronal activity
ii. Muscular activity
iii. Cardiac function
iv. Secretory activities of the glands
v. Coagulation of blood.

194. What is the normal blood calcium level?
9.4 mg%. It ranges between 9 and 11 mg%.

195. What are functions of bone?
Protective function: Protects soft tissues and vital organs of the body.
Mechanical function: Supports the body and brings out movements of the body.
Metabolic function: Plays an important role in the metabolism homeostasis of calcium and phosphate in the body.
Hematopoietic function: Red bone marrow in the bones is the site of production of blood cells.

196. Classify bones with examples.
Long bones : Bones of the limbs
Short bones : Bones in the wrist and ankle
Flat bones : Skull bones, mandible, scapula, etc
Irregular bones : Vertebra
Sesamoid bones : Patella.

197. What are the parts of bone?
Long bones are formed by a cylindrical tube of bone tissue, which has three portions:
i. Diaphysis: Mid portion or mid shaft
ii. Epiphysis: Wider extremity or the head on either end
iii. Metaphysis: Portion between the diaphysis and epiphysis.

198. What are the major types of cells in bone? Mention their functions.
i. Osteoblasts: Concerned with bone formation that involves the formation of bone matrix and deposition of calcium (osteoblastic activity)
ii. Osteocytes: Concerned with maintenance of bone
iii. Osteoclasts: Concerned with bone resorption that involves the destruction of bone matrix followed by removal of calcium (osteoclastic activity).

199. What is osteoporosis? What is the cause for it?
It is a bone disease characterized by loss of bone matrix and minerals. It occurs due to excess of bone resorption and decreased bone formation.

200. What is rickets? What is its cause?
It is a bone disease in children characterized by collapse of chest wall and curvature of spine. It is due to the inadequate mineralization of bone matrix.

201. What is osteomalacia? What is its cause?
Rickets in adults is called osteomalacia. It is because of deficiency of vitamin D.

202. What is osteomyelitis?
Osteomyelitis is the inflammation of bone or bone marrow caused bacterial infection or injury. It mostly affects the bones of arms, legs, pelvis and spine.

203. What is endocrine part of pancreas?
Islets of Langerhans form the endocrine part of pancreas.

204. Name the types of cells in islets of Langerhans.
i. A or alpha cells : Secrete glucagon
ii. B or beta cells : Secrete insulin
iii. D or delta cells : Secrete somatostatin
iv. F or PP cells : Secrete pancreatic polypeptide.

205. What is the significance of C-peptide test?
Measurement of concentration of C-peptide in blood is useful to evaluate insulin synthesis by pancreas and to determine mode of treatment of diabetic patients.

206. What are the actions of insulin?
i. Insulin is the antidiabetogenic hormone, i.e. it decreases the blood sugar level by acting on carbohydrate metabolism
ii. It increases synthesis and storage of proteins
iii. It increases the synthesis and storage of fat
iv. It promotes growth of the body along with growth hormone.

207. What are the actions of insulin on carbohydrate metabolism?
Insulin:
i. Facilitates the transport of glucose into the cells
ii. Increases peripheral utilization of glucose
iii. Increases the conversion of glucose into glycogen in liver and muscle
iv. Inhibits glycogenolysis
v. Inhibits gluconeogenesis.
By all these actions, insulin acts as an antidiabetogenic hormone, i.e. it decreases blood sugar level.

208. What are the actions of insulin on protein metabolism?
Insulin acts as protein sparer by:
i. Facilitating transport of amino acids into the cells
ii. Accelerating protein synthesis by influencing transcription of DNA and translation of mRNA
iii. Preventing the catabolism of proteins
iv. Preventing the conversion of proteins into glucose.

209. What are the actions of insulin on fat metabolism?
Insulin increases:
i. Synthesis of fatty acids and triglycerides
ii. Transport of fatty acids into adipose tissues
iii. Storage of fat.

210. What is the effect of insulin on growth?
Insulin promotes growth of the body by its:
i. Anabolic effects on proteins
ii. Protein sparing effects.

211. What is Houssay animal? What is its importance?
Houssay animal is the one in which both pancreas and anterior pituitary are removed.
This preparation proves the importance of insulin in growth of the animal along with growth hormone. When growth hormone alone or when insulin alone is administered to a Houssay animal, growth is not accelerated. But, when both growth hormone and insulin are given together, growth is accelerated very much.

212. How is insulin secretion regulated?
Insulin secretion is regulated mainly by blood glucose level. When blood sugar level is more, insulin secretion increases. And, when blood glucose level is less, insulin secretion decreases.
Insulin secretion is also increased by the following factors:
i. Increase in levels of amino acids such as arginine and lysine in blood
ii. Increase in β ketoacids level in blood
iii. Gastrointestinal hormones like gastrin, secretin, cholecystokinin and GIP
iv. Other endocrine hormones like glucagon, growth hormone and cortisol
v. Stimulation of parasympathetic nerve fibers (right vagus) to pancreas.

213. What are the actions of glucagon?
Glucagon:
i. Increases the blood sugar level
ii. Increases the transport of amino acids into the liver cells leading to gluconeogenesis
iii. Shows lipolytic and ketogenic actions
iv. Inhibits gastric secretion and increases bile secretion.

214. How does glucagon increase the blood sugar level?
Glucagon increases the blood sugar level by increasing glycogenolysis and gluconeogenesis.

215. Name the factors which increase secretion of glucagon.
i. Reduction in blood glucose level
ii. Increase in amino acid level
iii. Exercise
iv. Stress
v. Hormones such as gastrin, cholecystokinin and cortisol.

216. Name the factors which inhibit secretion of glucagon.
i. Increase in blood glucose level
ii. Somatostatin
iii. Insulin
iv. Free fatty acids
v. Ketone bodies.

217. What are the sources of secretion of somatostatin?
i. Hypothalamus
ii. D cells present in islets of Langerhans
iii. D cells present in stomach and upper part of small intestine.

218. What are the actions of somatostatin?
Somatostatin:
i. Inhibits the secretion of insulin and glucagon
ii. Decreases the motility of stomach and small intestine
iii. Decreases the secretion of CCK, GIP and VIP
iv. Decreases the secretion of growth hormone and thyroid stimulating hormone (hypothalamic somatostatin).

219. What is the action of pancreatic polypeptide?
Pancreatic polypeptide is believed to increase the secretion of glucagon.

220. What is the necessity for regulation of blood sugar level?
Glucose is the only nutrient that can be utilized by the tissues like brain, retina and germinal epithelium of gonads. So, the blood sugar level has to be regulated within normal limits.

221. What is the normal blood sugar level?
Fasting blood sugar = 70 to 110 mg%; Postprandial blood sugar = 100 to 140 mg%.

222. How is the blood sugar level maintained?
Blood sugar level is maintained by a regulating mechanism that is operated through liver and muscle under the influence of insulin and many other hormones like thyroxine, cortisol, glucagon and adrenaline.

223. What is the role of liver in the maintenance of blood sugar level?
Liver acts as an important glucose buffer system. When blood sugar level increases after meals, the excess glucose is converted into glycogen and stored in liver. Afterwards, when blood sugar level decreases, liver glycogen is broken into glucose that is released into blood. These actions are brought about under the influence of insulin and glucagon.

224. What is diabetes mellitus?
Persistent increase in blood sugar level with other clinical manifestations is known as diabetes mellitus.

225. What are the types of diabetes mellitus?
i. Type I diabetes mellitus or insulin dependent diabetes mellitus (IDDM) which is due to deficiency of insulin
ii. Type II diabetes mellitus or non-insulin dependent diabetes mellitus (NIDDM) which is due to the absence or reduced number of insulin receptors in the cells of the body.

226. What is juvenile diabetes?
Juvenile diabetes is a type of IDDM that occurs in infancy or childhood.

227. What are the causes for Type I diabetes mellitus?
i. Degeneration of beta cells in islets of Langerhans
ii. Destruction of beta cells by viral infection
iii. Congenital disorder of beta cells
iv. Formation of antibodies against beta cells during autoimmune diseases.

228. What are the causes for Type II diabetes mellitus?
i. Genetic factors
ii. Lifestyle changes such as bad eating habits and physical inactivity leading to obesity.

229. Name the endocrine disorders in which diabetes mellitus is common.
Gigantism, acromegaly and Cushing's syndrome.

230. What are the features of diabetes mellitus?
i. Glucosuria
ii. Osmotic diuresis
iii. Polyuria
iv. Polydipsia
v. Polyphagia
vi. Asthenia
vii. Acidosis
viii. Acetone breathing
ix. Kussmaul breathing
x. Circulatory shock
xi. Coma.

231. What is metabolic syndrome?
Metabolic syndrome or insulin resistance syndrome or syndrome X is a group of risk factors that increase the chances of developing heart disease, stroke and diabetes.

232. What are the risk factors involved in metabolic syndrome?
i. Obesity particularly abdominal obesity.
ii. High blood pressure.
iii. Increased fasting blood sugar level.
iv. Abnormal cholesterol level.
v. Abnormal triglyceride level.
vi. Low HDL level.

233. What is the cause of hyperinsulinism?
Tumor of beta cells of islets of Langerhans.

234. What are the features of hyperinsulinism?
i. Hypoglycemia
ii. Manifestations of CNS like nervousness, tremor and excessive sweating. If not treated immediately, hyperinsulinism leads to clonic convulsions and unconsciousness leading to coma.

235. Why are adrenal glands called life-saving glands?
Because, absence of adrenocortical hormones causes death within 3 to 15 days and absence of adrenomedullary hormones decreases the resistance to mental and physical stress.

236. Why are adrenal glands called suprarenal glands?
Because, adrenal glands are situated in abdomen above kidneys.

237. What are the parts of adrenal glands?
i. Outer portion called adrenal medulla
ii. Inner portion called adrenal cortex.

238. What are the parts of adrenal cortex?
i. Outer zona glomerulosa
ii. Middle zona fasciculata
iii. Inner zona reticularis.

239. Name the hormones secreted by adrenal cortex.
Adrenal cortex secretes three groups of hormones:
i. Mineralocorticoids: Aldosterone and 11 deoxycorticosterone secreted by zona glomerulosa
ii. Glucocorticoids: Cortisol and corticosterone secreted mainly by zona fasciculata and in small quantities by zona reticularis
iii. Sex hormones (androgens): Dehydroepiandrosterone, androstenedione and testosterone and small quantity of estrogen and progesterone secreted by zona reticularis.

240. Why is aldosterone called life-saving hormone?
Because, absence of aldosterone causes death within 3 to 14 days.

241. What are the actions of aldosterone (mineralocorticoid)?
Aldosterone increases:
i. Reabsorption of sodium ions
ii. ECF volume
iii. Blood pressure
iv. Excretion of potassium
v. Excretion of hydrogen ions
vi. Reabsorption of sodium from sweat and salivary glands
vii. Absorption of sodium from intestine.

242. Name the factors which stimulate the secretion of aldosterone.
i. Increase in potassium ion concentration in ECF
ii. Decrease in sodium ion concentration in ECF
iii. Decrease in ECF volume
iv. ACTH.

243. How is aldosterone secretion regulated?
Increase in potassium ion concentration in ECF directly acts on zona glomerulosa of adrenal cortex and increases the secretion of aldosterone. Reduction in sodium concentration and volume of ECF causes release of renin from juxtaglomerular apparatus of kidney. Renin converts angiotensinogen into angiotensin I. Angiotensin I is converted into angiotensin II by converting enzyme. Angiotensin II stimulates zona glomerulosa of adrenal cortex and increases the secretion of aldosterone.

244. Why is cortisol called life-protecting hormone?
Because, it helps the body to withstand stress and trauma in life.

245. What are the actions of cortisol on carbohydrate metabolism?
Cortisol is a diabetogenic hormone and it increases the blood sugar level by:
i. Promoting gluconeogenesis.
ii. Inhibiting glucose uptake and utilization by peripheral cells (antiinsulin action).

246. What are the actions of cortisol on protein metabolism?
Cortisol causes catabolism of proteins by:
i. Releasing amino acids from body cells into blood
ii. Increasing uptake of amino acids by livers cells for synthesis of proteins and carbohydrates.

247. What are the actions of cortisol on fat metabolism?
Cortisol increases:
i. Mobilization of fatty acids from adipose tissue
ii. Concentration of fatty acids in the blood
iii. Utilization of fat for energy.

248. What are the actions of cortisol on mineral metabolism?
Cortisol increases retention of sodium and water and excretion of potassium.

249. What are the non-metabolic actions of cortisol?
i. On blood cells: Cortisol decreases the circulating eosinophils, basophils and lymphocytes and increases neutrophils, red blood cells and platelets
ii. On vascular Response: Cortisol is essential for vasoconstrictor action of adrenaline and noradrenaline
iii. On nervous system: It is essential for normal functioning of nervous system
iv. Permissive action: It is essential for execution of actions of some hormones
v. Antistressor effects: It increases the resistance to stress
vi. Anti-inflammatory effects: Cortisol prevents inflammatory changes in cells caused by injury or infection
vii. Antiallergic actions: It prevents reactions in allergic conditions
viii. Immunosuppressive effect: Cortisol suppresses immune system.

250. How is the secretion of cortisol regulated?
By negative feedback mechanism through ACTH secreted by anterior pituitary and corticotropin releasing hormone by hypothalamus.

251. What are the actions of adrenocorticotropic hormone (ACTH)?
i. Adrenal actions (on adrenal cortex):
   a. Maintains the structural integrity and vascularization of gland
   b. Converts cholesterol into pregnenolone from which the glucocorticoids are synthesized
   c. Causes release of glucocorticoids
   d. Prolongs the glucocorticoid action.
ii. Non-adrenal actions:
   a. Mobilizes the fats from fat tissues
   b. Melanocyte stimulating effect.

252. What are the effects of hyperactivity of adrenal cortex?
i. Cushing's syndrome
ii. Hyperaldosteronism
iii. Adrenogenital syndrome.

253. What is the difference between Cushing's disease and Cushing syndrome?
If the disorder is due to pituitary origin (hypersecretion of ACTH resulting in hypersecretion of glucocorticoids), it is called Cushing's disease. If it is due to adrenal origin (hypersecretion of glucocorticoids), it is called Cushing's syndrome.

254. List the features of Cushing's syndrome.

i. Abnormal distribution of body fat resulting in moon face, torso, buffalo hump and pot belly
ii. Purple striae
iii. Thinning of extremities
iv. Thinning of skin and subcutaneous tissues
v. Darkening of skin in neck: Acanthosis
vi. Hyperpigmentation
vii. Facial plethora: Facial redness
viii. Hirsutism: Facial hair growth
ix. Muscular weakness
x. Bone resorption and osteoporosis
xi. Hyperglycemia
xii. Hypertension
xiii. Immunosuppression
xiv. Poor wound healing.

255. What is Nelson syndrome?

Nelson syndrome is a disorder that develops after surgical removal of both adrenal glands. It is because of the growth of pituitary tumor that secretes excess ACTH. The features include headache and visual problems.

256. What is hyperaldosteronism?

Excessive secretion of aldosterone is known as hyperaldosteronism.

257. Name the types and causes of hyperaldosteronism.

i. Primary hyperaldosteronism (Conn's syndrome): Due to tumor in zona glomerulosa
ii. Secondary hyperaldosteronism: Due to extra adrenal causes such as congestive cardiac failure, nephrosis, toxemia of pregnancy and cirrhosis of liver.

258. What are the features of hyperaldosteronism?

i. Increase in ECF volume and blood volume
ii. Hypertension
iii. Polyuria
iv. polydipsia
v. Muscular weakness
vi. Metabolic alkalosis.

259. What is aldosterone escape or escape phenomenon?

It is the escape of kidney from salt-retaining effects of excess administration or secretion of aldosterone.

In primary hyperaldosteronism, there is retention of sodium and water leading to increase in ECF volume. When ECF volume increases to certain level, atrial natriuretic peptide (ANP) is released from atrial muscles. ANP causes excretion of sodium and water from the kidney in spite of increased aldosterone secretion. This is known as escape phenomenon. Because of this, edema is not developed in primary hyperaldosteronism.

260. What is adrenogenital syndrome?

Adrenogenital syndrome is the condition with increased activity of sex organs due to excessive secretion of sex hormones from adrenal cortex.

261. What is virilism? What are its features?

Virilism is the development of male secondary sexual characters in females due to increased secretion of androgens.

Features:

i. Increase in muscle bulk
ii. Deepening of voice
iii. Amenorrhea
iv. Enlargement of clitoris
v. Male type of hair growth.

262. What are the features of adrenogenital syndrome in males?

i. Feminization
ii. Gynecomastia (enlargement of breast)
iii. Atrophy of testes
iv. Loss of interest in women.

263. What are the effects of hypoactivity of adrenal cortex?

i. Chronic adrenal insufficiency or Addison's disease
ii. Congenital adrenal hyperplasia.

264. What is Addison's disease?

It is the failure of adrenal cortex to secrete corticosteroids.

265. What is the cause of Addison's disease?

i. Atrophy of adrenal cortex due to autoimmune diseases
ii. Destruction of the gland because of tuberculosis
iii. Destruction of hormone secreting cells in adrenal cortex by malignant tissues
iv. Congenital failure to secrete cortisol.
v. Adrenalectomy and failure to take hormone therapy

266. What are the features of Addison's disease?

i. Hyperpigmentation of skin and mucus membrane
ii. Muscular weakness
iii. Dehydration
iv. Hypotension
v. Decreased cardiac output
vi. Hypoglycemia
vii. Nausea, vomiting and diarrhea
viii. Susceptibility to infections
ix. Inability to withstand stress.

267. What is Addisonian crisis? When does it occur?

Addisonian crisis is the sudden collapse of the person due to severe and acute need for large quantity of glucocorticoids.

It occurs in

i. Exposure to even mild stress.
ii. Hypoglycemia due to fasting
iii. Trauma
iv. Surgical operation
v. Sudden withdrawal of glucocorticoid treatment.

268. What is congenital adrenal hyperplasia?

It is the disease that develops due to the congenital absence of enzymes necessary for the synthesis of cortisol, particularly 21–hydroxylase. Since cortisol secretion is decreased, secretion of ACTH increases by feedback mechanism. ACTH acts on the adrenal glands and increases the number of cells leading to hyperplasia. Since, cortisol cannot be synthesized due to lack of enzymes, the synthesis of androgens increases leading to sexual abnormalities.

269. What are the features of congenital adrenal hyperplasia?

In boys:

Congenital adrenal hyperplasia leads to a condition called macrogenitosomia praecox. The features of this condition are:

i. Precocious body growth causing appearance of infant Hercules
ii. Precocious sexual development with enlarged penis. In girls, adrenal hyperplasia develops masculinization or virilism. In some cases, it causes pseudohermaphrodites.

In girls:

i. Masculinization or virilism
ii. Pseudohermaphroditism in some genetic disorders.

270. What are the hormones secreted by adrenal medulla?
Adrenal medulla secretes the following catecholamines
i. Adrenaline or epinephrine
ii. Noradrenaline or norepinephrine
iii. Dopamine.

271. Why are the hormones secreted by adrenal medulla called catecholamines?
Adrenal medullary hormones are the amines derived from catechol and so these hormones are called catecholamines.

272. Which is the precursor for catecholamines?
Catecholamines are synthesized from amino acid tyrosine.

273. What is the mode of action of catecholamines?
Actions of catecholamines are exerted through some receptors present in the target organs called adrenergic receptors.

274. What are the types of adrenergic receptors?
i. Alpha adrenergic receptors, which are divided into alpha$_1$and alpha$_2$ receptors
ii. Beta adrenergic receptors, which are divided into beta$_1$and beta$_2$ receptors.

275. What is the difference in the response of adrenergic receptors to adrenaline and noradrenaline?
Alpha receptors give more response to noradrenaline than for adrenaline.

Beta$_1$ receptors have equal response to both adrenaline and noradrenaline.

Beta$_2$ receptors give more response to adrenaline than to noradrenaline.

276. What are the actions of adrenaline and noradrenaline on metabolism?
Adrenaline has metabolic actions but noradrenaline does not have metabolic effects. Adrenaline is a calorigenic hormone and it increases the basal metabolic rate. It increases blood glucose level by increasing glycogenolysis. On fats, it causes mobilization of fatty acids from adipose tissues.

277. What is the action of adrenaline and noradrenaline on blood?
Adrenaline increases the red blood cell count and hemoglobin content of the blood by causing contraction of spleen. Noradrenaline does not show this action.

278. What is the action of adrenaline and noradrenaline on heart?
Adrenaline increases overall activity of the heart, i.e. it increases the rate and force of contraction and excitability of the cardiac muscle. Noradrenaline has mild effect on heart.

279. What are the actions of adrenaline and noradrenaline on blood vessels?
Noradrenaline has got stronger action on blood vessels.

It causes vasoconstriction throughout the body thus, increasing the total peripheral resistance. So noradrenaline is called general vasoconstrictor.

Adrenaline also causes vasoconstriction. But it causes the dilatation in some areas like skeletal muscle, liver and heart. So, adrenaline decreases the total peripheral resistance.

280. What are the actions of adrenaline and noradrenaline on blood pressure?
Adrenaline increases systolic blood pressure by increasing the rate and force of contraction of heart and cardiac output. But it decreases diastolic blood pressure by reducing the total peripheral resistance.

Noradrenaline increases diastolic blood pressure to a greater extent because of its general vasoconstrictor action that increases the total peripheral resistance. It increases systolic pressure to a lesser extent.

281. What are the actions of adrenaline on respiratory system?
Adrenaline increases the rate and force of respiration. When injected, it produces adrenaline apnea. It also causes bronchodilatation.

282. What are the actions of adrenaline on skin?
i. Causes contraction of arrector pili
ii. Increases sweat secretion.

283. What are the actions of adrenaline on skeletal muscle?
Adrenaline:
i. Causes severe contraction and quick fatigue of skeletal muscle
ii. Increases glycogenolysis and release of glucose from muscle into blood
iii. Causes vasodilatation in skeletal muscles.

284. What are the actions of catecholamines on smooth muscle?
Catecholamines cause contraction of smooth muscles in the following organs:
i. Splenic capsule
ii. Sphincters of gastrointestinal (GI) tract
iii. Arrector pili of skin
iv. Gallbladder
v. Uterus
vi. Dilator pupillae of iris
vii. Nictitating membrane of cat.

Catecholamines cause relaxation of smooth muscles in the following organs:
i. Non-sphincteric part of GI tract (esophagus, stomach and intestine)
ii. Bronchioles
iii. Urinary bladder.

285. What are the actions of adrenaline on nervous system?
Adrenaline increases the activity of brain. Adrenaline secretion increases during 'fight or flight reactions' after exposure to stress. It enhances the cortical arousal and other facilitatory functions of central nervous system.

286. What are the stimuli for the secretion of catecholamines?
i. Exposure to stress
ii. Exposure to cold
iii. Hypoglycemia.

287. What is pheochromocytoma?
Pheochromocytoma is a condition characterized by hypersecretion of catecholamines. It is caused by tumor of chromophil cells in adrenal medulla. Hypertension, hyperglycemia and glucosuria are the important features of this condition.

288. Where is pineal gland situated?
Pineal gland is situated in diencephalic area of brain above hypothalamus.

289. What is the function of pineal gland?
Pineal gland secretes melatonin. In some animals, melatonin stimulates gonads and, in some animals, it inhibits the gonads. In humans, it inhibits onset of puberty by inhibiting the gonads.

290. Where is thymus situated?
Thymus is situated in front of trachea below thyroid gland.

291. What are the functions of thymus gland?
i. It plays an important role in cellular immunity by processing the T lymphocytes
ii. It secretes thymosin (that helps in the proliferation of T lymphocytes) and thymin (that suppresses neuromuscular activity by inhibiting release of acetylcholine).

292. Mention the hormones secreted by kidney.
i. Erythropoietin
ii. Thrombopoietin
iii. Renin
iv. 1, 25 dihydroxy cholecalciferol
v. Prostaglandins.

293. Name the hormones secreted by heart. What is their action?
Atrial natriuretic peptide (ANP), brain natriuretic peptide (BNP) and C-type natriuretic peptide (CNP) are the hormones secreted by heart.
These hormones:
i. Increase sodium excretion through urine (escape phenomenon)
ii. Decrease blood pressure.

294. What are local hormones? What are the types of local hormones?
Local hormones are the substances which act on the same area of their secretion or in immediate neighborhood.
Types:
i. Hormones synthesized in tissues
ii. Hormones synthesized in the blood.

295. Name the local hormones synthesized in the tissues.
i. Prostaglandins and related substances like thromboxanes, prostacyclin, leukotrienes and lipoxins
ii. Other local hormones like acetylcholine, serotonin, histamine, substance P, heparin, leptin and GI hormones.

296. Name the local hormones synthesized in the blood.
Serotonin, angiotensin and kinins.

Section 7 Reproductive System

1. **Name the sex organs in males.**
   Primary sex organs or gonads: Testes
   Accessory sex organs: Seminal vesicles, prostate gland, urethra and external genitalia such as penis and scrotum.

2. **What are seminiferous tubules?**
   Seminiferous tubules are coiled tubular structures in the testes containing two types of cells, the spermatogenic cells and Sertoli cells.

3. **What are the spermatogenic cells?**
   Spermatogenic cells are the cells producing sperms in the testes. In children, only one type of spermatogenic cells is present called spermatogonia.
   After puberty, different stages of spermatogenic cells (spermatogonia, primary spermatocytes, secondary spermatocytes and spermatids) are found in the testes.

4. **What are Sertoli cells?**
   Sertoli cells are the supporting cells present in seminiferous tubules of testes.

5. **What are the functions of Sertoli cells?**
   Sertoli cells:
   i. Support and nourish the spermatogenic cells
   ii. Secrete the enzyme aromatase
   iii. Secrete androgen-binding protein (ABP)
   iv. Secrete estrogen-binding protein (EBP)
   v. Secrete inhibin
   vi. Secrete activin
   vii. Secrete Müllerian-regression factor (MRF) in fetus

6. **What is Müllerian-regression factor (MRF) Müllerian-inhibiting substance (MIS)?**
   MRF is secreted by Sertoli cells in fetal testes. It is responsible for regression of Müllerian duct during sex differentiation.

7. **What is blood-testes barrier?**
   It is a mechanical barrier that separates blood from seminiferous tubules of the testes. It is formed by tight junctions between the adjacent Sertoli cells.

8. **What is the function of blood-testes barrier?**
   Blood-testes barrier:
   i. Protects seminiferous tubules and spermatogenic cells by preventing the entry of toxic substances from blood into the lumen of seminiferous tubules
   ii. Prevents development of autoimmune disorders by inhibiting entry of antigenic products of spermatogenesis from testes into blood.

9. **What are the functions of testes?**
   Gametogenic function: Production of sperms. Endocrine function: Secretion of male sex hormones.

10. **What is spermatogenesis?**
    Production of sperms is known as spermatogenesis.

11. **Name the stages of spermatogenesis.**
    i. Stage of proliferation
    ii. Stage of growth
    iii. Stage of maturation
    iv. Stage of transformation.

12. **At what stage of spermatogenesis the number of chromosomes becomes haploid?**
    At the stage of maturation, i.e. in the spermatids.

13. **What is spermiogenesis?**
    It is the process by which spermatids become mature spermatozoa.

14. **What is spermination?**
    It is the process by which matured sperms are released from Sertoli cells into seminiferous tubules.

15. **Name the hormones necessary for spermatogenesis.**
    i. Testosterone
    ii. FSH
    iii. LH
    iv. Estrogen
    v. Growth hormone
    vi. Inhibin
    vii. Activin

16. **Name some factors which inhibit spermatogenesis.**
    i. Increase in temperature
    ii. Infectious diseases such as mumps.

17. **What is cryptorchidism? What is its cause?**
    It is a congenital disorder with undescended testes. It occurs because of absence of testosterone secretion.

18. **What are the hormones secreted by testes?**
    Androgens or male sex hormones:
    i. Testosterone
    ii. Dihydrotestosterone
    iii. Androstenedione.

19. **What is the source of secretion of testosterone?**
    i. Interstitial cells of Leydig present in testes
    ii. In small quantity in the adrenal cortex.

20. **What is the period of life during which testosterone is not secreted?**
    During the period between birth and puberty.

21. **What are the functions of testosterone in fetal life?**
    Testosterone helps in:
    i. Sex differentiation
    ii. Development of sex organs
    iii. Descent of testes.

22. **What are the genital ducts present in fetus?**
    i. Müllerian duct
    ii. Wolffian duct.

23. **What is Müllerian duct?**
    It is a genital duct in fetus. It gives rise to female accessary sex organs such as vagina, uterus and fallopian tubes.

24. What is Wolffian duct?
It is a genital duct in fetus. It gives rise to male accessary sex organs such as epididymis, vas deferens and seminal vesicles.

25. What are the functions of testosterone in adult life?
Testosterone:
i. Increases the size of sex organs
ii. Causes development of secondary sexual characters such as muscular growth, bone growth, changes in skin, hair distribution, voice, BMR, blood, electrolyte concentration and water content in the body.

26. How is testosterone secretion regulated?
In fetus, testosterone secretion is stimulated by human chorionic gonadotropin secreted from placenta. After puberty, testosterone secretion is stimulated by interstitial cell stimulating hormone (ICSH) secreted by anterior pituitary. The regulation is by negative feedback mechanism that involves ICSH and LH releasing hormone.

27. What is inhibin? What is its action?
Inhibin is a peptide hormone secreted by Sertoli cells. In females, it is secreted by ovarian follicles. It inhibits secretion of FSH and decreases the pace of spermatogenesis.

28. What is activin? What is its action?
Inhibin is a peptide hormone secreted by gonads. It increases secretion of FSH and accelerates spermatogenesis.

29. What are anabolic steroids or anabolic-androgenic steroids?
Anabolic steroids are synthetic forms of testosterone, which are used to increase the growth of muscles and bones. Like androgens, these steroids increase growth of muscles and bones by accelerating protein synthesis (anabolic effect).

30. What is male andropause? What are its other names?
Male andropause or climacteric is the condition in men, characterized by emotional and physical changes in the body, due to low androgen level with aging.

It is also called male climacteric or viropause or male menopause.

31. What are the effects of extirpation of testes before puberty?
i. The infantile sexual characters remain throughout life (eunuchism)
ii. Height is slightly more
iii. Bones are weak and thin
iv. Muscles are weak
v. Sex organs do not increase in size and male secondary sexual characters do not develop
vi. Feminine distribution of fat occurs.

32. What are the effects of extirpation of testes immediately after puberty?
i. Functions of sex organs are depressed
ii. Seminal vesicles and prostate gland undergo atrophy
iii. Penis remains smaller in size
iv. Many of the secondary sexual characters such as male distribution of hair, musculature and thickness of bones are lost
v. Loss of sexual desire and sexual activities.

33. What are the effects of extirpation of testes in adults?
i. Accessory sex organs such as seminal vesicle and prostate gland degenerate
ii. Penile erection may occur but there is no ejaculation
iii. The secondary sexual characters and sexual desire may not be affected much.

34. What is hypergonadism? What is its cause in males?
It is the condition characterized by hypersecretion of sex hormones from gonads. In males, it is due to the tumor of Leydig cells.

35. What are the effects of hypergonadism in males?
i. Rapid growth of muscles, bones, sex organs and secondary sexual characters
ii. Height of the person is less because of early closure of epiphysis
iii. Development of gynecomastia.

36. What is hypogonadism? What are its causes in males?
The condition characterized by reduction in the functional activity of gonads is known as hypogonadism.
Causes in males:
i. Congenital nonfunctioning testes
ii. Underdeveloped testes
iii. Cryptorchidism
iv. Castration
v. Absence of androgen receptors in testis
vi. Disorder of gonadotrophs
vii. Hypothalamic disorder.

37. What are the effects of hypogonadism in males?
Effects are similar to the effects of removal of testes before puberty. Refer Question 19 of this section.

38. What are the functions of fluid secreted from seminal vesicles?
i. It provides nutrition to the sperms
ii. Fibrinogen present in this fluid causes coagulation of semen
iii. Prostaglandin of the fluid enhances the fertilization of ovum.

39. What are the functions of prostatic fluid?
i. Prostatic fluid provides optimum pH for motility of sperms
ii. Clotting enzymes in this fluid cause coagulation of semen
iii. Fibrinolysin present in this fluid causes lysis of coagulum.

40. What is the nature of semen?
At the time of ejaculation, semen is liquid in nature. Immediately it is coagulated and the coagulated semen is known as coagulum.

Finally, it undergoes a secondary liquefaction.

41. What are the properties of semen?

Specific gravity	: 1.028
Volume	: 4 to 6 mL/ejaculation
Reaction	: Alkaline with a pH of 7.5

42. What is the composition of semen?
Semen contains sperms (10%) and seminal plasma (90%).
Seminal plasma contains:
i. Fluid from seminal vesicles (60%) containing ascorbic acid, fibrinogen, flavin, fructose, inositol, pepsinogen, phosphorylcholine, prostaglandin, citrate and citric acid
ii. Prostatic fluid (30%) containing acid phosphatase, cholesterol, clotting enzymes, fibrinolysin, glucose, lactate dehydrogenase, phospholipids, plasminogen activator, serminin, spermine, and inorganic substances
iii. Small amount of secretions from bulbourethral glands.

43. What is the normal sperm count?
100 to 150 millions/mL of semen.

44. At what level of sperm count does the sterility occur in males?
When the sperm count is below 20 million/mL of semen.

45. What is the survival time of sperms after ejaculation?
About 24 to 48 hours at a temperature equivalent to body temperature.

46. What is the survival time of sperms after ejaculation?
About 24 to 48 hours at a temperature equivalent to body temperature.

47. What are the minimum qualities of semen required for fertilization?
i. Volume of semen per ejaculation : 2 mL
ii. Sperm count : 20 millions/mL
iii. Number of sperms in each ejaculation : 40 millions
iv. Live sperms per ejaculation : 75%
v. Motile sperms : 50%
vi. Sperms with normal shape and structure : 30%
vii. Sperms with head defect must be less than : 35%.
viii. Sperms with midpiece defect must be less than : 20%.
ix. Sperms with tail defect must be less than : 20%.

48. What are the abnormalities of sperm?
Azoospermia: Lack of sperm in semen
Teratozoospermia: Presence of sperms with abnormal morphology. It is also called teratospermia
Aspermia: Lack of semen
Oligospermia: Low volume of semen
Hematospermia: Appearance of blood in semen

49. Name the sex organs in females.
Primary sex organs or gonads: Ovaries
Accessory sex organs: Fallopian tubes, uterus, cervix, vagina and external genitalia such as labia majora, labia minora and clitoris.

50. Name the parts of uterus.
i. Fundus (above the entrance points of fallopian tubes)
ii. Body (between fundus and isthmus)
iii. Cervix (below isthmus).

51. Name the layers of uterus.
i. Serous or outer layer
ii. Myometrium or middle muscular layer
iii. Endometrium or inner mucus layer.

52. Name the periods of lifespan of a female
First period: From birth to puberty
Second period: From puberty menopause
Third period: From menopause to rest of the life.

53. What are the functions of ovaries?
i. Secretion of female sex hormones
ii. Oogenesis
iii. Menstrual cycle.

54. Name the hormones secreted by ovaries.
i. Female sex hormones: Estrogen and progesterone
ii. Inhibin
iii. Relaxin
iv. Small quantities of androgens.

55. What are the sources of estrogen?
In a non-pregnant female: Follicles of ovaries
During pregnancy: Corpus luteum and placenta
A small quantity of estrogen is secreted from adrenal cortex throughout life.

56. What are the actions of estrogen on ovarian follicles?
Estrogen:
i. Promotes growth of ovarian follicles
ii. Increases secretory activity of theca cells.

57. What are the actions of estrogen on uterus?
Estrogen causes:
i. Enlargement of uterus
ii. Increase in blood supply to uterus
iii. Deposition of glycogen and fats in endometrium
iv. Proliferation and dilatation of endometrial blood vessels
v. Proliferation and dilatation of endometrial glands
vi. Increase in spontaneous activity of uterine muscles and sensitivity to oxytocin
vii. Increase in the contractility of uterine muscles.

58. What are the actions of estrogen on fallopian tubes?
Estrogen:
i. Increases the number and size of ciliated epithelial cells lining the fallopian tubes
ii. Increases the activity of cilia that facilitates the movement of ovum through the fallopian tube
iii. Enhances the proliferation of glandular tissues in fallopian tubes.

59. What are the actions of estrogen on vagina?
Estrogen:
i. Changes the cuboidal epithelium of vagina into stratified epithelium, which has more resistance to trauma and infection
ii. Increases the number of layers of vaginal epithelium by proliferation
iii. Reduces the pH of vagina causing more acidity.

60. What are the female secondary sexual characters influenced by estrogen?
i. Hair growth in pubic region and axilla and profuse hair growth in scalp
ii. Softness, smoothness and increased vascularity of the skin
iii. Narrow shoulders, broad hip, converged thighs and diverged arms and deposition of fat in breasts and buttocks
iv. Retention of prepubertal voice with high pitch.

61. What are the actions of estrogen on mammary glands?
Estrogen increases the size of mammary glands by causing:
i. Development of stromal tissues
ii. Extensive growth of ductile system
iii. Deposition of fat in the ductile system.

62. What are the actions of estrogen on bones?
Estrogen increases osteoblastic activity that accelerates the height at the time of puberty. At the same time, it causes early closure of epiphysis.

63. What are the actions of estrogen on metabolism?
Estrogen:
i. Increases the protein synthesis
ii. Causes deposition of fat in the subcutaneous tissues, breasts, buttocks and thighs.

64. How is the secretion of estrogen regulated?
Secretion of estrogen is regulated by FSH secreted from anterior pituitary through negative feedback mechanism. The secretion of FSH, in turn, is under the control of gonadotropic releasing hormone secreted from hypothalamus.

65. What are the sources of progesterone?
In a non-pregnant female: Small quantity of progesterone is secreted from theca cells of ovary during follicular phase and large quantity is secreted from corpus luteum of ovary during the luteal phase of menstrual cycle.

In first trimester of pregnancy: Corpus luteum and placenta secrete a large quantity of progesterone.
In second and third trimester of pregnancy: Placenta secretes a large quantity of progesterone
A small quantity is secreted from adrenal cortex throughout life.

66. What is the action of progesterone on fallopian tubes?
Progesterone increases the secretion from mucosa of fallopian tube that is essential for the nutrition of fertilized ovum.

67. What are the actions of progesterone on uterus?
Progesterone:
i. Increases thickness of endometrium
ii. Increases size of the uterine glands
iii. Increases secretory activities of glandular epithelial cells
iv. Increases deposition of lipid and glycogen in the stromal cells
v. Increases blood supply to endometrium
vi. Decreases the frequency of uterine contractions, which favor the implantation and continuation of pregnancy.

68. What are the actions of progesterone on cervix?
Progesterone increases the thickness of cervical mucosa and thereby inhibits the transport of sperm into uterus.

69. What are the actions of progesterone on mammary glands?
Progesterone:
i. Promotes the development of lobules and alveoli of mammary glands
ii. Makes the mammary glands secretory in nature.
iii. Increases the size of mammary glands by increasing the secretory activity and fluid accumulation in the subcutaneous tissue.

70. How is the secretion of progesterone regulated?
LH from anterior pituitary activates the corpus luteum to secrete progesterone. Secretion of LH is influenced by the gonadotropinreleasing hormone secreted in hypothalamus. Progesterone inhibits the release of LH from anterior pituitary by negative feedback.

71. Define menstrual cycle.
Cyclic events which take place in a rhythmic fashion during the reproductive period of a women's life is called menstrual cycle.

72. What is the normal duration of menstrual cycle?
Normal duration of menstrual cycle is 28 days. Under normal conditions it ranges between 20 and 40 days.

73. What is menarche? At what age does it occur?
Commencement of menstrual cycle is known as menarche. It occurs at the age of 12 to 15 years that marks the onset of puberty.

74. What is menopause?
Menopause is the permanent stoppage of menstrual cycle in old age.

75. Enumerate the changes taking place during menstrual cycle.
i. Ovarian changes
ii. Uterine changes
iii. Vaginal changes
iv. Changes in cervix uteri.

76. Name the phases of ovarian changes during menstrual cycle.
i. Follicular phase: Development of Graafian follicle and secretion of large amount of estrogen
ii. Luteal phase: Development of corpus luteum and secretion of large amount of progesterone.

77. Name the different ovarian follicles.
i. Primordial follicle
ii. Primary follicle
iii. Vesicular follicle
iv. Graafian follicle.

78. What is ovulation? When does it occur?
Process by which ovum is released by rupture of Graafian follicle is known as ovulation. It occurs on 14th day of menstrual cycle in a normal 28 days cycle.

79. How does ovulation occur?
Ovulation occurs because of rupture of stigma which is a protrusion developed on the surface of the Graafian follicle. Rupture of Graafian follicle releases ovum into the abdominal cavity.

80. What is LH surge?
Just prior to ovulation, a large quantity of LH is secreted. The need for excessive secretion of LH is known as LH surge or luteal surge or ovulatory surge.

81. How is ovulation time determined?
i. By determining basal body temperature
ii. By determining the hormonal excretion in urine
iii. By determining hormonal level in plasma
iv. By ultrasound scanning.
v. By cervical mucus pattern

82. What is the importance of knowing ovulation time?
Determination of ovulation time is necessary to adopt rhythm method (safe period) of family planning.

83. What is corpus luteum?
It is the glandular yellow body that develops from the remaining cells of Graafian follicle after the release of ovum (after ovulation).

84. Name the types of cells present in corpus luteum.
i. Lutein cells derived from granulosa cells
ii. Cells of theca interna.
Lutein cells are surrounded by cells of theca externa.

85. What is the function of corpus luteum?
Corpus luteum:
i. Functions as temporary endocrine gland and secretes large amount of progesterone and small amount of estrogen.
ii. Helps to maintain the pregnancy in the first trimester (till the placenta starts secreting the hormones).

86. What is the fate of corpus luteum?
Fate of corpus luteum depends whether pregnancy occurs or not.
If pregnancy does not occur: Corpus luteum involutes and degenerates into corpus luteum menstrualis or spurium. Corpus luteum menstrualis is transformed into a whitish scar called corpus albicans.
If pregnancy occurs: It increases in size and remains for 3 to 4 months. During this period, it secretes large amount of progesterone and small amount of estrogen, which are essential to maintain pregnancy.

87. Name the phases of uterine changes during menstrual cycle.
i. Menstrual phase
ii. Proliferative phase
iii. Secretory phase.

88. What are the uterine changes during menstrual phase?

i. Lack of estrogen and progesterone causes sudden involution of endometrium
ii. It leads to reduction in the thickness of endometrium
iii. During the next 24 hours, tortuous blood vessels in endometrium undergo severe constriction
iv. Vasoconstriction leads to hypoxia and necrosis of endometrium
v. Necrosis causes rupture of blood vessels and oozing of blood
vi. Outer layer of the necrotic endometrium is separated and passes out along with blood
vii. This process is continued for about 24 to 36 hours
viii. Within 48 hours after the reduction in the secretion of estrogen and progesterone, the superficial layers of endometrium are completely desquamated
ix. Desquamated tissues and the blood in the endometrial cavity initiate the contraction of uterus
x. Uterine contractions expel the blood along with desquamated uterine tissues to the exterior through vagina.

89. What are the causes for uterine changes during menstrual phase?

At the end of menstrual cycle, there is sudden decrease in the level of estrogen and progesterone. This leads to sudden involution of endometrium at the beginning of next cycle. Since estrogen and progesterone are vasodilators, lack of these hormones causes severe vasoconstriction. Prostaglandin secreted by the involuted endometrium also causes vasoconstriction. Due to severe vasoconstriction, hypoxia and necrosis occur in the endometrium. Necrosis causes rupture of blood vessels leading to bleeding.

90. What is the composition of menstrual fluid?

i. Blood (about 35 mL)
ii. Serous fluid (about 35 mL)
iii. Desquamated endometrial tissues.

91. How much of blood is lost during menstrual phase?

About 35 mL

92. Why the menstrual blood does not clot?

During menstruation, blood clots as soon as it oozes into the uterine cavity. Fibrinolysin released from the endothelium of damaged blood vessels causes lysis of the clot in the uterine cavity itself so that the menstrual blood does not clot.

93. What are the uterine changes during proliferative phase?

i. Endometrial cells proliferate
ii. Epithelium reappears on the surface of endometrium
iii. Uterine glands start developing
iv. Blood vessels also appear in stroma
v. Endometrium reaches the thickness of 3 to 4 mm.

94. What are the uterine changes during secretory phase?

i. Uterine glands increase in size and become more tortuous
ii. Cytoplasm of stromal cells increases due to deposition of glycogen and lipids
iii. New blood vessels appear in endometrium
iv. Blood supply to the endometrium increases
v. Thickness of endometrium increases to about 5 to 6 mm.

95. What are the changes, which occur in cervix during menstrual cycle?

During menstrual phase, under the influence of estrogen, the mucous membrane of cervix becomes thin and alkaline. This helps for the survival and motility of sperms. During secretory phase, because of the action of progesterone, mucous membrane of cervix becomes thick and adhesive.

96. What are vaginal changes during menstrual cycle?

During proliferative phase: Vaginal epithelium is cornified because of estrogen.
During secretory phase: Proliferation of vaginal epithelium because of progesterone and infiltration of leucocytes in the vaginal epithelium.

97. Name the hormones, which influence the ovarian changes during menstrual cycle.

During follicular phase: FSH, LH and estrogen
During ovulation: LH
During luteal phase: FSH and LH.

98. Name the hormones, which influence the uterine changes during menstrual cycle.

During proliferative phase: Estrogen
During secretory phase: Progesterone
During menstrual phase: Sudden withdrawal of estrogen and progesterone.

99. What are the abnormal types of menstruation?

i. Amenorrhea: Absence of menstruation during reproductive period of females
ii. Hypomenorrhea: Decreased menstrual fluid
iii. Menorrhagia: Excessive menstrual bleeding
iv. Oligomenorrhea: Decreased frequency of menstrual bleeding
v. Polymenorrhea: Increased frequency of menstrual bleeding
vi. Dysmenorrhea: Menstruation with pain
vii. Metrorrhagia: Uterine bleeding in between menstruations.

100. What is anovulatory cycle?

Anovulatory cycle is the menstrual cycle without ovulation.

101. What are menstrual symptoms?

Menstrual symptoms are unpleasant symptoms with discomfort, which appear in many women during menstruation. These symptoms are due to hormonal withdrawal, leading to cramps in uterine muscle before or during menstruation.

102. What are the common menstrual symptoms?

i. Abdominal pain
ii. Dysmenorrhea (menstrual pain)
iii. Headache
iv. Occasional nausea and vomiting
v. Irritability
vi. Depression
vii. Migraine (neurological disorder, characterized by intense headache causing disability).

103. What is premenstrual syndrome? What are the other names for it?

It is the symptom of stress that appears before onset of menstruation and lasts for about 4 to 5 days prior to menstruation. It is due to salt and water retention caused by estrogen.

It is also called premenstrual stress syndrome, premenstrual stress or premenstrual tension.

104. What is the cause for menopause?

Throughout life there is degeneration of primordial follicles in the ovary. At the age of 45 years and above, the number of primordial follicles reduces leading to decrease in the secretion of estrogen by the ovary. When all the primordial

follicles are atrophied estrogen secretion stops completely. This period is called menopause.

105. What is postmenopausal syndrome?
Postmenopausal syndrome is the group of symptoms that appear in women immediately after menopause. It is characterized by certain physical, physiological and psychological changes. The symptoms start appearing soon after the ovaries stop functioning.

106. What are the symptoms of postmenopausal syndrome?
i. Hot flashes characterized by extreme flushing of the skin
ii. Vasomotor instability
iii. Fatigue
iv. Nervousness
v. Emotional outburst like crying and anger
vi. Mental depression
vii. Insomnia
viii. Palpitation
ix. Vertigo
x. Headache
xi. Numbness or tingling sensation
xii. Urinary disturbances such as increased frequency of micturition
xiii. Long-term effects of estrogen lack such as osteoporosis and atherosclerosis.

107. How is postmenopausal syndrome treated?
Postmenopausal syndrome can be treated by psychotherapy and hormone therapy. In hormone therapy, estrogen and progesterone are administrated with careful adjustment of dose.

108. What are the causes for male infertility?
i. Decrease in sperm count to about 20 millions/mL
ii. Presence of abnormal sperms like tailless sperms, two headed sperms and non-motile sperms
iii. Obstruction of reproductive ducts like vas deferens
iv. Other causes such as:
a. Cryptorchidism
b. Trauma
c. Mumps
d. Long-term use of drugs
e. Alcoholism
f. Genetic disorders
g. Hypothalamic disorders
h. Disorders of pituitary, thyroid and pancreas.

109. What are the causes for female infertility?
i. Abnormalities of ovaries
ii. Abnormalities of uterus
iii. Absence of ovulation
iv. Other causes such as
a. Diabetes mellitus
b. Renal diseases
c. Liver diseases
d. Hypothalamic disorders
e. Disorders of pituitary gland, thyroid and adrenal glands.

110. What is fertilization?
Fertilization refers to fusion (union) of male and female gametes (sperm and ovum) to form a new offspring.

111. Where does fertilization of ovum occur?
Fertilization of ovum occurs in the fallopian tube.

112. When does the zygote get implanted in the uterus?
After fertilization, the zygote takes 3 to 5 days to reach the uterus. In the uterus, the zygote remains freely in the uterine cavity for 2 to 4 days and then gets implanted. So, it takes about one week for the zygote to get implanted.

113. What is the duration of pregnancy (gestation period)?
280 days.

114. What are the consequences of abnormality in sex determination?
i. Hermaphroditism: A congenital condition characterized by the presence of both male and female reproductive organs.
ii. Gonadal dysgenesis: Defective development of gonads.

115. What are the changes taking place in ovary during pregnancy?
When pregnancy occurs, follicular growth does not occur in ovary because of lack of FSH and LH. Corpus luteum grows in size and remains for three months and secretes large amount of progesterone and small amount of estrogen. After third month of pregnancy, when placenta starts secreting the hormones, corpus luteum degenerates.

116. What are the changes taking place in uterus during pregnancy?
i. Increase in the volume (from zero volume to 5 to 7 L)
ii. Increase in size
iii. Increase in weight (from 30 to 50 g to 1000 to 1200 g) of the uterus
iv. Shape of the uterus changes from pyriform to globular
v. Histological changes also occur with the development of decidua.

117. What are the changes taking place in vagina during pregnancy?
i. Size increases
ii. Violet coloration due to increase in blood supply
iii. Deposition of glycogen in epithelial cells.

118. What are the changes taking place in cervix during pregnancy?
i. Increase in number of cervical glands
ii. Increase in blood supply
iii. Increase in mucus secretion
iv. Softening of cervix
v. Formation of mucus plug, which closes cervical canal.

119. What are the changes taking place in mammary glands during pregnancy?
i. Development of new ducts
ii. Formation of new alveoli
iii. Deposition of fat
iv. Increase in size
v. Increase in vascularization
vi. Pigmentation of nipple and areola.

120. How much is the weight gain of the body during pregnancy?
Average weight gain of the body during pregnancy is 20 to 30 kg.

121. What are the metabolic changes during pregnancy?
i. Increase in BMR
ii. Increase in protein synthesis
iii. Increase in blood glucose level that may lead to diabetes in pregnancy

iv. Deposition of fat in maternal body with increased blood cholesterol level and ketosis
v. Retention of water, sodium, calcium and phosphorus.

122. What are the changes taking place in blood during pregnancy?
i. Blood volume increases by about 20% (1 liter) mainly because of the increase in plasma volume
ii. Hemodilution occurs
iii. Anemia may develop.

123. What are the cardiovascular changes during pregnancy?
i. Cardiac output increases
ii. Blood pressure decreases slightly in second trimester
iii. Hypertension may develop later if proper prenatal care is not taken.

124. What are the changes taking place in excretory system during pregnancy?
i. Increase in renal blood flow, glomerular filtration rate and urine formation
ii. Formation of dilute urine
iii. Increase in frequency of micturition.

125. What are the changes taking place in digestive system during pregnancy?
i. Morning sickness involving nausea, vomiting and giddiness occurs during initial stage of pregnancy
ii. Movement of gastrointestinal tract decreases resulting in constipation
iii. Indigestion and hypochlorhydria may occur.

126. What are the changes taking place in endocrine glands during pregnancy?
Generally, all the endocrine glands increase in size with increased hormonal secretion.

127. What are the changes taking place in nervous system during pregnancy?
During early stages of pregnancy, there is excitement of nervous system leading to psychological imbalance such as change in the moods, excitement and depression.

128. What is preeclampsia?
Toxemia of blood characterized by elevated blood pressure is known as preeclampsia.

129. What are the causes for hypertension in preeclampsia?
i. Release of vasoconstrictor substances from placenta
ii. Hypersecretion of adrenal hormones
iii. Development of autoimmune processes induced by the presence of placenta or fetus.

130. What is eclampsia?
Toxemia of blood characterized by severe hypertension and convulsions is known as eclampsia.

131. What are the features of eclampsia?
i. Convulsions
ii. Hypertension due to spasm of blood vessels
iii. Renal failure
iv. Liver failure
v. Heart failure
vi. Convulsions
vii. Coma.

132. What is parturition?
Expulsion or delivery of the fetus from the mother's body at the end of pregnancy is known as parturition.

133. Enumerate the hormones involved in the process of parturition.
i. Maternal hormones: Oxytocin, prostaglandins, cortisol, catecholamines and relaxin
ii. Fetal hormones: Oxytocin, cortisol and prostaglandins
iii. Placental hormones: Estrogen, progesterone and prostaglandins.

134. What is the role of estrogen in parturition?
Estrogen increases the force of uterine contractions and the number of oxytocin receptors in the uterine wall. It also accelerates the synthesis of prostaglandins.

135. What is the role of progesterone in parturition?
Progesterone does not play any role in parturition. But it is responsible for the suppression of uterine contractions throughout the period of gestation. So, it is essential for the maintenance of pregnancy. At the end of gestation period, progesterone secretion decreases suddenly and parturition is induced.

136. What is the role of oxytocin in parturition?
Oxytocin causes contraction of uterus and enhances labor through positive feedback mechanism and neuroendocrine reflex.

137. What are Braxton Hicks contractions?
Braxton Hicks contractions are the weak, irregular, short and usually painless uterine contractions, which start after 6th week of pregnancy. These contractions do not induce cervical dilatation, but may cause softening of cervix. Often called the practice contractions, Braxton Hicks contractions help the uterus practice for upcoming labor.

138. Mention sources of relaxin secretion. What are the actions of relaxation?
During initial period of pregnancy; Corpus luteum
At the time of labor: Placenta and mammary glands.
Relaxin:
i. Helps labor by softening the cervix and loosening the ligaments of symphysis pubis, so that the dilatation of cervix occurs
ii. Increases the number of receptors for oxytocin in the myometrium
iii. Simultaneously suppresses the inhibitory action of progesterone on uterine contraction, so that the uterus starts contracting.
iv. Facilitates the development of mammary glands.

139. What are the actions of prostaglandins during labor?
Prostaglandins particularly PGE_2 facilitate labor by increasing the force of uterine contractions.

140. What is placenta?
Placenta is a temporary membranous vascular organ that develops in females during pregnancy. It is expelled after childbirth. Placenta forms a link between the fetus and mother. It is considered as an anchor for the growing fetus.

141. Enumerate the functions of placenta.
i. Anchoring function
ii. Nutritive function
iii. Excretory function
iv. Respiratory function
v. Endocrine function.

142. What is Bohr's effect? And what is double Bohr's effect?
Bohr's effect is the reduction in affinity of hemoglobin for oxygen due to increased carbon dioxide tension. On the

other hand, when the carbon dioxide tension decreases, the affinity for oxygen is increased. In fetus, along with metabolic end products, carbon dioxide is completely excreted from fetal blood into mother's blood. This develops low partial pressure of carbon dioxide in the fetal blood. So, the affinity of fetal hemoglobin for oxygen increases resulting in diffusion of more amount of oxygen from mother's blood into fetal blood.

Simultaneously, the partial pressure of carbon dioxide increases in mother's blood. This reduces the affinity of hemoglobin in mother's blood for oxygen resulting in diffusion of more amount of oxygen from mother's blood into fetal blood. This type of operation of Bohr's effect in both fetal blood and mother's blood is known as double Bohr's effect.

143. Name the hormones secreted by placenta.

i. Human chorionic gonadotropin (hCG)
ii. Estrogen
iii. Progesterone
iv. Human chorionic somatomammotropin (HCS)
v. Relaxin.

144. What are the actions of hCG?

On corpus lutium: hCG is responsible for the preservation and maintenance of secretory activity of corpus luteum
On fetal testes: In male fetus, it stimulates the interstitial cells of Leydig and causes secretion of testosterone.

145. What are the actions of human chorionic somatomammotropin (HCS)?

HCS:

i. Causes enlargement of mammary glands in animals. But, in human beings, its action on mammary glands is not known
ii. Causes synthesis of proteins
iii. Reduces peripheral utilization of glucose in mother resulting in availability of more glucose for fetus
iv. Causes mobilization of fat from fat depots, thus making the availability of large.

146. What is fetoplacental unit?

Fetus and placenta are together called fetoplacental unit because of their interaction during the synthesis of steroid hormones.

147. Explain the function of fetoplacental unit briefly.

i. Cholesterol enters placenta from mother's blood
ii. From cholesterol, placenta synthesizes pregnenolone
iii. From pregnenolone, progesterone is synthesized. Some amount of pregnenolone enters fetus from placenta. Fetal liver also produces small amount of pregnenolone.
iv. From pregnenolone, dehydroepiandrosterone sulfate (DHEAS) and 16 – hydroxy dehydroepiandrosterone sulfate (16 DHEAS) are formed. DHEAS and 16 – DHEAS enter placenta from fetus to form estrogen.
v. Some amount of progesterone enters the fetus from placenta to form cortisol and corticosterone in fetal adrenal gland.

148. What is the basis for pregnancy tests?

Determination of presence or absence of the hormone called human chorionic gonadotropin (hCG) in the urine of woman suspected for pregnancy.

149. Enumerate the biological tests for pregnancy.

i. Aschheim-Zondek test
ii. Kupperman test
iii. Friedman test
iv. Hogben test
v. Galli-Mainini test.

150. What is the principle of immunological test for pregnancy?

Principle of immunological test is to determine the presence or absence of agglutination of sheep's red blood cells or latex particles coated with hCG. Presence of agglutination indicates that the woman is not pregnant. And absence of agglutination indicates that the woman is pregnant.

151. What are the advantages of immunological test for pregnancy?

i. Immunological test is accurate
ii. The result is obtained within few minutes
iii. Procedure of the tests is easy to perform
iv. Test can be performed within first few days of conception.

152. What is thelarche?

Thelarche is the beginning of changes in mammary glands at the time of puberty.

153. Name the hormones involved in the growth of mammary glands.

i. Estrogen
ii. Progesterone
iii. Prolactin
iv. Growth hormone
v. Thyroxine
vi. Cortisol
vii. Placental hormones.

154. What is benign breast disease?

Benign breast disease is a group of conditions characterized by noncancerous changes in tissues of mammary glands. Some type of benign breast conditions may cause pain or discomfort and may need treatment.

155. What are the types of benign breast disease?

i. Fibroadenoma of breast.
ii. Hyperplasia of breast.
iii. Cysts.
iv. Intraductal papillomas.
v. Adenosis of breast.
vi. Fat necrosis.

156. What is lactation?

Lactation means synthesis, secretion and ejection of milk.

157. What are the processes involved in lactation?

i. Milk secretion
ii. Milk ejection.

158. What are the phases of milk secretion?

i. Lactogenesis: Initiation of milk secretion
ii. Galactopoiesis: Maintenance of milk secretion.

159. What are the hormones involved in milk secretion?

Prolactin: Necessary for initiation of milk secretion
Growth hormone, thyroxine and cortisol: Necessary for maintenance of milk secretion.

160. What is the effect of lactation on menstrual cycle?

Woman who nurses her child regularly does not have menstrual cycle for about 24 to 30 weeks after delivery. It is because, regular nursing the baby stimulates prolactin secretion continuously. Prolactin inhibits GnRH secretion resulting in suppression of gonadotropin secretion. In the absence of gonadotropin, the ovaries become inactive and ovulation does not occur.

When the frequency of nursing the baby decreases (after about 24 weeks) the secretion of GnRH and gonadotropins starts slowly. When sufficient quantity of gonadotropins is secreted, the menstrual cycle starts.

161. What are the contraceptive methods in females?

i. Rhythm method
ii. By using mechanical barriers like cervical cap or diaphragm
iii. Pill method (oral contraceptives)
iv. By using intrauterine contraceptive devices (IUCD)
v. Medical termination of pregnancy (MTP)
vi. Tubectomy.

162. What is safe period? When does it exist?

Period of menstrual cycle during which there is no danger of pregnancy after sexual intercourse is known as safe period. It is 4 to 5 days after menstrual bleeding and 5 to 6 days before the onset of next menstrual cycle.

163. What is the disadvantage of rhythm method of conception?

Knowledge of determining the time of ovulation is difficult for uneducated or less educated women. So, it is not a successful method among such women. Also, there must be understanding between the couples regarding this and self restrain is essential. Otherwise, it cannot be practiced.

164. What are oral contraceptives?

Oral contraceptives are the pills containing synthetic estrogen and progesterone.

165. What is the mechanism of action of oral contraceptive pills?

Oral contraceptive pills prevent maturation of follicles and ovulation by suppressing the secretion of gonadotropins from pituitary. Thus, menstrual cycle becomes anovulatory in nature under the influence of these pills.

166. Name the types of oral contraceptives.

i. Classical pills
ii. Sequential pills
iii. Mini pills.

167. What are the disadvantages of using oral contraceptive pills?

i. Regular intake of pills without fail is difficult
ii. Long term use of these pills results in inhibition of synthesis of anticoagulants and clotting factors and endometrial carcinoma.

168. What is the mechanism of action of intrauterine contraceptive device (IUCD)?

The IUCD prevents fertilization and implantation of ovum. The IUCD with copper content has got spermicidal action also.

169. Name the commonly used IUCD.

Lippe's loop and copper T.

170. What are the disadvantages of using IUCD?

i. It causes heavy bleeding in some women
ii. It has the tendency to cause infection
iii. It may come out of uterus accidentally.

171. What is medical termination of pregnancy? How is it done?

Abortion during first few months of pregnancy is called medical termination of pregnancy (MTP). There are three ways of doing MTP:

i. Dilatation and curettage (D and C)
ii. Vacuum aspiration
iii. Administration of prostaglandin.

172. What is the permanent method of sterilization in females?

Permanent method of sterilization in females is tubectomy. In this, the fallopian tubes are cut and the cut ends are ligated so that, the entry of ovum into uterus is prevented. Though this can cause permanent sterility, if necessary, recanalization of fallopian tube can be done using plastic tube.

173. Name the contraceptive methods in males.

i. Using condoms
ii. Vasectomy.

174. What is the permanent method of sterilization in males?

Permanent method of sterilization in males is vasectomy. In this, the vas deferens is cut and the cut ends are ligated so that, the entry of sperms into ejaculatory duct and into semen is prevented. Though vasectomy causes permanent sterility, if necessary, recanalization of vas deferens can be done.

Section 8 Cardiovascular System

1. **Name the layers of wall of the heart.**
   i. Outer pericardium
   ii. Middle myocardium
   iii. Inner endocardium.
2. **What are the layers of pericardium?**
   i. Outer parietal pericardium
   ii. Inner visceral pericardium or epicardium.
3. **What pericardial cavity or pericardial space?**
   It is the space between the two layers of pericardium.
4. **Name the types of muscle fibers that form the myocardium?**
   i. Muscle fibers which form contractile unit of heart
   ii. Muscle fibers which form pacemaker
   iii. Muscle fibers which form conductive system.
5. **What is intercalated disk? What is its significance?**
   Each cardiac muscle fiber is branched. Branches from the neighboring fibers join together. At the point of the union of the branches, the membranes of both the muscle fibers fuse together and form a tough structure which is called intercalated disk.
   These disks pull the muscle fibers with one another during contraction.
6. **What is syncytium?**
   Syncytium is the structure in which all the muscle fibers act like a single unit. Gap junctions present at the sides of adjacent cardiac muscle fibers, which allow the free exchange of substances between the muscle fibers.
7. **What are the actions heart? Mention their types.**
   i. Chronotropic action is the frequency of heartbeat or heart rate. It is of two types:
      a. Tachycardia or increase in heart rate
      b. Bradycardia or decrease in heart rate.
   ii. Inotropic action or force of contraction of heart. It is of two types:
      a. Positive inotropic action or increase in the force of contraction.
      b. Negative inotropic action or decrease in the force of contraction.
   iii. Dromotropic action or conduction of impulse through heart. It is of two types:
      a. Positive dromotropic action or increase in the velocity of conduction
      b. Negative dromotropic action or decrease in the velocity of conduction.
   iv. Bathmotropic action or excitability of cardiac muscle. It is also of two types:
      a. Positive bathmotropic action or increase in the excitability of cardiac muscle
      b. Negative bathmotropic action or decrease in the excitability of cardiac muscle.
   v. Lusitropic action is the ability of cardiac muscle to relax after contraction.
      It is also of two types:
      a. Positive lusitropic action or increase in relaxation of cardiac muscle
      b. Negative lusitropic action or decrease in relaxation of cardiac muscle.
8. **What are the layers of wall of aorta and arteries?**
   i. Outer tunica adventitia, which is made up of connective tissue layer. It is the continuation of fibrous layer of parietal pericardium
   ii. Middle tunica media, which is formed by smooth muscles
   iii. Inner tunica intima, which is made up of endothelium. It is the continuation of endocardium.
9. **What are the layers elastic tissue of aorta and arteries?**
   Aorta, arteries and arterioles have two layers of elastic tissues:
   i. External elastic lamina between tunica adventitia and tunica media.
   ii. Internal elastic lamina between tunica media and tunica intima
10. **What is the difference in content of elastic tissue and smooth muscle fibers between different blood vessels of arterial system?**
    Aorta and arteries have more elastic tissue and arterioles have more smooth muscle fibers.
11. **Why are arterioles called resistant vessels?**
    Because, resistance (peripheral resistance) is offered to blood flow in the arterioles.
12. **Why are venules called capacitance vessels?**
    Because, a large quantity of is held in venules at a time.
13. **What is arteriosclerosis?**
    Arteriosclerosis is a disease of arteries associated with hardening, thickening and loss of elasticity of wall of the vessels.
14. **What is atherosclerosis?**
    Arteriosclerosis is a disease characterized by narrowing of lumen of arterial vessels due to deposition of cholesterol.
15. **What are the divisions of circulation?**
    i. Systemic or greater circulation
    ii. Pulmonary or lesser circulation.
16. **Enumerate the properties of cardiac muscle.**
    i. Excitability
    ii. Rhythmicity
    iii. Conductivity
    iv. Contractility. Contractility includes
       a. All or none law
       b. Staircase phenomenon
       c. Summation of subliminal stimuli
       d. Refractory period.

17. How much is the resting membrane potential in cardiac muscle fiber and SA node?
Cardiac muscle fiber: – 85 to – 95 mV
SA node: – 90 to – 100 mV.

18. What is the difference between the action potential in skeletal muscle and cardiac muscle?
In skeletal muscle: Action potential occurs in two stages:
i. Depolarization
ii. Repolarization.
In cardiac muscle: Action potential occurs in four stages:
i. Rapid depolarization
ii. Initial rapid repolarization
iii. Plateau
iv. Final repolarization.

19. What is the cause (ionic basis) of plateau in action potential of cardiac muscle?
Plateau in the action potential of cardiac muscle is due to influx of calcium ions into the cardiac muscle.

20. What is the significance of plateau in action potential of cardiac muscle?
Because of the plateau, the contraction time of cardiac muscle is prolonged. It is about 5 to 15 times longer than the contraction time in skeletal muscle.

21. Why the action potential spreads rapidly through cardiac muscle?
Because of presence of gap junctions between cardiac muscle fibers.

22. Define rhythmicity.
It is the ability of a tissue to produce its own impulses regularly.

23. Define pace maker of the heart.
Pace maker is the part or area of the heart that produces the impulses for the heartbeat.

24. Name the pace maker in mammalian (human) heart and amphibian (frog) heart.
Mammalian heart: Sinoatrial (SA) node
Amphibian heart: Sinus venosus

25. What is sinoatrial node?
Sinoatrial (SA) node is a small strip of modified cardiac muscle, situated in superior part of lateral wall of right atrium, just below the opening of superior vena cava. It generates impulses for heart beat. Fibers of this node do not have contractile elements.

26. What are the experimental evidences to prove the SA node as the pace maker in human heart?
i. Stimulation of SA node increases the heart rate
ii. Destruction of it causes immediate stoppage of heart
iii. Local cooling of SA node decreases heart rate
iv. Local warming of SA node increases heart rate
v. Electrical activity starts first in SA node.

27. Give the rhythmicity (per minute) in different parts of the heart.

SA node	: 70 to 80
AV node	: 40 to 60
Atrial muscle	: 40 to 60
Purkinje fibers	: 35 to 40
Ventricular muscle	: 20 to 40

28. What is pace maker potential? What is its significance? What is funny current?
The unstable resting membrane potential in between the action potentials in SA node is known as pace maker potential or prepotential. It is responsible for development of action potential.

29. What is funny current?
Pacemaker current (pacemaker potential) is always referred as funny current because of its unusual properties. It is initiated by opening of channels thorough which there is inward movement of sodium ions. It triggers action potential.

30. What is the ionic basis of pace maker potential?
Initial part of pace maker potential is due to slow influx of sodium ions and the later part is due to slow influx of calcium ions.

31. Name the components of conductive system (junctional tissues) in human heart.
i. Internodal fibers (fibers of Bachman, Wenckebach and Thorel)
ii. Atrioventricular (AV) node
iii. Bundle of His
iv. Right and left branches of bundle of His
v. Purkinje fibers.

32. What is the velocity of conduction of impulses (meter per second) at different parts of conductive system of the heart?

Atrial muscle fibers	: 0.3
Internodal fibers	: 1
AV node	: 0.05
Bundle of His	: 0.12
Purkinje fibers	: 4
Ventricular muscle fibres	: 0.5

33. What is all or none law?
When a stimulus is applied, whatever may be the strength of stimulus, the muscle gives maximum response or it does not give response at all. This is called all or none law.

34. To which muscle is all or none law applicable?
All or none law is applicable to whole of cardiac muscle and to one single muscle fiber in skeletal muscle.

35. What is the cause of all or none law in whole of cardiac muscle?
All or none law is applicable to whole of cardiac muscle because syncytial arrangement of cardiac muscle.

36. Define staircase phenomenon. Why does it occur?
If stimuli are applied repeatedly with an interval of 2 seconds to the cardiac muscle, the force of contraction increases gradually for the first few contractions. Later, the force remains the same. The gradual increase in the force of contraction is known as staircase phenomenon.

Staircase phenomenon occurs because of the short interval of 2 seconds in between the stimuli. During this period, the beneficial effect is produced and this facilitates the force of successive contraction.

37. Define refractory period.
Refractory period is the period during which the muscle does not show any response to a stimulus.

38. What are the types of refractory period?
i. Absolute refractory period: The period during which the muscle does not show any response at all, whatever may be the strength of the stimulus
ii. Relative refractory period: The period during which the muscle shows response if the strength of stimulus is maximum.

39. What is the duration of refractory period in cardiac muscle?
Cardiac muscle has long refractory period.
Absolute refractory period (throughout systole): 0.27 sec
Relative refractory period (first half of diastole): 0.26 sec
Total refractory period: 0.53 second.

40. What is the significance of long refractory period in cardiac muscle?
Because of long refractory period, the complete summation of contractions, fatigue and tetanus do not occur in cardiac muscle.

41. Define cardiac cycle.
Cardiac cycle is defined as the sequence of coordinated activities, which take place during every heartbeat.

42. Name the divisions and subdivisions of ventricular events of cardiac cycle.
i. Ventricular systole
Subdivisions:
a. Isometric contraction
b. Ejection period
ii. Ventricular diastole
Subdivisions:
a. Protodiastole
b. Isometric relaxation
c. Rapid filling
d. Slow filling
e. Last rapid filling which coincides with atrial systole.

43. Give the time duration of divisions of cardiac cycle.
Duration of:

One cardiac cycle	: 0.8	second
Atrial systole	: 0.1	second
Atrial diastole	: 0.7	second
Ventricular systole	: 0.27	second
Ventricular diastole	: 0.53	second

44. What is isometric (isometric) contraction of the heart?
Period during which the ventricles of the heart contract as closed cavities (because all the valves are closed) without any change in the volume of ventricular chambers or in the length of muscle fibers is known as isometric (isovolumetric) contraction. During this period, the pressure increases very much.

45. What is the significance of isometric contraction of the heart?
During isometric contraction, pressure in the ventricles is greatly increased. When ventricular pressure increases more than the pressure in aorta and pulmonary artery the semilunar valves open. Thus, the high pressure developed during isometric contraction is responsible for the opening of semilunar valves leading to ejection of blood from the ventricles.

46. What is isometric or isovolumetric relaxation of the heart?
Period during which the ventricles of the heart relax as closed cavities (because all the valves are closed) without any change in the volume of ventricular chambers or in the length of muscle fibers is known as isometric or isovolumetric relaxation. The pressure decreases very much during this period.

47. What is the significance of isometric relaxation of the heart?
During isometric relaxation, the pressure decreases greatly in ventricles. When the pressure becomes less than the atrial pressure, the atrioventricular valves open resulting in ventricular filling.

48. How is intraatrial pressure determined?
Right atrial pressure: By cardiac catheterization
Left atrial pressure: By measuring pulmonary capillary wedge pressure.

49. Mention the maximum and minimum pressures in right and left atria.
Right atrium:
Maximum pressure = 5 to 6 mm Hg
Minimum pressure = 0 to 2 mm Hg
Left atrium:
Maximum pressure = 7 to 8 mm Hg
Minimum pressure = 0 to 2 mm Hg.

50. How is intraventricular pressure determined?
By cardiac catheterization.

51. Mention the maximum and minimum pressures in right and left ventricles.
Right ventricle:
Maximum pressure = 25 mm Hg
Minimum pressure = 2 to 3 mm Hg
Left ventricle:
Maximum pressure = 120 mm Hg
Minimum pressure = 5 mm Hg.

52. Why is the pressure always more in left ventricle than in right ventricle?
Because of the thick wall of left ventricle.

53. How is the ventricular volume determined?
i. By Henderson's cardiometer: Used only in animals
ii. By angiography: Done in both animals and humans.

54. Define and give the normal value of end-systolic volume.
End systolic volume is the minimum volume of blood present in each ventricle at the end of systole (after ejection)
Normal value: About 70 mL in each ventricle.

55. Define and give normal value of end-diastolic volume.
End diastolic volume is the maximum volume of blood present in each ventricle at the end of diastole (after filling)
Normal value: 130 to 150 mL in each ventricle.

56. Mention the methods of measurement of end-systolic volume and end-diastolic volume.
i. Radionuclide angiocardiography (multigated acquisition: MUGA scan)
ii. Echocardiography
iii. Catheterization
iv. Computed tomography (CT) scan
v. Magnetic resonance imaging (MRI).

57. What is ejection fraction? Give its normal value.
Ejection fraction refers to the fraction (or portion) of end-diastolic volume that is ejected out by each ventricle per beat. From 130 to 150 mL of end-diastolic volume, 70 mL is ejected out by each ventricle (stroke volume).
Normal ejection fraction is 60 to 65%.

58. Give the maximum and minimum pressures in systemic aorta and pulmonary artery.
Systemic aorta:
Maximum pressure = 120 mm Hg
Minimum pressure = 80 mm Hg
Pulmonary artery:
Maximum pressure = 25 mm Hg
Minimum pressure = 7 to 8 mm Hg.

59. What are heart sounds?
Heart sounds are the sounds produced by mechanical activities of heart during each cardiac cycle.

60. What is the cause for each heart sound?

First heart sound	: Simultaneous closure of atrioventricular valves
Second heart sound	: Simultaneous closure of semilunar valves
Third heart sound	: Rushing of blood into ventricles
Fourth heart sound	: Atrial systole.

61. Name the methods to study the heart sounds.

i. By using stethoscope : First and second heart sounds can be heard
ii. By using microphone : First, second and third heart sounds are heard.
iii. By phonocardiogram : All the fourth heart sounds are recorded.

62. What are the auscultation areas? Name them.

Areas on the chest wall where the heart sounds can be heard with the help of stethoscope are known as the auscultation areas. Auscultation areas:

i. Mitral (bicuspid) area: In left V intercostal space about 3 inches from midline (apex beat area)
ii. Tricuspid area: Over the xiphoid process
iii. Pulmonary area: Over left II intercostal space close to sternum
iv. Aortic area: Over right II intercostal space close to sternum.

First heart sound is heard best in mitral and tricuspid areas. Second heart sound is heard best in pulmonary and aortic areas.

63. What is apex beat? And what is apex beat area?

Apex beat is the thrust of the apex of the ventricles against the wall of the chest during systole.

Apex beat area is the mitral area which lies in the left V intercostal space about 3 inches from the midline.

64. Define phonocardiogram.

Phonocardiogram is the graphical record of heart sounds.

65. What are the characteristic features of heart sounds?

First heart sound: Long, soft and low pitched. It resembles the spoken word "LUB"
Second heart sound: Short, sharp, and high pitched. It resembles the spoken word "DUB"
Third heart sound: Short and low pitched
Fourth heart sound: Short, low pitched and inaudible. Many times, it merges with first heart sound.

66. What is reduplication of first heart sound? Mention its types.

Reduplication means splitting of the heart sound. First heart sound is split when the atrioventricular valves do not close simultaneously (asynchronous closure).

Types of reduplication of first heart sound:

i. Physiological splitting: Occurs normal conditions but it is rare
ii. Pathological splitting: Occurs in stenosis of atrioventricular valves and atrial septal defect.

67. What is reduplication of second heart sound? Mention its types.

Splitting of second heart sound occurs due to asynchronous closure of semilunar valves.

Types of reduplication of second heart sounds:

i. Physiological splitting: Occurs during deep inspiration
ii. Pathological splitting: Occurs in pulmonary stenosis, right bundle branch block and right ventricular hypertrophy.

68. What is reverse splitting or paradoxical splitting of second heart sound? When does it occur?

It is the splitting of second heart sound, in which aortic valve closes after the closure of pulmonary valve. It is due to the delay in emptying of left ventricle.

It occurs in left bundle-branch block, aortic stenosis and left ventricular hypertrophy.

69. What is triple heart sound or gallop rhythm? When does it occur?

It is an abnormal rhythm of heart, characterized by three clear heart sounds during each heartbeat. It is due to an abnormal third or fourth heart sound that is heard besides first and second heart sounds.

It occurs in myocardial infarction and severe hypertension.

70. What is quadruple heart sound or quadruple gallop? When does it occur?

It is an abnormal rhythm of heart, characterized by four clear heart sounds during each heartbeat. It is also called quadruple rhythm. It is due to third and fourth heart sounds that are heard besides first and second heart sounds. It occurs during congestive heart failure.

71. Define cardiac murmurs or bruits.

Cardiac murmurs or bruits are abnormal heart sounds.

72. What are the causes for cardiac murmurs?

i. Valvular diseases
ii. Septal defects
iii. Vascular defects.

73. What are the valvular diseases?

i. Stenosis or narrowing of the valves
ii. Incompetence or weakness of the valves or valvular insufficiency.

74. Classify cardiac murmurs.

i. Systolic murmur that is produced during:
   a. Incompetence of atrioventricular valve
   b. Stenosis of semilunar valve
   c. Anemia
   d. Intraventricular or intra-atrial septal defects
   e. Coarctation of aorta.
ii. Diastolic murmur that is produced in:
   a. Stenosis of atrioventricular valve
   b. Incompetence of semilunar valves
iii. Continuous murmur that is produced during patent ductus arteriosus.

75. What is coarctation of aorta?

It is a congenital disorder characterized by narrowing of a part of aorta.

76. What is patent ductus arteriosus?

Intact ductus arteriosus is called patent ductus arteriosus.

77. Define electrocardiogram (ECG).

Electrocardiogram (EGC) is the graphical registration of electrical activities of the heart, which occur prior to mechanical activities.

78. What are the uses of ECG?

ECG is used in determining the following:

i. Heart rate
ii. Heart rhythm

ECG is also used in diagnosis of the following:

i. Abnormal electrical conduction in heart
ii. Poor blood flow to heart muscle (ischemia)
iii. Heart attack
iv. Coronary artery disease
v. Hypertrophy of heart chambers.

79. Explain electrocardiographic grid. What are the uses of it?

Electrocardiographic grid refers to the markings (lines) on ECG paper. ECG paper has horizontal and vertical lines at regular intervals of 1 mm. Every 5th line (5 mm) is thickened.

80. What are the uses of electrocardiographic grid?
It is used to determine the following:
i. Time duration of different ECG waves which is plotted horizontally on X-axis
On X-axis:
1 mm = 0.04 second
5 mm = 0.20 second
ii. Amplitude of ECG waves which is plotted vertically on Y-axis.
On Y-axis:
1 mm = 0.1 mV
5 mm = 0.5 mV

81. What is the speed of the paper in ECG machine?
Usually movement of paper through the machine is fixed at the speed of 25 mm/sec. If heart rate is very high, speed of the paper is changed to 50 mm/sec.

82. Define ECG leads.
ECG leads are the electrodes connecting the surface of the body and ECG machine while recording ECG.

83. What are the types of ECG leads?
ECG leads are of two types:
i. Bipolar leads (standard limb leads) in which both the leads are active electrodes
ii. Unipolar leads in which one is active electrode and the other one is an indifferent electrode.
Unipolar leads are of two types:
a. Unipolar limb leads
b. Unipolar chest leads.

84. What are bipolar limb leads or standard limb leads?
Bipolar limb leads or the standard limb leads are those in which both the electrodes are active electrodes and are taken from two of the three limbs, i.e. right arm, left arm and left leg.

Bipolar limb leads are of three types:
i. Lead I connecting right arm and left arm
ii. Lead II connecting right arm and left leg
iii. Lead III connecting left arm and left leg.

85. What are unipolar limb leads or augmented limb leads?
Unipolar limb leads or augmented limb leads are those in which the active electrode is connected to one limb and the indifferent electrode is obtained by connecting the other two limbs through a resistance.

Augmented limb leads are:
i. aVR: Active electrode is from right arm
ii. AVL: Active electrode is from left arm
iii. aVF: Active electrode is from the left leg (foot).

86. What are unipolar chest leads?
Unipolar chest leads are those in which the indifferent electrode is obtained by connecting the three limbs, i.e. left arm, left leg and right arm through a resistance of 5000 ohms.

Active electrode is placed on six points over the chest:
V1: Over IV intercostal space near right sternal margin
V2: Over IV intercostal space near left sternal margin
V3: In between V2 and V4
V4: Over left V intercostal space on the midclavicular line
V5: Over left V intercostal space on the anterior axillary line
V6: Over left V intercostal space on the midaxillary line.

87. What are the waves of normal ECG?
i. P wave or atrial complex
ii. QRS complex or initial ventricular complex
iii. T wave or final ventricular complex.

88. Why atrial repolarization is not recorded as a separate event in ECG?
Since the atrial repolarization coincides with the ventricular depolarization, it is merged with QRS complex in ECG.

89. What is the causes for P wave of ECG?
Depolarization of atrial musculature.

90. What is the normal duration and amplitude of P wave of ECG?
Duration : 0.1 sec
Amplitude: 0.1 to 0.12 mV

91. What is the cause for QRS complex of ECG?
QRS complex is due to depolarization of ventricular musculature
Q wave: Due to depolarization of basal portion of interventricular septum.
R wave: Due to depolarization of apical portion of interventricular septum and apical portion of ventricular muscle.
S wave: Due to depolarization of basal portion of ventricular muscle near the atrioventricular ring.

92. What is the normal duration and amplitude of QRS complex of ECG?
Duration: 0.08 to 0.1 sec
Amplitude of 'Q' wave: 0.1 to 0.2 mV
Amplitude of 'R' wave: 1 mV
Amplitude of 'S' wave: 0.4 mV.

93. What is the causes for T wave of ECG?
Repolarization of ventricular musculature.

94. What is the normal duration and amplitude of T wave of ECG?
Duration : 0.2 sec
Amplitude : 0.3 mV

95. What is U wave in ECG? What is its cause?
U wave is a rare and insignificant wave in ECG. It is due to repolarization of papillary muscle and Purkinje fibers.

96. Define P–R interval. What is its significance?
P–R interval is the interval between the onset of P wave and onset of Q wave.
It signifies the atrial depolarization and conduction of impulses through A–V node.

97. What is the normal duration of P–R interval? When is it prolonged?
Normal duration of P–R interval is 0.18 second (0.12 to 0.2 second).
It is prolonged more than 0.2 second during A–V nodal delay.

98. What is S–T segment of ECG?
It is the interval between the end of S wave and onset of T.

99. What is the significance of observing S–T segment?
Alteration of S–T segment indicates some pathological condition. Normally S–T segment is isoelectric. It is elevated in myocardial infarction and depressed in hypokalemia.

100. How will you calculate heart rate in ECG?
i. Time is plotted horizontally (X-axis).
ii. On X-axis, interval between two thick lines is 0.2 second.
iii. Time duration for 30 thick lines is 6 seconds
iv. Count number of R waves in 6 seconds (30 thick lines)
v. Multiply it by 10 to obtain heart rate.
vi. For the sake of convenience, the ECG paper has special time marking at every 3 seconds. So, it is easy to find the time duration of 6 seconds.

101. What is heart rate variability (HRV)?
Refers to the beattobeat variations. Under resting conditions, the ECG of healthy individuals exhibits some periodic variation in RR intervals. This rhythmic phenomenon is known as respiratory sinus arrhythmia (RSA), since it fluctuates with the phases of respiration. 'RR' interval is shortened during inspiration and prolonged during expiration.

102. What is the significance of HRV?
HRV decreases in many clinical conditions like:
i. Cardiovascular dysfunctions such as hypertension.
ii. Diabetes mellitus.
iii. Psychiatric problems such as panic and anxiety.

103. What is cardiac vector or axis?
When current flows through heart, the electrical potential travels in a particular direction at an instant. The direction of the travel of the potential is called cardiac vector or axis.

104. What are the types of vector?
i. Instantaneous vector
ii. Calculated vector or mean QRS vector.

105. What is the significance of vectoral analysis?
Vectoral analysis helps to determine the diseases of heart like ventricular hypertrophy and bundle branch block.

106. What is vector cardiogram?
Vector cardiogram is the simultaneous recording of electrical potential in different axis across the heart above downwards and side-to-side. It is obtained by using cathode ray oscilloscope.

107. Define arrhythmia.
Arrhythmia is the abnormal or irregular heartbeat.

108. Classify arrhythmia.
Arrhythmia is classified into two types:
i. Normotropic arrhythmia in which SA node is the pacemaker.
ii. Ectopic arrhythmia in which one of the structures of heart other than SA node is the pacemaker. This is divided into two types:
a. Homotropic arrhythmia in which the impulses for heartbeat arise from any part of the conductive system
b. Heterotropic arrhythmia in which the impulses for heartbeat arise from the musculature of the heart other than conductive system.

109. What is sinus arrhythmia?
Sinus arrhythmia is the rhythmical variation in the heart rate along with respiration. During inspiration, the heart rate increases and during expiration the heart rate decreases. It is a physiological phenomenon.

110. What is sinus tachycardia? When does it occur?
Sinus tachycardia is the increase in heart rate due to increased discharge from SA node. Heart rate increases up to 150/minute

It occurs both in physiological and pathological conditions

Physiological conditions when tachycardia occurs:
i. Exercise
ii. Emotion
iii. High altitude
iv. Pregnancy.

Pathological conditions when tachycardia occurs:
i. Fever
ii. Anemia
iii. Hyperthyroidism
iv. Hypersecretion of catecholamines
v. Cardiomyopathy
vi. Valvular heart disease
vii. Hemorrhagic shock.

111. What are the features of sinus tachycardia?
i. Palpitations (sensation of feeling the heartbeat)
ii. Dizziness
iii. Fainting
iv. Shortness of breath
v. Chest discomfort (angina).

112. What is sinus bradycardia? When does it occur?
Sinus bradycardia is the reduction in heart rate due to reduced discharge from SA node sinus bradycardia. Heart rate decreases to 40/minute.

It occurs both in physiological and pathological conditions

Physiological conditions when bradycardia occurs:
i. Sleep
ii. Athletic

Pathological conditions when bradycardia occurs:
i. Disease of SA node
ii. Hypothermia
iii. Hypothyroidism
iv. Heart attack
v. Congenital heart disease
vi. Degenerative process of aging
vii. Obstructive jaundice
viii. Increased intracranial pressure
ix. Use of certain drugs like beta blockers, channel blockers, digitalis and other antiarrhythmic drugs
x. Atherosclerosis.

113. What are the features of sinus bradycardia?
i. Sick sinus syndrome
ii. Fatigue
iii. Weakness
iv. Shortness of breath
v. Lack of concentration
vi. Difficulty in exercising.

114. What is sick sinus syndrome?
It is the common feature of sinus bradycardia characterized by dizziness and unconsciousness.

115. Define and classify heart block.
Heart block is the blockage of impulses generated from SA node while passing through conductive system of the heart. It is classified into two types:
i. Sinoatrial block
ii. Atrioventricular block.

116. What is sinoatrial block or sinus block? And what is AV nodal rhythm?
Sinoatrial block is the failure of impulse transmission from SA node to AV node.

117. What is AV nodal rhythm?
During sinoatrial block, heart stops beating. Later the AV node becomes the pacemaker and heart starts functioning but with a slower rate. This is known as AV nodal rhythm.

118. What is atrioventricular block? What are its types?
Atrioventricular block is the heart block in which the impulses are not transmitted from atria (from AV node) to ventricles because of defective conductive system.
Atrioventricular block is of two types:
i. Incomplete heart block
ii. Complete heart block.

119. What is incomplete block? What are its types?
Incomplete heart block is the condition in which the transmission of impulses from atria to ventricles is slowed down and not blocked completely. Impulses reach ventricles late.

Incomplete heart block is of four types:
i. First degree heart block
ii. Second degree heart block
iii. Wenckebach phenomenon
iv. Bundle branch block.

120. What is Wenckebach phenomenon or syndrome?
Wenckebach phenomenon is a type of heart block characterized by progressive increase in AV nodal delay, resulting in missing of one beat. Afterwards, the conduction of impulse is normal or slightly delayed.

121. What is complete block?
Complete heart block is the condition in which the impulses produced by SA node cannot reach the ventricles. It is also called complete atrioventricular block or third-degree heart block.

122. What is idioventricular rhythm?
In complete heart block, the impulses from SA node do not reach the ventricles. So, the ventricles beat in their own rhythm, independent of atrial beat. This is called idioventricular rhythm.

123. What is Stokes-Adams syndrome?
Stokes-Adams syndrome is the sudden attack of dizziness and unconsciousness caused by heart block. It may be accompanied by convulsions also.

124. What is ectopic focus?
Ectopic focus is the discharge of impulses for heart beat from any part of the heart other than SA node.

125. What is extrasystole?
Extrasystole is the premature contraction of the heart before it's normal contraction. It is caused by ectopic focus.

126. What is compensatory pause? What is its cause?
Extrasystole is always followed by a long pause (stoppage of heart) when the heart stops. The temporary stoppage of heart immediately after extrasystole is called compensatory pause. It is because the heart has to wait for the arrival of next natural impulse from the pacemaker.

127. Name the types of extrasystole.
i. Atrial extrasystole
ii. Nodal extrasystole
iii. Ventricular extrasystole.

128. Name some conditions when extrasystole occurs in human heart.
i. Heart diseases
ii. Emotion
iii. Excessive ingestion of coffee or alcohol
iv. Excessive smoking
v. Hyperthyroidism.

129. What is paroxysmal tachycardia or Bouveret-Hoffmann syndrome?
Paroxysmal tachycardia is the sudden attack of increased heart rate due to ectopic foci arising from atria, AV node or ventricle.

130. What is circus movement or atrial echo beat?
Circus movement is defined as circuitous propagation of impulses around a structural or functional obstruction, resulting in reentry of the impulse and re-excitation of heart.

When there is a sudden and temporary block in normal conductive system, the impulses from SA node reach the ventricle through bundle of Kent. By this time, the blockage in normal conductive system disappears. Now, the impulse, which passes through bundle of Kent, after exciting the ventricular muscle, travels in the opposite direction through the normal conductive system and finally, it re-enters the AV node. Reentered impulse activates the AV node and depolarizes the atria, resulting in atrial contraction.

131. What is circus Wolff-Parkinson-White syndrome?
It is the condition characterized by repeated attacks of AV nodal paroxysmal tachycardia in persons with bundle of Kent.

132. What is bundle of Kent?
It is an additional conductive system present in some persons. It connects atria and ventricles directly so the conduction is very rapid than the regular conductive system.

133. What is circus Lown-Ganong-Levine syndrome?
It is another condition characterized by AV nodal paroxysmal tachycardia. This occurs in persons who have got another type of abnormal conductive fibers like bundle of Kent.

134. What is atrial flutter? Why it is called so? What is the atrial rate in this condition?
Atrial flutter is an arrhythmia characterized by rapid ineffective atrial contractions, caused by ectopic foci originating from atrial musculature. It is often associated with atrial paroxysmal tachycardia.

Both the atria beat rapidly like the wings of a bird, hence the name atrial flutter.

Atrial rate is about 250 to 350 per minute. Maximum number of impulses conducted by AV node is about 230 to 240 per minute. So, during atrial flutter, the second degree of heart block occurs. The ratio between atrial beats and ventricular beats is 2:1 or sometimes 3:1.

135. When does atrial flutter occur?
Atrial flutter is common in persons suffering from cardiovascular diseases such as hypertension and coronary artery disease.

136. What is atrial fibrillation?
Atrial fibrillation is the type of arrhythmia characterized by rapid and irregular atrial contractions at the rate of 300 to 400 beats per minute. It is mostly due to circus movement of impulses within atrial musculature.

137. When does atrial fibrillation occur?
Atrial fibrillation is common in old people and patients with heart diseases.

138. What is ventricular fibrillation?
Ventricular fibrillation is the dangerous cardiac arrhythmia, characterized by rapid and irregular twitching of ventricles. Ventricles beat very rapidly and irregularly due to the circus movement of impulses within ventricular muscle. The rate reaches 400 to 500 per minute.

139. What is the seriousness of ventricular fibrillation?
Ventricular fibrillation is a serious condition as it may lead to death since ventricles cannot pump blood.

140. When does ventricular fibrillation occur?
Ventricular fibrillation is common in the following conditions:
i. Electric shock
ii. Ischemia of conductive system
iii. Coronary occlusion
iv. Chloroform and cyclopropane anesthesia

v. Trauma of heart
vi. Disturbances of heart (due to improper handling) during cardiac surgery.

141. What is abnormal pacemaker? What are the common abnormal pacemakers?
Abnormal pacemaker is the part of the heart other than SA node that becomes the pacemaker and discharges ectopic foci.
Common abnormal pacemakers:
i. Atrioventricular node
ii. Atrial musculature
iii. Ventricular musculature.

142. What is current of injury?
Current of injury means flow of current from an injured region of heart to the unaffected part. When ischemia occurs in any part of the ventricular musculature due to coronary occlusion, that part of ventricle becomes depolarized either partially or completely and the repolarization does not occur. It causes flow of current from affected (depolarized) part to unaffected part of the ventricular muscle.

143. What is the effect of change in the blood sodium concentration on the heart?
Normal sodium concentration in blood is 135 to 145 mE/L
i. Increased sodium concentration in blood decreases the rate and force of contraction.
ii. Very high sodium concentration can stop the heart in diastole.
iii. Very low level of sodium produces low voltage waves in ECG.

144. What is the effect of hyperkalemia on the heart?
Normal potassium concentration in serum is about 3.5 to 5 mEq/L
i. When it increases above 6 mEq/L (hyperkalemia), resting membrane potential in cardiac muscle is decreased leading to hyperpolarization. It reduces the excitability of the muscle
ii. When it increases above 8 mEq/ L, it affects the conductive system also
iii. During severe hyperkalemia (above 9 mEq/L), atrial muscle becomes unexcitable
In experimental animals, increased potassium concentration stops the heart in diastole immediately.

145. What is the effect of hypokalemia on the heart?
Hypokalemia reduces the sensitivity of heart muscle.

146. What is the effect of hypercalcemia on human heart?
Normal serum calcium level is 9 to 11 mg%.
In hypercalcemia, there is slight increase in excitability and contractility.

147. What is calcium rigor?
It is the stoppage of the heart in systole when a large quantity of calcium ion is infused in experimental animals. It is a reversible phenomenon. When the calcium ions are washed, the heart starts functioning normally.

148. What is the effect of hypocalcemia on heart?
Hypocalcemia reduces the excitability of the cardiac muscle.

149. What is cardiac output?
Cardiac output is the amount of blood pumped out by each ventricle.
It is expressed by three terms:
i. Stroke volume
ii. Minute volume
iii. Cardiac index.

150. What is stroke volume? Give normal value.
Stroke volume is the amount of blood pumped out by each ventricle during each beat.
Normal value: 70 mL (60 to 80 mL) when heart rate is normal (72/minute).

151. What is minute volume? Give normal value.
Minute volume the amount of blood pumped out by each ventricle in one minute.
It is the product of stroke volume and heart rate.
Normal value: 5 L/ventricle/minute.

152. What is cardiac index? Give normal value.
Cardiac index is the minute volume expressed in square meter of body surface area of the body.
Normal value: 2.8 L/square meter of body surface/ minute.

153. What is cardiac reserve? Give values.
Cardiac reserve is the maximum amount of blood that can be pumped out by the heart above normal value. It is expressed in percentage. In conditions like exercise, the cardiac output reaches the maximum.
Values of cardiac reserve:
i. In normal healthy adult: 300 to 400%
ii. In old age: 200 to 300%
iii. In cardiac diseases: Minimum or nil.

154. Give some important physiological variations of cardiac output.
Cardiac output increases in the physiological conditions like:
i. Increase in environmental temperature
ii. Emotional conditions
iii. After meals
iv. Exercise
v. High altitude
vi. Pregnancy.
Cardiac ouptut decreases in conditions like:
i. Changing the posture from recumbent to upright position
ii. Sleep.

155. Give some pathological variations of cardiac output.
Cardiac output increases in:
i. Fever
ii. Anemia
iii. Hyperthyroidism.
Cardiac output decreases in:
i. Hypothyroidism
ii. Atrial fibrillation
iii. Incomplete heart block
iv. Congestive cardiac failure
v. Shock
vi. Hemorrhage.

156. Explain distribution of cardiac output.
The whole amount of blood pumped out by the right ventricle goes to lungs. But the blood pumped by the left ventricle is distributed to different parts of the body.
Fraction of cardiac output distributed to a particular region or organ depends upon the metabolic activities of that region or organ.

Distribution of blood pumped out of left ventricle:
i. Liver : 1,500 mL/min (30%)
ii. Kidney : 1.300 mL/min (26%)
iii. Skeletal muscles : 900 mL/min (18%)
iv. Brain : 800 mL/min (16%)
v. Skin, bone, G.I tract : 300 mL/min (6%)
vi. Heart : 200 mL/min (4%)

157. Name the factors determining cardiac output.

i. Venous return
ii. Force of contraction of heart
iii. Frequency of heart beat
iv. Peripheral resistance.

Cardiac output is directly proportional to venous return, force of contractions of heart and heart rate.

It is inversely proportional to peripheral resistance.

158. Name the factors determining venous return.

i. Respiratory pump
ii. Muscle pump
iii. Gravity
iv. Venous pressure
v. Sympathetic tone

Venous return is directly proportional to respiratory pump, muscle pump and sympathetic tone

It is inversely proportional to gravity and venous pressure.

159. What is the role of respiratory pump or abdomino-thoracic pump in venous return?

Respiratory pump is the respiratory activity.

During inspiration, thoracic cavity expands and makes the intrathoracic pressure more negative. It increases the diameter of inferior vena cava, resulting in increased venous return.

At the same time, descent of diaphragm increases the intra-abdominal pressure, which compresses abdominal veins and pushes the blood upward towards the heart and thereby the venous return is increased.

160. What is the role of muscle pump in venous return?

Muscle pump is the muscular activity

During muscular activities, the veins are compressed or squeezed

Due to the presence of valves in veins, during compression the blood is moved towards the heart

When muscular activity increases, the venous return is more.

161. What is Frank-Starling law? How is it applied to cardiac muscle?

Frank-Starling law states that, the force of contraction is directly proportional to the initial length of the muscle fibers within physiological limits.

When diastolic period increases and when venous return is more, the ventricular filling is more. This causes stretch and increase in the initial length of ventricular muscle fibers. And when ventricles contract the force of contraction is more resulting in increased cardiac output.

162. What is preload? What is the relation between preload and cardiac output?

Preload is the stretching of the cardiac muscle fibers at the end of diastole, just before contraction. Stretching of muscle fibers increases their length, which increases the force of contraction and cardiac output.

Force of contraction of heart and cardiac output are directly proportional to preload

163. What is afterload? What is the relation between afterload and cardiac output?

Afterload is the force against which ventricles must contract and eject the blood. Force is determined by the arterial pressure.

At the end of isometric contraction period, semilunar valves are opened and blood is ejected into the aorta and pulmonary artery. So, the pressure increases in these two vessels. Now, the ventricles have to work against this pressure for further ejection.

Thus, the afterload for left ventricle is determined by aortic pressure and afterload for right ventricular pressure is determined by pressure in pulmonary artery.

Force of contraction of heart and cardiac output are inversely proportional to afterload

164. What is peripheral resistance?

Peripheral resistance is the resistance offered to blood flow at the peripheral blood vessels.

165. Which blood vessels are called the resistant vessels and why?

Arterioles are called the resistant vessels because, the resistance to blood flow is offered mainly in arterioles. The sympathetic tone, i.e. the constant partial vasoconstrictor effect of sympathetic nerves on arterioles is the cause for resistance.

166. In which area is peripheral resistance maximum?

Peripheral resistance is maximum in splanchnic region.

167. List the various methods to measure cardiac output.

i. Direct methods (used only in animals): By using:
   a. Cardiometer
   b. Flow meter
ii. Indirect methods (used in both animals and humans):
   a. Fick's principle
   b. Indicator dilution technique
   c. Thermodilution technique
   d. Ultrasonic Doppler transducer technique
   e. Doppler echocardiography
   f. Ballistocardiographic method.

168. What is Doppler effect?

Ultrasound is the sound with very high frequency. It is very much beyond the audible range of human ears. The waves of the ultrasound are transmitted through a blood vessel. These sound waves are called transmitted waves. While passing through the blood vessels, the sound waves hit against the blood cells, particularly the red blood cells and are reflected back. Frequency of the reflected waves is different from that of the transmitted waves. This effect is called the Doppler effect.

169. What is Fick's principle?

According to Fick's principle, the amount of a substance taken up by an organ (or by the whole body) or given out in a unit time is the product of amount of blood flowing through the organ and the arteriovenous difference of the substance across the organ.

Fick's principle can be modified to measure cardiac output.

170. What is cardiac catheterization?

Cardiac catheterization is an invasive procedure in which a catheter is inserted intravenously into any chamber of the heart or blood vessel.

171. What are the uses of cardiac catheterization?

Cardiac catheterization is useful for both diagnostic and therapeutic purposes. It gives crucial information about the need for cardiac surgery, coronary angioplasty and other therapeutic procedures. It also gives information about anticipated risks and reversibility in the patient's condition during cardiac surgery or other therapeutic interventions.

172. What is interventional cardiology?

Interventional cardiology is a branch of cardiology that deals with non-surgical cardiovascular treatment by using intravascular catheter-based techniques.

173. What are the uses of interventional cardiology or therapeutic cardiac catheterization?

i. Thrombolysis.
ii. Percutaneous transluminal coronary angioplasty.
iii. Laser coronary angioplasty.
iv. Catheter ablation.

174. What is thrombolysis or reperfusion therapy?

Thrombolysis or reperfusion therapy is the procedure used to break up and dissolve a thrombus (clot) in the coronary artery of patient affected by acute myocardial infarction due to coronary thrombus. Cardiac catheterization is used for intracoronary administration of thrombolytic agents.

175. What is cardiac tamponade?

Cardiac tamponade is the mechanical compression of heart due to accumulation of fluid in pericardial space. In addition to intrapleural pressure, accumulation of fluid in pericardial space also increases the extracardiac pressure and compresses the heart. In cardiac tamponade, the cardiac output decreases and output curve is shifted to right.

176. What are thrombolytic agents? Name some thrombolytic agents.

Thrombolytic agents are the substances which dissolve the thrombus (clot in blood vessel). Thrombolytic agents are:

i. Alteplase, reteplase and tenecteplase which are the recombinant (produced in lab by recombinant biotechnology) tissue plasminogen activators
ii. Streptokinase
iii. Urokinase.

These thrombolytic agents convert plasminogen into plasmin which degrades fibrin in clot and restores normal blood flow.

177. What is coronary percutaneous transluminal coronary angioplasty?

Coronary angioplasty means the correction of narrowed or totally obstructed lumen of blood vessels by mechanical methods. In percutaneous transluminal coronary angioplasty (PTCA), a narrowed coronary artery is dilated by inflating a balloon attached to the tip of catheter that is introduced into the blood vessel. Sometimes, a stent (expandable wire mesh) is introduced into the corrected blood vessel by the catheter to keep the vessel in dilated state.

178. Define cardiac function curves or Frank-Starling curves? Classify them.

Cardiac function curves are Frank-Starling curves which demonstrate the capacity of ventricles to pump blood and maintain circulation of blood throughout the body.

Cardiac function curves are of two types:

i. Cardiac output curves
ii. Venous return curves.

179. What is normal heart rate? Define tachycardia and bradycardia?

Normal heart rate is 72/min. It ranges between 60 and 100/min

Tachycardia is increased heart rate above 100/min

Bradycardia is decreased heart rate below 60/min.

180. Mention the conditions when tachycardia occurs.

i. Physiological conditions:
   a. Childhood
   b. Exercise
   c. Pregnancy
   d. Emotional conditions such as anxiety.
ii. Pathological condition:
   a. Fever
   b. Anemia
   c. Hypoxia
   d. Hyperthyroidism
   e. Hypersecretion of catecholamines
   f. Cardiomyopathy
   g. Diseases of heart valves.

181. Mention the conditions when bradycardia occurs.

i. Physiological conditions:
   a. Sleep
   b. Athletes
ii. Pathological condition:
   a. Hypothermia
   b. Hypothyroidism
   c. Heart attack
   d. Congenital heart disease
   e. Regenerative process in aging
   f. Obstructive jaundice
   g. Increased intracranial pressure.

182. Mention the drugs which cause bradycardia.

i. Beta blockers
ii. Channel blockers
iii. Digitalis and other antiarrhythmic drugs.

183. How is heart rate regulated?

Heart rate is regulated by nervous mechanism which consists of:

i. Vasomotor center
ii. Motor (efferent) nerve fibers to heart
iii. Sensory (afferent) nerve fibers from heart.

184. What is vasomotor center? Where is it situated?

Vasomotor center is the nervous center that regulates the heart rate. It is the same center in brain, which regulates the blood pressure. It is also called the cardiac center.

Vasomotor center is bilaterally situated in the reticular formation of medulla oblongata and lower part of pons.

185. What are the areas vasomotor center?

Vasomotor center has three areas:

i. Vasoconstrictor area
ii. Vasodilator area
iii. Sensory area.

186. Where is vasoconstrictor area? What are its other names?

Vasoconstrictor area is situated in the reticular formation of medulla in floor of IV ventricle and it forms the lateral portion of vasomotor center.

It is also called cardioaccelerator center or pressor area.

187. What are the functions of vasoconstrictor area?

Vasoconstrictor area increases the heart rate by sending accelerator impulses to heart, through sympathetic nerves.

It also causes constriction of blood vessels.

188. Where is vasodilator area? What are its other names?

Vasodilator area is situated in the reticular formation of medulla oblongata in the floor of IV ventricle. It forms the medial portion of vasomotor center.

It is also called cardioinhibitory center or depressor area.

189. What are the functions of vasodilator area?

Vasodilator area decreases the heart rate by sending inhibitory impulses to heart through vagus nerve

It also causes dilatation of blood vessels.

190. Where is sensory area of vasomotor center?
Sensory area lies in nucleus of tractus solitarius. It forms posterior part of vasomotor center.

191. What is the function of sensory area of vasomotor center?
Sensory area receives sensory impulse via glossopharyngeal nerve and vagus nerve from periphery, particularly, from the baroreceptors.

In turn, this area controls the vasoconstrictor and vasodilator areas.

192. What are the motor (efferent) nerves supplying the heart?
Heart receives efferent nerves from both the divisions of autonomic nervous system.

Parasympathetic fibers: Arise from the medulla oblongata and pass through cardiac branch of vagus nerve.

Sympathetic fibers: Arise from upper thoracic (T1 to T4) segments of spinal cord.

193. What is the action of vagus nerve on heart?
Vagus nerve is cardioinhibitory in function. It carries impulses from vasodilator area to heart. These impulses decrease the rate and force of contraction of heart.

194. Explain distribution of fibers of right and left vagus nerve in heart?
Most of the fibers from right vagus terminate in sinoatrial (SA) node. Remaining fibers supply the atrial muscles and atrioventricular (AV) node.

Most of the fibers from left vagus supply AV node and some fibers supply the atrial muscle and SA node.

Ventricles do not receive vagus nerve supply.

195. What is vagal tone or cardioinhibitory tone or parasympathetic tone?
Vagal tone is the continuous stream of inhibitory impulses from vasodilator area to heart via vagus nerve. Heart rate is kept under control because of vagal tone. Heart rate is inversely proportional to vagal tone.

196. What is vagal escape?
Vagal escape refers to escape of ventricle from inhibitory effect of vagal stimulation. If stimulation of vagus nerve is stopped, heart starts beating normally.

197. What is the cause for vagal escape?
Stimulation of right vagus stops the heartbeat due to inhibition of SA node and atria. However, ventricles are not supplied by vagus. So, the ventricles are not inhibited by vagal stimulation. Because of this, when stoppage of heartbeat is continued for some time (by vagal stimulation), a part of ventricular musculature becomes pacemaker and starts producing impulses. It results in contraction of ventricles, which is called vagal escape.

198. What is the mode of action of vagus nerve?
Vagus nerve inhibits heart by secreting neurotransmitter acetylcholine.

199. Explain the sympathetic nerve fibers to heart.
Preganglionic fibers of the sympathetic nerves to heart arise from lateral gray horns of first 4 thoracic (T1 to T4) segments of the spinal cord. Preganglionic fibers reach the superior, middle and inferior cervical sympathetic ganglia situated in the sympathetic chain.

Postganglionic fibers from sympathetic ganglia form three nerves:

i. Superior cervical sympathetic nerve, which innervates larger arteries and base of the heart
ii. Middle cervical sympathetic nerve, which supplies the rest of the heart
iii. Inferior cervical sympathetic nerve, which serves as sensory (afferent) nerve from the heart.

200. What is the action of sympathetic nerves on heart?
Sympathetic nerves have cardioacceleratory function and carry cardioacceleratory impulses from vasoconstrictor area to heart. These impulses increase the rate and force of contraction of heart.

201. What is sympathetic tone or cardioaccelerator tone?
Sympathetic or cardioaccelerator tone is the continuous stream of impulses produced by vasoconstrictor area. These impulses past through sympathetic nerves and accelerate the heart rate.

202. What is the mode of action of sympathetic nerves?
Sympathetic nerves accelerate heart rate by secreting neurotransmitter noradrenaline.

203. Which are the afferent (sensory) nerve fibers of the heart?
Afferent (sensory) nerve fibers of the heart pass through inferior cervical sympathetic nerve. Afferent nerve fibers carry sensations of stretch and pain from heart to the brain via spinal cord.

204. Define baroreceptors.
Baroreceptors are the receptors, which give response to change in blood pressure.

205. Mention the situation and nerve supply of baroreceptors.
Baroreceptors are situated in the carotid sinus and arch of aorta.

Carotid baroreceptors are supplied by Hering's nerve, which is the branch of glossopharyngeal nerve.

Aortic baroreceptors are supplied by aortic nerve, the branch of vagus nerve.

206. What is the effect of baroreceptors on heart rate?
When blood pressure increases, the baroreceptors are stimulated and send stimulatory impulses to vasodilator area (cardioinhibitory center). This causes increase in vagal tone and reduction in heart rate.

207. What is Marey's law? When is it applicable?
According to Marey's law, the heart rate is inversely proportional to blood pressure. It is applicable only in resting conditions.

208. What is Marey's reflex?
Marey's reflex is a cardioinhibitory reflex that decreases heart rate when blood pressure increases.

209. Define chemoreceptors.
Chemoreceptors are the receptors, which give response to change in chemical constituents of blood such as decrease in oxygen, increase in carbon dioxide and increase in hydrogen ion concentration.

210. Mention the situation and nerve supply of peripheral chemoreceptors.
Peripheral chemoreceptors are situated in the carotid body and aortic body.

Carotid chemoreceptors are supplied by Hering's nerve, which is the branch of glossopharyngeal nerve.

Aortic chemoreceptors are supplied by aortic nerve, which is the branch of vagus nerve.

211. What is the effect of chemoreceptors on heart rate?
Whenever there is hypoxia, hypercapnea or increased hydrogen ion concentration, chemoreceptors send inhibi-

tory impulses to vasodilator area (cardioinhibitory center). Now, the vagal tone decreases and heart rate increases.

Chemoreceptors play a major role in maintaining respiration than heart rate.

212. What is Bain-Bridge reflex or right atrial reflex?
Bain-Bridge reflex is a cardioaccelerator reflex that increases heart rate when venous return increases.

213. What is Bezold-Jarish reflex or coronary chemoreflex?
It is the reflex characterized by tachycardia and hypotension caused by stimulation of chemoreceptors present in wall of left ventricle by substances such as alkaloids.

214. What is dynamics? What is hemodynamics?
Dynamics means study of motion. Hemodynamics refers to study of movement of blood through circulatory system.

215. What is mean volume of blood flow?
Mean volume of blood flow is the volume of blood which flows into a region of circulatory system in a given unit of time. It is the product of mean velocity of blood flow and cross- sectional area of vascular bed.

216. What are the types of blood flow through a blood vessel?
Blood flow through a blood vessel is of two types:
i. Streamline flow or laminar flow: It is a silent flow.
ii. Turbulent flow: It is a noisy flow.

217. What is Reynolds number?
Reynolds number is the critical velocity at which flow becomes turbulent.

218. What is windkessel effect? What are windkessel blood vessels?
Windkessel effect is the recoiling effect of blood vessels that convert the pulsatile flow into continuous flow.
Blood vessels showing this effect are known as windkessel vessels.

219. What is the mean velocity of blood flow at different blood vessels?

Large arteries	: 50 cm/sec
Small arteries	: 5 cm/sec
Arterioles	: 0.50 cm/sec
Capillaries	: 0.05 cm/sec
Venules	: 0.10 cm/sec
Small veins	: 1.00 cm/sec
Large veins	: 2.00 cm/sec.

220. What is autoregulation. Name some organs where autoregulation is more effective.
Autoregulation means the regulation of blood flow through an organ by the organ itself. It is defined as the intrinsic capacity of an organ to regulate a constant blood flow in spite of changes in the perfusion pressure.

It is more effective in some vital organs such as kidney, heart and brain.

221. What is perfusion pressure? What is effective perfusion pressure?
Perfusion pressure is the balance between the pressures on either side of an organ i.e. arterial pressure on one side and venous pressure on other side.

Effective perfusion pressure is the perfusion pressure divided by resistance in blood vessels.

222. What are the theories of autoregulation?
i. Myogenic theory
ii. Metabolic theory.

223. Define arterial blood pressure.
Arterial blood pressure is defined as the lateral pressure exerted by the contained column of blood on the wall of the arteries.

224. What are the terms by which the arterial blood pressure is expressed?
i. Systolic pressure: Maximum pressure exerted in arteries during systole of heart
ii. Diastolic pressure: Minimum pressure exerted in arteries during diastole of heart
iii. Pulse pressure: Difference between systolic and diastolic pressures
iv. Mean arterial pressure: Average pressure existing in the arteries. It is diastolic pressure plus one-third of pulse pressure.

225. Give the normal value of arterial blood pressure.
Systolic pressure : 120 mm Hg (110 to 140 mm Hg)
Diastolic pressure : 80 mm Hg (60 to 80 mm Hg)
Pulse pressure : 40 mm Hg.
Mean arterial pressure : 93 mm Hg.

226. Why is diastolic pressure (not the systolic pressure) considered to determine the mean arterial pressure?
Because the diastolic period of heart is much longer (0.53 second) than the systolic period (0.27 second).

227. Mention some physiological variations of arterial blood pressure.
Arterial blood pressure is less in infants, children and in females. It decreases during sleep. It increases during emotional conditions, after meals and after exercise.

228. What are the pathological variations of arterial blood pressure?
Hypertension: Pathological increase in arterial blood pressure
Hypertension: Pathological decrease in arterial blood pressure.

229. Name the factors determining arterial blood pressure.
Factors necessary to maintain normal blood pressure are called local factors or mechanical factors or determinants of blood pressure.

These factors are of two types:
i. Central factors:
   a. Cardiac output
   b. Heart rate.
ii. Peripheral factors:
   a. Peripheral resistance
   b. Blood volume
   c. Venous return
   d. Elasticity of blood vessel
   e. Velocity of blood flow
   f. Diameter of blood vessels
   g. Viscosity of blood.

230. Name the important factors determining systolic and diastolic blood pressures.
i. Cardiac output: It is the important factor that determines systolic pressure. Systolic pressure is directly proportional to stroke volume.
ii. Peripheral resistance: It is the important factor, which determines diastolic pressure. Diastolic pressure is directly proportional to peripheral resistance.

231. Name the various mechanisms involved in the regulation of arterial blood pressure.
i. Nervous mechanism or short-term regulation
ii. Renal mechanism or long-term regulation
iii. Hormonal mechanism
iv. Local mechanism.

232. What is vasomotor system?
Vasomotor system is the one through which the nervous mechanism operates to regulate arterial blood pressure.

233. What are the components of vasomotor system?
i. Vasomotor center
ii. Vasoconstrictor fibers
iii. Vasodilator fibers.

234. Where is vasomotor center situated?
Vasomotor center is bilaterally situated in the reticular formation of medulla oblongata and lower part of ponds.

235. What are the components of vasomotor center?
i. Vasoconstrictor or pressor area
ii. Vasodilator or depressor area
iii. Sensory area.

236. Name the vasoconstrictor nerve fibers.
Vasoconstrictor fibers are the sympathetic adrenergic fibers.

237. Name the vasodilator nerve fibers.
Vasodilator fibers are:
i. Parasympathetic fibers
ii. Sympathetic cholinergic fibers
iii. Antidromic nerve fibers.

238. What is the mode of action of sympathetic adrenergic fibers on blood vessels?
Sympathetic adrenergic fibers cause constriction of blood vessels (vasoconstriction) by secreting noradrenaline.

239. What is vasomotor tone? What are the other names for it?
Vasomotor tone is the continuous discharge of impulses from vasoconstrictor center to arterioles through vasoconstrictor nerve fibers. Vasomotor tone maintains arterial blood pressure by producing constant partial constriction of blood vessels (peripheral resistance). The arterial blood pressure is directly proportional to vasomotor tone. Vasomotor tone is also called sympathetic constrictor tone or sympathetic tone.

240. What is antidromic reflex? What are antidromic vasodilator fibers?
Normally, impulses produced by a cutaneous receptor (like pain receptor) pass through sensory nerve fibers. But, some of these impulses pass through the other branches of the axon in the opposite direction and reach the blood vessels supplied by these branches. These impulses now dilate the blood vessels. It is called the antidromic or axon reflex and the nerve fibers are called antidromic vasodilator fibers.

241. What is the role of baroreceptors when blood pressure increases?
When arterial blood pressure rises rapidly, baroreceptors send stimulatory impulses to nucleus of tractus solitarius. Nucleus of tractus solitarius inhibits the vasoconstrictor area and excites the vasodilator area.

Inhibition of vasoconstrictor area reduces vasomotor tone resulting in vasodilatation and decrease in peripheral resistance.

Simultaneous excitation of vasodilator center increases vagal tone resulting in decrease in the rate and force of contraction of heart, and reduction in cardiac output. These two factors, i.e. decreased peripheral resistance and reduced cardiac output bring the arterial blood pressure back to normal level.

242. What is the role of baroreceptors when blood pressure decreases?
The fall in arterial blood pressure decreases the pressure in carotid sinus. This causes inactivation of baroreceptors. Now, there is no inhibition of vasoconstrictor center or excitation of vasodilator center. Therefore, the blood pressure rises.

243. What is pressure buffer mechanism? What are buffer nerves?
Baroreceptor mechanism is called pressure buffer mechanism since it acts against the rise in arterial blood pressure.

Nerves from baroreceptors are called the buffer nerves.

244. Explain briefly the role of chemoreceptors in maintaining blood pressure.
Peripheral chemoreceptors are sensitive to lack of oxygen, excess of carbon dioxide and hydrogen ion concentration in blood. Whenever blood pressure decreases, blood flow to chemoreceptors decreases, resulting in decreased oxygen content and excess of carbon dioxide and hydrogen ion.

These factors excite the chemoreceptors, which send impulses to stimulate vasoconstrictor center. Blood pressure rises and blood flow increases.

Chemoreceptors play a major role in maintaining respiration rather than blood pressure.

245. What is sinoaortic mechanism?
It is the mechanism constituted by combined actions of baroreceptors and chemoreceptors in carotid and aortic regions. It regulates heart rate and blood pressure.

246. What is the role of kidney in regulation of arterial blood pressure?
Kidney is responsible for the long-term regulation of arterial blood pressure.
Kidney regulates blood pressure by:
i. Regulating extracellular fluid volume by means of pressure diuresis
ii. Renin-angiotensin mechanism.

247. What is pressure diuresis? What is pressure natriuresis?
Pressure diuresis is the excretion of large quantity of water in urine because of increased blood pressure.

Pressure natriuresis is the excretion of large quantity of sodium in urine.

248. What is the significance of pressure diuresis and pressure natriuresis?
Because of diuresis and pressure natriuresis, there is a decrease in ECG volume and blood volume. Because of these two factors arterial blood pressure is brought back to normal.

249. Explain briefly the renin-angiotensin mechanism.
When arterial blood pressure falls, kidney secretes renin. Renin acts on angiotensinogen and converts it into angiotensin I. Angiotensin I is converted into angiotensin II by the action of converting enzyme secreted in lungs. Angiotensin II increases blood pressure by vasoconstriction. Simultaneously it stimulates adrenal cortex to release aldosterone from adrenal cortex. Aldosterone causes retention of water and sodium leading to further increase in blood pressure. Angiotensin III and IV also increase the blood pressure by vasoconstriction and increasing aldosterone secretion.

250. Name the hormones which increase the blood pressure.
i. Adrenaline
ii. Noradrenaline
iii. Thyroxine
iv. Aldosterone
v. Vasopressin
vi. Angiotensins
vii. Serotonin.

251. Name the hormones which decrease the blood pressure.
i. Vasoactive intestinal polypeptide
ii. Bradykinin
iii. Prostaglandins
iv. Histamine
v. Acetylcholine
vi. Atrial natriuretic peptide
vii. Brain natriuretic peptide
viii. C-type natriuretic peptide.

252. What is the action of adrenaline on blood vessels?
Adrenaline causes constriction of blood vessels. But it causes vasodilation in some areas of the body like skeletal muscle, liver and heart. So total peripheral resistance decreases.

253. Why noradrenaline is called general vasoconstrictor?
Because it causes constriction of all blood vessels in the body.

254. What is the action of adrenaline and noradrenaline on arterial blood pressure?
Adrenaline increases systolic blood pressure by increasing force of contraction of heart and stroke volume. But it decreases the diastolic blood pressure by decreasing peripheral resistance through vasodilatation in some areas of the body like skeletal muscles.

Noradrenaline increases diastolic blood pressure by increasing total peripheral resistance through its general vasoconstrictor action. It has very mild effect on heart. It increases force of contraction of heart and systolic blood pressure to a certain extent.

255. What is the action of thyroxine on arterial blood pressure?
Thyroxine increases systolic pressure by increasing cardiac output.

But it decreases the diastolic pressure indirectly. Due to increased metabolic activity of thyroxine, many metabolites are produced. These metabolites cause vasodilatation leading to reduction in diastolic pressure.

256. Mention the effects of some important hormones which increase the arterial blood pressure.
Aldosterone causes retention of sodium and water leading to increase in ECF volume and blood volume. So, the blood pressure increases.

Vasopressin (antidiuretic hormone), angiotensin and serotonin (5 HT) increase the arterial blood pressure by causing vasoconstriction.

257. Mention the effects of some important hormones which decrease the arterial blood pressure.
Hormones like vasoactive intestinal polypeptide (VIP), bradykinin, prostaglandin (PGE_2), histamine, acetylcholine, atrial natriuretic peptide (ANP), brain natriuretic peptide (BNP) and C-type natriuretic factor decrease the arterial blood pressure by causing vasodilatation.

258. Name the local vasoconstrictor substances. What is their action?
Local vasoconstrictor substances are endothelines. Endothelines activate the phospholipase. This in turn activates prostacyclin and thromboxane A_2 which cause vasoconstriction.

259. Name the local vasodilator substances.
i. Vasodilators of metabolic origin like carbon dioxide, lactate, hydrogen ions and adenosine
ii. Vasodilators of endothelial origin like nitric oxide.

260. What are Korotkoff sounds?
Korotkoff sounds are the sound heart through stethoscope while measuring arterial blood pressure by auscultatory method using sphygmomanometer.

261. What are the five phases of Korotkoff sounds?
First phase : Tapping sound
Second phase : Murmuring sound
Third phase : Gong sound
Fourth phase : Muffled sound
Fifth phase : Disappearance of sound
Appearance of tapping sound indicates systolic pressure
Disappearance of muffled sound indicates diastolic pressure.

262. What is hypertension?
Persistent increase in arterial blood pressure is known as hypertension. Clinically, when systolic pressure rises above 150 mm Hg and diastolic pressure rises above 90 mm Hg, it is considered as hypertension.

263. What are the types of hypertension?
i. Primary hypertension
ii. Secondary hypertension.

264. What is primary hypertension? What is its cause?
Increase in arterial blood pressure in the absence of any underlying disease is known as primary or essential hypertension or hypertension. The arterial pressure increases because of increased peripheral resistance that occurs due to some unknown cause.

265. What is secondary hypertension? What are the types of secondary hypertension?
Increase in arterial blood pressure due to some underlying disease or disorder is known as secondary hypertension.
Types:
i. Cardiovascular hypertension: Due to atherosclerosis and coarctation of aorta
ii. Endocrine hypertension: Due to pheochromoctytoma, hyperaldosteronism and Cushing's syndrome
iii. Renal hypertension: Due to renal disorders
iv. Neurogenic hypertension: Due to nervous disorders
v. Hypertension during pregnancy: Due to toxemia of blood, retention of water and sodium and secretion of vasoconstrictors from placenta.

266. What is arteriosclerosis?
Arteriosclerosis is the narrowing of arteries, associated with hardening, thickening and loss of elasticity in the wall of the vessels. It occurs in old age leading to increased arterial blood pressure.

267. What is atherosclerosis?
Atherosclerosis is a disease of the arterial blood vessels characterized by narrowing of the blood vessels due to deposition of cholesterol. It leads to hypertension.

268. What are the manifestations of hypertension?
i. Renal failure
ii. Left ventricular failure

iii. Myocardial infarction
iv. Cerebral hemorrhage
v. Retinal hemorrhage

269. What is hypotension?
Hypotension is the low blood pressure. When systolic pressure is less than 90 mm Hg, it is considered as hypotension.

270. What is orthostatic hypotension?
Orthostatic hypotension is the sudden fall in blood pressure while standing for some time.

271. What is the normal venous blood pressure in the extremities of the body?
Venous blood pressure is greater in parts of the body above the level of the heart than in parts below the level of the heart.
Venous blood pressure in dorsal venous arch of foot: 13.2 mm Hg (17.9 cm H_2O).
Venous blood pressure in jugular vein : 5.1 mm Hg (6.9 cm H_2O).

272. What is the normal venous blood pressure in peripheral vein and central vein?
Venous blood pressure is greater in peripheral veins than in central veins.
Venous blood pressure in antecubital vein: 7.1 mm Hg (9.6 cm H_2O).
Venous blood pressure in superior vena cava: 4.6 mm Hg (6.2 cm H_2O).

273. Name the factors regulating the venous blood pressure.
i. Vis a tergo or force from behind (left ventricular pressure).
ii. Vis a fronte or force from front (atrial pressure)
iii. Vis a latre or force from side (resistance offered to blood flow at veins)
iv. Volume of venous blood
v. Peripheral resistance
vi. Gravity and posture.

274. What is Valsalva maneuver?
Valsalva maneuver is the forced expiration with closed glottis. It increases intrathoracic pressure and peripheral venous blood pressure.

275. What is Müeller's maneuver?
Müeller's maneuver is the forced inspiration with closed glottis. It decreases the intrathoracic pressure and peripheral venous blood pressure.

276. What is the normal capillary blood pressure?
Capillary blood pressure is about 30 to 32 mm Hg in the arterial end of the capillary and 15 mm Hg in venous end.

277. Name the organs in which the capillary blood pressure is greatly altered with its functional significance.
Capillary pressure is very high (60 mm Hg) in renal glomerular capillaries. This is responsible for glomerular filtration.
Capillary pressure is very low very low (7 mm Hg) lungs. This is responsible for exchange of gases between blood and alveoli.

278. Define arterial pulse.
Arterial pulse is defined as the pressure changes transmitted in the form of waves through arterial wall and blood column from heart to periphery.

279. How is the radial pulse recorded?
By:
i. Mercury manometer
ii. Dudgeon's sphygmograph
iii. Electronic transducer.

280. What are the different waves of radial pulse tracing?
i. Ascending limb or anacrotic limb: Obtained during systole
ii. Descending limb called catacrotic limb: Obtained during diastole
iii. Catacrotic notch in the upper part of descending limb: Due to the back flow of blood towards the left ventricle during the closure of semi lunar valve
iv. Precatacrotic wave: Wave appearing before catacrotic notch
v. Postcatacrotic wave: Wave appearing after catacrotic notch.

281. What are the observations to be made during the examination of arterial pulse?
i. Rate
ii. Rhythm
iii. Character
iv. Volume
v. Condition of wall of the blood vessel
vi. Delayed pulse.

282. Name some of the abnormal pulse.
i. Pulsus deficit
ii. Pulses alternans
iii. Anacrotic pulse
iv. Thready or weak pulse
v. Pulsus paradoxus
vi. Water hammer pulse
vii. Pulse in patent ductus arteriosus
viii. Abnormal pulse in aortic regurgitation.

283. What is pulsus deficit? When does it occur?
Pulsus deficit is the condition in which the pulse rate is less than the heart rate. It occurs during atrial fibrillation.

284. What is pulsus alternans? When does it occur?
Pulsus alternans is the condition characterized by alternation of strong and week pulse. It is common in severe myocardial diseases, paroxysmal tachycardia and atrial fibrillation.

285. What is anacrotic pulse? When does it occur?
Anacrotic pulse is the abnormal pulse, characterized by a slow ascending limb which has an anacrotic notch. It is produced in aortic stenosis.

286. What is thready pulse? When does it occur?
Thready or weak pulse is the abnormally weak and very feeble pulse because of its low volume. It occurs in severe hemorrhage and severe chills.

287. What is pulsus paradoxus? When does it occur?
Pulsus paradoxus is the condition characterized by a weak pulse with marked decrease in volume during inspiration caused by fall in systolic blood pressure by 10 mm Hg.
Pulsus paradoxus and inspiratory fall in systolic blood pressure are noticed in cardiac tamponade, constrictive pericarditis, myocardial infarction, hypovolemia, asthma, chronic obstructive pulmonary disease (COPD), pneumothorax and pulmonary embolism.

288. What is water hammer pulse? When does it occur?
Water hammer pulse or collapsing or Corrigan or pistol-shot pulse is the abnormal pulse, characterized by a rapid upstroke and an equally rapid downstroke.
It is seen in patent ductus arteriosus, aortic regurgitation and arteriovenous fistula.

289. What type of pulse appear in patent ductus arteriosus?
Water hammer pulse appears in patent ductus arteriosus.

290. What type of pulse appear aortic regurgitation?
Water hammer pulse appears in aortic regurgitation also.

291. Define venous pulse.
Venous pulse is defined as pressure changes transmitted in the form of waves from right atrium to the veins near the heart.

292. What is the significance of venous pulse recording?
Venous pulse recording is used to determine the rate of atrial contraction. In addition, more phases of cardiac cycle can be recognized by means of venous pulse tracing.

293. What is phlebogram? What are its waves?
Graphical recording of jugular venous pulse tracing is known as phlebogram.

It has three positive waves: a, c and v and three negative waves: x, x_1 and y.

294. What are the causes of different waves of phlebogram?
'a' wave: Atrial systole
'x' wave: Atrial diastole
'c' wave: Bulging of atrioventricular valves into atria during isometric contraction
'x1' wave: Pulling of atrioventricular ring towards ventricles
'v' wave: Atrial filling
'y' wave: Ventricular filling.

295. What are coronary arteries? Why the name coronary arteries?
Heart is supplied by right and left coronary arteries which arise from aorta. Arteries encircle the heart in the manner of a crown and hence the name coronary arteries.

296. What is physiological shunt in heart? What is the other component of physiological shunt?
Physiological shunt is the connection, through which the venous (deoxygenated) blood is mixed with arterial blood.

In heart deoxygenated blood flowing from thebesian veins into cardiac chambers makes up the part of normal physiological shunt.

Other component of physiological shunt is present in lungs.

297. What is the normal blood flow to heart (through coronary circulation)?
Normal blood flow to heart is 200 mL/minute

It is about 65 to 70 mL/minute/100 g of cardiac muscle.

298. What are the phasic changes in the coronary blood flow?
During systole of the heart, the flow of blood to cardiac muscle decreases due to compression of intramural vessels.

During diastole, these blood vessels are distended so that, the blood flow increases.

299. What is the importance of autoregulation in coronary of blood flow?
Because of autoregulation in coronary blood flow, the blood supply to the heart is maintained even if the mean arterial blood pressure varies between 60 mm Hg and 150 mm Hg.

300. Name the factors determining the blood flow to the heart. Which is the most important factor?
i. Need for oxygen
ii. Metabolic factors
iii. Coronary perfusion pressure
iv. Nervous factors. Most important factor is the need for oxygen.

301. What is coronary perfusion pressure?
Coronary perfusion pressure is the difference between the mean arterial pressure and resistance offered to blood flow to heart.

302. Name some metabolites, which increase the blood flow to heart. What is their mode of action?
i. Adenosine
ii. Potassium ions
iii. Hydrogen ions
iv. Carbon dioxide
v. Adenosine phosphate

All these substances increase the blood flow to heart by causing coronary vasodilatation.

303. What is coronary occlusion?
Coronary occlusion is the partial or complete obstruction of coronary artery.

304. What is myocardial ischemia?
Myocardial ischemia is the reaction of myocardium in response to hypoxia due to occlusion of a coronary blood vessel.

305. What is necrosis? Explain necrosis in myocardium.
Necrosis refers to death of cells or tissues by injury or disease in a localized area. Ischemia leads to necrosis of myocardium if a large part of myocardium is involved or the occlusion is severe involving larger blood vessels. Necrosis is irreversible.

306. What is myocardial infarction or heart attack?
Myocardial infarction or heart attack is necrosis of the part of myocardium due to ischemia.

307. What is myocardial stunning?
Myocardial stunning is a type of transient mechanical dysfunction of heart, caused by a mild reduction in blood flow. A substantial reduction in coronary blood flow causes ischemia followed by necrosis. A mild reduction in blood flow causes only ischemia and it may not be sufficient to cause necrosis of myocardium. However, it produces some transient (short lived) mechanical disturbances or dysfunction of the heart. Since it is short lived, heart recovers completely from this.

308. What are the common symptoms of myocardial infarction?
i. Cardiac pain
ii. Nausea
iii. Vomiting
iv. Palpitations
v. Difficulty in breathing
vi. Extreme weakness
vii. Sweating
viii. Anxiety.

309. What is angina pectoris or cardiac pain?
Angina pectoris or cardiac pain is the chest pain produced by myocardial ischemia. The pain starts beneath the sternum and radiates to the surface of left arm and left shoulder (referred pain).

310. What is the cause for cardiac pain?
During myocardial ischemia, there is accumulation of anaerobic metabolic end products such as uric acid. Metabolites and other pain producing substances like substance P, histamine and kinin stimulate the sensory nerve endings, leading to pain.

311. What is cerebral circulation? What is its importance?
Cerebral circulation refers to flow of blood through the blood vessels of brain. Brain tissues need adequate blood

supply continuously. Stoppage of blood flow to brain for 5 seconds leads to unconsciousness and for 5 minutes leads to irreparable damage to the brain cells.

312. What are the cerebral blood vessels?
Brain receives blood from the basilar artery and internal carotid artery. Branches of these arteries form circle of Willis. Venous drainage is by sinuses, which open into internal jugular vein.

313. What is the normal blood flow to brain?
Normal blood flow to brain is 750 to 800 mL/minute. It is about 50 to 55 mL/minute/100 g of brain tissue.

314. What is the importance of autoregulation in cerebral circulation?
Because of autoregulation, the blood flow to brain is maintained even if the mean arterial blood pressure varies between 60 mm Hg and 140 mm Hg.

315. What is the important factor determining cerebral blood flow?
The important factor that determines cerebral blood flow is the cerebral vascular resistance. The cerebral vascular resistance reduces the blood flow to brain. It is offered by intracranial pressure, cerebrospinal fluid pressure and viscosity of blood.

316. What is Cushing's reflex or Cushing's reaction?
Cushing's reflex or Cushing's reaction is the reflex that maintains the cerebral blood flow when there is an increase in the intracranial pressure or cerebrospinal fluid pressure.

317. What is Monro-Kelle doctrine?
According to Monro-Kelle doctrine, though cerebral arteries are compressed by increased intracranial pressure or cerebrospinal fluid pressure, the volume of brain tissue is not affected. It is because the brain tissue is not compressible.

318. Name some chemical factors, which increase the cerebral blood flow.
i. Decreased oxygen tension
ii. Increased carbon dioxide tension
iii. Increased hydrogen ion concentration.
These factors increase cerebral blood flow by causing vasodilatation.

319. What is stroke? What are the other names for it?
Stroke is the sudden death of neurons in localized area of brain due to inadequate blood supply. It is characterized by reversible or irreversible paralysis with other symptoms.
Stroke is also called cerebrovascular accident (CVA) or brain attack.

320. What are the types of stroke?
Stroke is of two types:
i. Ischemic stroke: It occurs due to interruption of blood flow to a part of brain by thrombus or atherosclerotic embolus
ii. Hemorrhagic stroke: This develops due to the rupture of a blood vessel in the brain and spilling of blood into the surrounding areas.

321. What are the cause of stroke?
i. Heart disease
ii. Hypertension
iii. High cholesterol in blood
iv. Diabetes mellitus
v. Heavy smoking
vi. Heavy alcohol consumption.

322. What are the features of stroke?
Common features:
i. Dizziness
ii. Loss of consciousness
iii. Coma or death.
Other features:
i. Weakness
ii. Numbness or paralysis, particularly on one side of the body
iii. Impairment of speech
iv. Emotional disturbances
v. Loss of coordination
vi. Loss of memory.

323. What is aneurysm? What is the consequence of aneurysm in brain?
Aneurysm is the abnormal dilation or bulging of a blood vessel caused by weakening of wall of the vessel. At the point of aneurysm, the vessel may leak or rupture resulting in bleeding (internal hemorrhage). Aneurysm in brain may rupture and cause hemorrhagic stroke.

324. What are the constituents of splanchnic circulation?
i. Mesenteric circulation supplying blood to GI tract
ii. Splenic circulation supplying blood to spleen
iii. Hepatic circulation supplying blood to liver.

325. What are the unique features of splanchnic circulation?
Unique feature of splanchnic circulation is that the blood from mesenteric bed and spleen forms a major amount of blood flowing to liver. Blood flows to liver from GI tract and spleen through portal system

326. What is the distribution of blood flow in mesenteric circulation?

Stomach	: 35 mL/100 g/min
Intestine	: 50 mL/100 g/min
Pancreas	: 80 mL/100 g/min

327. What is functional hyperemia? When does it occur hyperemia in mesenteric circulation?
Functional hyperemia is defined as the increase in blood flow to an organ due to increased metabolic activity of that organ. It occurs in mesenteric circulation after food intake.

328. What is the normal blood flow to liver?
Liver is the organ that receives maximum blood supply.
It is about 1500 mL/minute or 100 mL/minute/100 g of tissue.

329. Explain in brief the pattern of capillary system.
Capillaries are disposed between arterioles and venules. From arterioles, meta- arterioles take origin. From meta-arterioles, two types of capillaries arise:
i. Preferential channels or continuous capillaries: After arising from meta-arterioles, these capillaries form a network and finally join the venules. These capillaries have same diameter as meta-arterioles.
ii. True capillaries: True capillaries also form a network and join the venules. Diameter of the true capillaries is less than that of the meta-arterioles.

330. What is precapillary sphincter?
It is the smooth muscle that encircles the beginning of true capillaries and functions as a sphincter. It controls the blood flow through true capillaries.

331. What is anatomical shunt? What physiological shunt?
Anatomical shunt or arteriovenous shunt: It is the connection between arterioles and venules. Flow of blood through capillaries where exchange of nutrients,

gases and other substances takes place is called nutritional flow.

Physiological shunt: It is the connection arterial and venous side of circulation provided by meta-arteriole. Many tissues of the body such as muscles do not have anatomical shunts. However, the meta-arteriole in these tissues acts as the physiological shunt between arterial and venous sides of the circulation.

332. What is the difference between shunt in capillaries and shunt in heart?

Physiological shunt in capillaries is different from physiological shunt in heart.

In capillaries, the oxygenated blood flows towards deoxygenated blood.

But in heart, the deoxygenated blood flows towards the oxygenated blood'

333. What are the peculiarities of capillary blood flow?

i. Blood does not pass through capillary system continuously
ii. Direction of blood flow through capillaries is not fixed as in the case of other blood vessels. Blood may flow in opposite direction in two adjacent capillaries
iii. In capillaries, blood flows as a single pile or single row of blood cells
iv. Under resting conditions, most of the capillaries lie in collapsed state. Only during activity, all the capillaries open up and increase the vascularity
v. Amount of blood flowing through the capillary system throughout the body is very low. It is only about 150 mL/min
vi. Velocity of blood flow is least in capillaries. It is only about 0.05 cm/sec. It facilitates exchange of substances between capillaries and tissues.

334. What are the functions of capillaries?

Most important function of capillaries is the exchange of substances between blood and tissues.

Oxygen, nutrients and other essential substances enter the tissues from capillary blood. Carbon dioxide, metabolites and other unwanted substances are removed from tissues by capillary blood.

335. Name some chemical factors, which affect the capillaries.

Capillary dilatation by:
i. Excess of carbon dioxide
ii. Increased hydrogen ion concentration
iii. Lack of oxygen
iv. Histamine
v. Metabolites like lactic acid.

Constriction by:
i. Serotonin.

336. What is the amount of blood flow to skeletal muscles during resting condition and exercise?

Resting condition : 4 to 7 mL/minute/100 g
Exercise : 100 mL/minute/100 g.

337. What is the peculiarity of sympathetic fibers to skeletal muscles?

Sympathetic nerve fibers are generally adrenergic in nature. But the sympathetic fibers supplying the skeletal muscles are cholinergic and cause vasodilatation in skeletal muscles.

338. What is varicose vein?

Varicose vein is the vein that becomes irregularly swollen (twisted or tortuous) and enlarged. Superficial veins of the leg are mostly affected.

339. What are the causes for varicose veins?

i. Permanent dilatation of veins due to incompetence of the valves of the veins or absence of muscular activity for long periods. So, varicose veins are common in individuals with occupations, which require standing for long periods
ii. Thrombophlebitis: Inflammation of vein associated with formation of thrombus

Varicose veins may also develop in obese persons and pregnant women.

340. What are the functions of cutaneous circulation?

i. Supply of nutrition to skin
ii. Regulation of body temperature by heat loss.

341. What is the normal blood flow to skin?

i. Under normal conditions: 250 mL/sq. m/min
ii. During increased body temperature: 2800 mL/sq. m/min because of cutaneous vasodilation.

342. Name the vascular responses of skin to mechanical stimuli.

i. White reaction
ii. Triple response.

343. What is white reaction?

White reaction is the response of the blood vessels in skin to a mechanical stimulus. When the surface of skin is stroked lightly with a pointed object, a pale line appears within 20 seconds. This line takes the path of the stroke. This response in skin is known as white reaction. Maximum intensity of the line is obtained in 1 minute and it fades away after 5 minutes.

344. What is the cause for white reaction?

White reaction is due to the constriction of cutaneous capillaries.

345. Define Lewis triple response. And mention the reactions of this response.

Lewis triple response is the vascular response of skin that includes three consecutive reactions of blood vessels of skin to a mechanical stimulus.

Vascular reactions of skin to various injuries occur in three stages:
i. Red reaction
ii. Flare
iii. Wheal.

346. What are the causes of each stage of Lewis triple response?

Red reaction: Dilatation of capillaries by H substances released by damaged tissues due to mechanical stimulus
Flare: Dilatation of arterioles due to axon reflex
Wheel: Leakage of fluid from capillaries.

347. What is dermographism or writing on skin?

It is the process of embossing signs over skin. Some letters or designs can be embossed upon the skin over back or in the forearm in the same manner by which the wheal is produced.

348. How fetal circulation is different from adult circulation?

Fetal circulation is different from adult circulation because of the presence of placenta. Since fetal lungs are non-

functioning, placenta is responsible for exchange of gases between fetal blood and mother's blood. So, the blood from right ventricle is diverted to placenta.

349. What is foramen ovale?
It is an opening intra-atrial septum in fetal heart. From right atrium, major portion of blood is diverted to left atrium through this.

350. What is ductus arteriosus?
It is a small vessel connecting pulmonary artery and systemic aorta in fetus. It allows majority of blood from right ventricle to bypass non-functioning fetal lungs.

351. Why pulmonary vascular resistance is very high in fetus? What is the effect of this?
Pulmonary vascular resistance is very high in fetus because the fetal lungs are non-functional. Because of this the pressure in pulmonary blood vessels is very high and blood is diverted from pulmonary artery into systemic aorta through ductus arteriosus.

352. What are the changes taking place in circulation and respiration after birth?
i. First breath of the child
ii. Flow of blood to lungs
iii. Closure of foramen ovale
iv. Reversal of blood flow in ductus arteriosus
v. Closure of ductus venosus
vi. Closure of ductus arteriosus

353. What is the cause for the onset of respiration after birth?
Since the umbilical cord is cut after delivery of the baby, the flow of placental blood stops. This leads to hypoxia and hypercapnea in the baby. These two factors strongly stimulate the respiratory centers and this is responsible for onset of respiration after birth.

354. Define hemorrhage and list the types of hemorrhage.
Hemorrhage is defined as excessive loss of blood due to rupture of blood vessels. Types:
i. Accidental hemorrhage
ii. Capillary hemorrhage
iii. Internal hemorrhage
iv. Postpartum hemorrhage
v. Hemorrhage due to premature detachment of placenta.

355. What is acute hemorrhage?
Acute hemorrhage is the sudden loss of large quantity of blood. It occurs in conditions like accidents. Decreased blood volume in acute hemorrhage causes hypovolemic shock.

356. What is chronic hemorrhage?
Chronic hemorrhage is the loss of blood either by internal or by external bleeding over a long period of time. Internal bleeding occurs in conditions like ulcer. External bleeding occurs in conditions like hemophilia and excess vaginal bleeding (menorrhagia).

Chronic hemorrhage produces different types of effects such as anemia.

357. What are the immediate effects of hemorrhage on heart?
i. Reduction in venous return, ventricular filling and cardiac output
ii. Reflex tachycardia.

358. What is the immediate effect of hemorrhage on blood pressure?
Arterial blood pressure is not affected if bleeding occurs slowly or if there is loss of a small amount of blood up to 300 to 500 mL.

In severe hemorrhage with loss of about 1500 to 2000 mL of blood, the arterial blood pressure decreases.

359. What are the delayed effects of hemorrhage?
i. Restoration of plasma volume
ii. Restoration of plasma proteins
iii. Restoration of RBC count and hemoglobin content.

360. What is the effect of severe hemorrhage on brain?
Severe hemorrhage decreases the blood supply to brain causing hypoxia. Due to hypoxia, ischemia of brain tissues (cerebral ischemia) develops within 5 minutes. This causes irreversible damage to brain tissues.

361. Define shock and circulatory shock.
Shock is a general term that refers to the depression or suppression of body functions produced by any disorder.

Circulatory shock refers to the shock developed by inadequate blood flow throughout the body. It is a life-threatening condition and it may result in death if the affected person is not treated immediately.

362. What are the stages of circulatory shock?
i. First stage or compensated stage
ii. Second stage or progressive stage
iii. Third stage or irreversible stage.

363. What are the types and causes of circulatory shock?
i. Hypovolemic or cold shock: Due to reduced blood volume
ii. Vasogenic or low resistance or distributive shock: Due to increased vascular capacity
iii. Cardiogenic shock: Due to heart diseases
iv. Obstructive shock: Due to obstruction of blood flow.

364. Define syncope or fainting or syncope.
It is the sudden and transient (short time) loss of consciousness and postural tone with spontaneous recovery. It occurs temporary inadequate cerebral blood flow.

365. List the different types of syncope.
i. Vasovagal or emotional or neurocardiogenic syncope
ii. Postural syncope
iii. Micturition syncope
iv. Effort syncope
v. Cough syncope
vi. Carotid sinus syncope.

366. What is trauma? What is traumatic shock?
Trauma means serious injury or wound caused by some external force.

Traumatic shock is the shock caused by trauma. Shock occurs due to the damage of muscles and bones, which is common in battlefields and road accidents. Apart from loss of blood, the plasma escapes to the tissue spaces.

367. Define vasovagal syncope or vasovagal fainting.
Fainting due to severe emotional disturbances is known as vasovagal syncope or vasovagal fainting. It is due to activation of sympathetic vasodilator fibers, which cause dilatation of peripheral blood vessels leading to fall in blood pressure. Simultaneously, the vasoconstrictor (cardioinhibitory) center is stimulated and vagal tone increases leading to reduced heart rate. The reduced heart rate and decreased blood pressure cause reduction in blood flow to brain, leading to fainting

368. What is anaphylaxis? What is anaphylactic shock.

Anaphylaxis means exaggerated allergic reaction to a foreign protein or antigen or any other substance to which the person has been previously sensitized.

Shock that develops during anaphylactic reactions is called anaphylactic shock. Shock occurs because of vasodilatation and sudden fall in blood pressure. It is caused by the chemical mediators such as histamine that are secreted during anaphylactic reaction.

369. What is sepsis? What is septic shock?

Sepsis is the pathological condition characterized by the presence of pathogenic organisms or their toxins in blood or tissues. Shock developed during sepsis is known as septic shock or blood poisoning.

370. What is heart failure or cardiac failure?

Heart failure or cardiac failure is the condition in which the heart loses the ability to pump sufficient amount of blood to all parts of the body. Heart failure may involve left ventricle or right ventricle or both.

371. What is acute heart failure?

Acute heart failure refers to sudden and rapid onset of signs and symptoms of abnormal heart functions. Its symptoms are severe initially. However, the symptoms last for a very short time and the condition improves rapidly. Usually it requires treatment.

372. What is chronic heart failure?

Chronic heart failure is the heart failure that is characterized by the symptoms that appear slowly over a period of time and become worst gradually.

373. What is congestive heart failure?

Congestive heart failure is a general term used to describe the heart failure resulting in accumulation of fluid in lungs and other tissues. When heart is not able to pump blood through aorta, the blood remains in heart. It results in dilatation of the chambers and accumulation of blood in veins (vascular congestion). Fluid retention and pulmonary edema also occur in this condition.

374. What is compensated and decompensated heart failure?

Compensated heart failure is the heart failure with adequate cardiac output. Heart tries to maintain cardiac output by normal compensatory mechanisms.

Decompensated heart failure is the heart failure with inadequate cardiac output. It is characterized by deterioration, and sudden and drastic worsening of cardiac function, resulting in death.

375. What are types of exercise. Give examples.

i. Dynamic exercise:

Dynamic exercise primarily involves the isotonic muscular contraction. It keeps the joints and muscles moving.

In this type of exercise, the heart rate, force of contraction, cardiac output and systolic blood pressure increase. However, diastolic blood pressure is unaltered or decreased.

Examples: Swimming, bicycling, walking, etc.

ii. Static exercise:

Static exercise involves isometric muscular contraction without movement of joints. During this exercise, heart rate, force of contraction, cardiac output. systolic blood pressure and diastolic blood pressure

Example: Pushing heavy object.

376. Classify exercise on the basis of metabolism.

i. Aerobic exercise
ii. Anaerobic exercise.

377. What is aerobic exercise? Give examples.

Aerobic exercise is the type of exercise for which the energy is obtained by utilizing nutrients in the presence of oxygen. It involves activities with lower intensity, which is performed for longer period.

Examples: Fast walking, jogging, running, bicycling, skiing, skating, hockey, soccer, tennis, badminton, swimming and rowing.

378. What is anaerobic exercise? Give examples.

Anaerobic exercise is the type of exercise for which energy is obtained by utilizing nutrients without oxygen. It involves exertion for short periods followed by periods of rest. It uses the muscles at high intensity and a high rate of work for a short period.

Examples: Pull-ups, push-ups, weightlifting, sprinting and any other rapid burst of strenuous exercise.

379. Classify exercise on the basis of severity.

i. Mild exercise
ii. Moderate exercise
iii. Severe exercise.

380. What are the effects of moderate muscular exercise on heart?

Increase in heart rate, venous return, ventricular filling and cardiac output.

381. What is the effect of moderate muscular exercise on arterial blood pressure?

Systolic blood pressure increases due to increase in heart rate and stroke volume. Diastolic blood pressure is not altered because the peripheral resistance is not affected.

382. What is the effect of severe muscular exercise on arterial blood pressure?

Systolic pressure increases because of increase in heart rate and stroke volume.

Diastolic pressure decreases because of reduction of peripheral resistance.

383. What happens to arterial blood pressure after exercise?

After exercise, the blood pressure falls slightly below the resting level. It is because of vasodilatation developed by the metabolic end products produced in the muscles during exercise. Pressure returns quickly as soon as the metabolic end products are removed from the muscles.

384. What is Harvard step test?

Harvard step test is a type of fitness test

385. What is sedentary life?

Sedentary lifestyle is the type of lifestyle in which the person does little or no physical activity.

386. What are the common consequences of sedentary life?

i. Obesity.
ii. Anxiety and depression
iii. Diabetes.
iv. Increase in cholesterol level.
v. Hypertension.
vi. Cardiovascular diseases such as coronary artery disease.
vii. Increased risk of cancer
viii. Early death.

387. Define yoga.
Yoga is a system of exercise involving postures, breathing and calmness in order to become more fit or flexible, to improve breathing and to relax the mind.

Yoga is also defined as a psychosomatic discipline, that works on holistic principle and aims to improve health as a whole by providing a means to balance and harmonize at physical, mental and emotional levels.

388. Define the components of yoga.
Components of yoga are asanas, pranayama. Asanas are the physical postures maintained during exercises in yoga. Pranayama is defined as the technique that involves conscious control of breathing.

389. Mention benefits of yoga on muscles and bones.
Yoga:
i. Increases blood supply to skeletal muscles.
ii. Improves muscle strength and muscle tone.
iii. Increases the flexibility at different joints, muscular endurance and muscle power.
iv. Improves strength of bones, prevents osteoporosis.
v. It reduces stiffness of joints, relieves pain in patients having arthritis.

390. Mention benefits of yoga on digestive system.
Yoga:
i. Increases digestion and absorption of nutritive substances.
ii. Increases the basal metabolic rate.
iii. Improves blood supply and helps removal of toxic substances from most of the organs such as stomach, intestine, liver, spleen and pancreas.
iv. Prevents diarrhea, constipation, gastric acidity.
v. Reduces blood sugar, cholesterol and LDL and prevents obesity and heart diseases.

391. Mention benefits of yoga on renal system.
Yoga helps the effective functioning of kidneys and decrease or prevent damage or dysfunction of kidneys.

392. Mention benefits of yoga on cardiovascular and lymphatic systems.
Yoga:
i. Increases strength of cardiac muscles.
ii. Decreases heart rate and blood pressure.
iii. Prevents heart diseases and hypertension.
iv. Increases the effectiveness of lymphatic system in filtering the toxins and allowing antibodies to recirculate through cardiovascular system.

393. Mention benefits of yoga on respiratory system.
Yoga:
i. Increases lung compliance, breath holding time, vital capacity, FEV, FEV1 and peak expiratory flow rate.
ii. Increases the strength of inspiratory and expiratory muscles.
iii. Improves breathing capacity in asthma patients and the health condition of patients suffering from bronchitis and tuberculosis.

394. Mention benefits of yoga on endocrine system.
Yoga:
i. Improves blood supply and oxygen supply to brain including hypothalamus and stimulates the activity of pituitary and adrenal glands via hypothalamo-pituitary-adrenal axis.
ii. Stimulate thyroid, parathyroid and pancreas also.
iii. Reduce the effects of symptoms of hypothyroidism, adrenal disorders and diabetes mellites.

395. Mention benefits of yoga on reproductive system.
Yoga:
i. Increases the blood supply to reproductive organs also both in males and females.
ii. Reduces or prevents obstetric complications in pregnant women.

396. Mention benefits of yoga on immune system.
Yoga:
i. Helps to accelerate immune system of the body.
ii. Prevents stress induced changes in immune system.
iii. Increases blood level of interleukins, the cytokines that accelerate inflammatory response and destruction of invading organisms.

397. Mention benefits of yoga on nervous system.
Yoga:
i. Improves concentration, attention.
ii. Decreases stress level, anxiety, nervousness, aggressiveness and depression.
iii. Improves coordinated activities and delays fatigue.
iv. Improves quality of sleep and decreases dullness, lethargy, headache and vertigo.
v. Strengthens the spine and decreases back pain.

398. What is meditation?
Meditation is an act of remaining silent and focussing the mind to relax in order to relieve stress.

399. Mention benefits of meditation on stress and its consequences.
Meditation:
i. Reduces the stress level and helps relieve the symptoms of anxiety.
ii. Helps relieve the symptoms of depression.
iii. Prevents emotional outbursts induced by stress.

400. Mention benefits of meditation on stress and its consequences.
Meditation helps to release tension, to relax the body and mind and to obtain a peaceful state by which sleep is induced.

401. Mention benefits of meditation on blood pressure.
Meditation helps to control blood pressure by reducing body's responsiveness to stress hormones such as cortisol and by inhibiting sympathetic activity on heart and blood vessels.

402. Mention benefits of meditation on pain tolerance.
Meditation helps to increase pain tolerance.

Section 9 Respiratory System and Environmental Physiology

1. **Define respiration.**
   Respiration is the process by which oxygen is taken in and carbon dioxide is given out.
2. **What is the normal respiratory rate?**
   12 to 16 per minute.
3. **What are the types of respiration?**
   i. External respiration: This involves exchange of respiratory gases, i.e. oxygen and carbon dioxide between the alveoli of the lungs and blood
   ii. Internal respiration: This involves exchange of respiratory gases between blood and tissues.
4. **What are upper and lower respiratory tracts?**
   i. Upper respiratory tract that includes all the structures from nose up to vocal cords; vocal cords are the folds of mucous membrane within larynx that vibrates to produce the voice.
   ii. Lower respiratory tract which includes trachea, bronchi and lungs.
5. **What are the phases of respiration?**
   i. Inspiration: During this phase air enters the lungs from atmosphere.
   ii. Expiration: During this phase air leaves the lungs.
6. **What is pleura pleural sac? What are its layers?**
   Pleura is a two layered serous membrane that encloses the lung. It has two layers:
   i. Inner visceral layer
   ii. Outer parietal layer.
7. **What is intrapleural space or pleural cavity?**
   It is a narrow space between two layers of pleura.
8. **What is intrapleural fluid? What are its functions?**
   Intrapleural fluid is a thin film of serous fluid that occupies intrapleural space. This fluid is secreted by visceral layer of pleura.
   Functions of intrapleural fluid:
   i. It functions as the lubricant to prevent friction between two layers of pleura
   ii. It is involved in creating the negative pressure called intrapleural pressure within intrapleural space.
9. **What happens to pleural cavity in abnormal conditions?**
   Expansion of pleural cavity in pathological conditions:
   i. Pneumothorax: Accumulation of air
   ii. Hydrothorax: Accumulation of water
   iii. Hemothorax: Accumulation of blood
   iv. Pyothorax: Accumulation pf pus.
10. **What is tracheobronchial tree? What are its components?**
    Trachea and bronchi are together called tracheobronchial tree. It forms part of air passage.
    Components of tracheobronchial tree:
    i. Trachea
    ii. Right and left primary bronchi
    iii. Secondary bronchi
    iv. Tertiary bronchi
    v. Terminal bronchiole
    vi. Respiratory bronchioles.
11. **What are the parts of respiratory tract?**
    i. Upper respiratory tract: Includes all structures from nose to vocal cords
    ii. Lower respiratory tract: Includes trachea, bronchi and lungs.
12. **Define respiratory unit. Name the structures of respiratory unit.**
    Respiratory unit is the terminal portion of respiratory tract where the exchange of gases occurs.
    Structures of respiratory unit:
    i. Respiratory bronchiole
    ii. Alveolar ducts
    iii. Antrum
    iv. Alveolar sacs
    v. Alveoli.
13. **What is respiratory membrane?**
    Respiratory membrane is the membranous structure through which exchange of gases occur. It is formed by alveolar membrane and capillary membrane.
14. **List the non-respiratory functions of respiratory tract.**
    i. Olfaction
    ii. Vocalization
    iii. Prevention of dust particles
    iv. Defense mechanism
    v. Maintenance of water balance
    vi. Regulation of body temperature
    vii. Regulation of acid base balance
    viii. Anticoagulant function
    ix. Secretion of angiotensin converting enzyme (ACE)
    x. Synthesis of hormonal substances.
15. **What is the role of lungs in defense mechanism?**
    i. Lung's own defense: Secretion of immune factors such as defensins and cathelicidins.
    ii. Leukocytes: Neutrophils and lymphocytes kill the bacteria and virus.
    iii. Macrophages: Engulf dust particles and pathogens, act as antigen presenting cells. Macrophages secrete interleukins, tumor necrosis factors and chemokines.
    iv. Mast cell: Produces hypersensitivity reactions.
    v. Natural killer cell: First line of defense against virus.
    vi. Dendritic cells: Function as antigen presenting cells.
16. **List the hormonal substances synthesized in lungs.**
    i. Prostaglandins
    ii. Acetylcholine
    iii. Serotonin
17. **What are the respiratory protective reflexes?**
    Respiratory protective reflexes are the reflexes that protect lungs and air passage from foreign particles. Respiratory

process is modified by these reflexes in order to eliminate the foreign particles or to prevent the entry of these particles into the respiratory tract.

Respiratory protective reflexes:

i. Cough reflex
ii. Sneezing reflex
iii. Swallowing reflex.

18. What is cough reflex?

Cough reflex is a modified respiratory process characterized by deep inspiration followed by forced expiration with closed glottis. It is a protective reflex that causes expulsion of irritant substances out of respiratory tract. It is caused by irritation of respiratory tract and some other areas such as external auditory meatus.

19. What is sneezing reflex?

Sneezing reflex is a modified respiratory process characterized by deep inspiration followed by forceful expiratory effort with open glottis. It is a protective reflex that causes expulsion of irritant agents out of respiratory tract. It is caused by irritation of nasal mucous membrane.

20. What is swallowing reflex?

Swallowing reflex is a respiratory protective reflex that prevents entrance of food particles into the air passage during swallowing.

During second stage (pharyngeal stage) of swallowing, there is temporary arrest of respiration is called swallowing apnea. It prevents entry of food particles into the respiratory tract.

21. What is physiological shunt in lungs? What is the other component of physiological shunt?

Physiological shunt is the diverted route (diversion), through which the venous (deoxygenated) blood is mixed with arterial (oxygenated) blood.

In lungs deoxygenated blood from bronchial circulation flows into pulmonary vein without being oxygenated and makes up the part of normal physiological shunt.

Other component of physiological shunt is present in heart.

22. What is venous admixture? What is wasted blood?

Venous admixture refers to mixing of deoxygenated blood with oxygenated blood. It is caused by physiological shunt.

Fraction of venous blood, which is not fully oxygenated, is generally considered as wasted blood.

23. What is the relation between physiological shunt and physiological dead space?

Physiological shunt is analogous to physiological dead space. Physiological shunt includes wasted blood and physiological dead space includes wasted air.

Both wasted blood and wasted air exist on either side of alveolar membrane and both affect ventilationperfusion ratio.

24. What are the characteristic features of pulmonary circulation?

i. Pulmonary artery has a thin wall
ii. Pulmonary blood vessels are highly elastic and more distensible
iii. Smooth muscle coat is not well developed in the pulmonary blood vessels
iv. True arterioles have less smooth muscle fibers
v. Pulmonary capillaries are larger than systemic capillaries. Pulmonary capillaries are also dense and have multiple anastomoses
vi. Vascular resistance in pulmonary circulation is very less
vii. Pulmonary vascular system is a low-pressure system
viii. Pulmonary artery carries deoxygenated blood from heart to lungs and pulmonary veins carry oxygenated blood from lungs to heart.
ix. Physiological shunt is present.

25. What is the normal blood flow to lungs?

Lungs receive whole amount of blood pumped out from right ventricle i.e. 5 L / minute.

26. What is the normal pulmonary blood pressure?

Systolic pressure : 25 mm Hg
Diastolic pressure : 10 mm Hg
Mean arterial pressure: 15 mm Hg
Capillary pressure : 7 mm Hg.

27. Enumerate the factors regulating pulmonary circulation.

i. Cardiac output
ii. Pulmonary vascular resistance
iii. Nervous factors
iv. Chemical factors
v. Gravity and hydrostatic pressure.

28. Mention the type of blood flow in different areas (portions) of lungs.

Apical portion of lungs: Area of zero blood flow
Midportion: Area of intermittent blood flow
Lower portion : Area of continuous blood flow

29. Name the primary inspiratory and primary expiratory muscles with the nerve supply.

Primary inspiratory muscles:

i. Diaphragm: Innervated by phrenic nerve
ii. External Intercostal muscles: Innervated by intercostal nerves.

Primary expiratory muscles:

Internal intercostal muscles: Innervated by intercostal nerves.

30. Name the accessory respiratory muscles.

Accessory inspiratory muscles:

i. Sternomastoid scalene
ii. Anterior serrati
iii. Elevators of scapulae
iv. Pectorals.

Accessory expiratory muscles:

Abdominal muscles.

31. What are the movements of thoracic cage during inspiration?

Thoracic cage enlarges during inspiration and its size increases in all diameters.

Increase in anteroposterior diameter: Due to movement of thoracic lid (manubrium sterni and first pair of ribs) and elevation of upper costal series (second to sixth pair of ribs) and the upward and forward movement of sternum.

Increase in transverse diameter: Due to the elevation of upper and lower costal series (seventh to tenth pair of ribs)

Increase in vertical diameter: Due to descent of diaphragm.

32. What is pump handle movement? What is its significance?

During inspiration the upper costal series are elevated and the sternum moves upward and forward. This type of movement of ribs and sternum is called pump handle movement.

Significance: It increases the anteroposterior diameter of thoracic cage during inspiration.

33. What is bucket handle movement? What is its significance?

During inspiration the central portions (arches) of upper costal series (second to sixth pair of ribs) and lower costal series (seventh to tenth pair of ribs) swing outward and upward. This is called bucket handle movement.

Significance: It increases the transverse diameter of thoracic cage during inspiration.

34. What is the significance of contraction of diaphragm during inspiration?

When the diaphragm contracts, it is flattened. This increases the vertical diameter of thoracic cage during inspiration.

35. What is collapsing tendency of lungs?

Constant threat of collapse of the lungs is called collapsing tendency of lungs.

36. What are the factors causing collapsing tendency of lungs?

i. Elastic property of lung tissues that induces the recoiling tendency of lungs
ii. Surface tension exerted by the alveolar fluid.

37. What are the factors preventing the collapsing tendency of lungs?

i. Intrapleural pressure that overcomes elastic recoiling tendency of lungs
ii. Surfactant that overcomes surface tension.

38. What is surfactant? What is pulmonary surfactant?

Surfactant is a surface acting material or agent that is responsible for lowering the surface tension of a fluid.

Pulmonary surfactant is surface acting material that lines the epithelium of the alveoli in lungs and it decreases the surface tension on alveolar membrane.

39. What is the source of surfactant? What is pulmonary surfactant?

Surfactant is secreted by:

i. Type II alveolar epithelial cells of lungs
ii. Clara cells situated in bronchioles.

40. What are the chemical components of surfactant?

Surfactant consists of:

i. Phospholipids like dipalmitoyl phosphatidyl choline (DPPC)
ii. Other lipids like neutral lipids and phosphatidylglycine (PG)
iii. Specific surfactant apoproteins
iv. Calcium ions.

41. What are the functions of surfactant?

i. Surfactant reduces the surface tension in the alveoli of lungs and prevents collapsing tendency of lungs
ii. Surfactant is responsible for stabilization of the alveoli, which is necessary to withstand the collapsing tendency
iii. It plays an important role in the inflation of lungs after birth
iv. It plays an important role in defense within the lungs against infection and inflammation

42. What is respiratory distress syndrome or hyaline membrane disease?

It is the condition in infants with collapse of lungs due to the absence of surfactant. In adults it is called adult respiratory distress syndrome (ARDS).

43. Define intrapleural or intrathoracic pressure.

Intrapleural or intrathoracic pressure is the pressure existing in the pleural cavity that is in between visceral and parietal layers of pleura. It is always negative.

44. Give normal value of intrapleural or intrathoracic pressure.

In normal conditions it always negative. Normal values:

At the end of normal inspiration:
– 6 mm Hg (760 – 6 = 754 mm Hg)

At the end of normal expiration:
– 2 mm Hg (760 – 2 = 758 mm Hg)

At the end of forced inspiration: 30 mm Hg

At the end of forced inspiration with closed glottis (Müller maneuver): – 70 mm Hg

At the end of forced expiration with closed glottis (Valsalva maneuver): + 50 mm Hg.

45. What is the cause for negative intrapleural pressure?

Intrapleural pressure is negative because of constant pumping of fluid (secreted by visceral layer of pleura) from the intrapleural space into lymphatic vessels.

46. What are the functions of intrapleural pressure?

Throughout the respiratory cycle intrapleural pressure remains lower than intra-alveolar pressure. This keeps the lungs always inflated.

Intrapleural pressure has two important functions:

i. It prevents the collapsing tendency of lungs
ii. It is responsible for venous return. It acts as respiratory pump for venous return.

47. How is intrapleural pressure measured?

By using intraesophageal balloon.

48. Define intra-alveolar or intrapulmonary pressure.

Intra-alveolar or intrapulmonary pressure is the pressure existing in the alveoli of lungs.

49. Give normal values of intra-alveolar or intrapulmonary pressure.

Normally, intra-alveolar pressure is equal to the atmospheric pressure, which is 760 mm Hg.

It becomes negative during inspiration and positive during expiration.

Normal values are:

During normal inspiration:
– 1 mm Hg (760 – 1 = 759 mm Hg)

During normal expiration:
+ 1 mm Hg (760 + 1 = 761 mm Hg)

At the end of inspiration and expiration:
Equal to atmospheric pressure (760 mm Hg)

During forced inspiration with closed glottis (Müller maneuver): – 80 mm Hg

During forced expiration with closed glottis (Valsalva maneuver): + 100 mm Hg.

50. How is intraalveolar pressure measured?

By plythesmograph.

51. What is the significance of intra-alveolar pressure?

i. It causes flow of air into alveoli during inspiration and out of alveoli during expiration
ii. It helps in exchange of gases between alveoli and blood.

52. What is transpulmonary pressure? What does it indicate?

Transpulmonary pressure is the difference between the intra-alveolar pressure and intrapleural pressure. It is the measure of elastic forces in lungs, which is responsible for collapsing tendency of lungs.

53. What is compliance?

Compliance is the ability of the lungs and thorax to expand or it is the expansibility of lungs and thorax.

54. Define compliance in relation to intra-alveolar pressure and give normal value.

In relation to intra-alveolar pressure, compliance is defined as the volume increase in lungs per unit increase in intraalveolar pressure.

Compliance of lungs and thorax = 130 mL/cm H_2O

Compliance of lungs alone = 220 mL/cm H_2O.

55. Define compliance in relation to intrapleural pressure and give normal value.

In relation to intrapleural pressure, compliance is defined as the volume increase in lungs per unit decrease in the intrapleural pressure.

Compliance of lungs and thorax = 100 mL/cm H_2O

Compliance of lungs alone = 200 mL/cm H_2O.

56. What are the conditions when compliance increases?

Physiological condition: Old age

Pathological condition: Emphysema.

57. What are the pathological conditions when compliance decreases?

i. Deformities of thorax like kyphosis and scoliosis
ii. Fibrotic pleurisy
iii. Paralysis of respiratory muscles
iv. Pleural effusion
v. Abnormal thorax such as pneumothorax, hydrothorax, hemothorax and pyothorax

58. Define work of breathing.

Work of breathing is the work done by respiratory muscles during breathing to overcome the resistance in thorax and respiratory tract.

59. What are the types of resistance for which energy is utilized during work of breathing?

i. Airway resistance: Which is overcome by airway resistance work
ii. Elastic resistance of lungs and thorax: Which is overcome by compliance work
iii. Non-elastic viscous resistance: Which is overcome by tissue resistance work.

60. What are the lung function tests?

i. Static lung function tests:
Static lung function tests are based on volume of air that flows into or out of lungs. These tests do not depend upon the rate at which air flows.
Static lung function tests include static lung volumes and static lung capacities
ii. Dynamic lung function tests:
Dynamic lung function tests are based on time, i.e. rate at which air flows into or out of lungs.
These tests include forced vital capacity, forced expiratory volume, maximum ventilation volume and peak expiratory flow.
Dynamic lung function tests are useful in determining the severity of obstructive and restrictive lung diseases.

61. Define and give normal values of lung volumes.

i. Tidal volume: Volume of air breathed in and out of lungs in a single normal quiet breathing.
Normal value: 500 mL
ii. Inspiratory reserve volume: Additional amount of air that can be inspired forcefully beyond normal tidal volume.
Normal value: 3,300 mL
iii. Expiratory reserve volume: Additional amount of air that can be expired forcefully after normal expiration.
Normal value: 1,000 mL
iv. Residual volume: Amount of air remaining in the lungs even after forced expiration.

62. What is lung capacity? Define and give normal values of lung capacities.

Two or more lung volumes together are called lung capacity.

Lung capacities:

i. Inspiratory capacity: Maximum volume of air that can be inspired from the end expiratory position.
It includes tidal volume and inspiratory reserve volume.
Normal value: 3,800 mL.
ii. Vital capacity: Maximum volume of air that can be expelled out forcefully after a maximal (deep) inspiration. It includes inspiratory volume, tidal volume and expiratory reserve volume. Normal value: 4,800 mL.
iii. Functional residual capacity: Volume of air remaining in the lungs after normal expiration (after tidal expiration).
It includes expiratory reserve volume and residual volume
Normal value: 2,200 mL.
iv. Total lung capacity: Amount of air present in the lungs after a maximal (deep) inspiration.
It includes all the four lung volumes i.e., inspiratory reserve volume, tidal volume, expiratory reserve volume and residual volume.
Normal value: 6,000 mL.

63. What is the significance of residual volume?

i. It helps in the exchange of gases in between breathing and during expiration
ii. It maintains the contour of the lungs.

64. What are the instruments used to measure lung volumes and lung capacities?

i. Spirometer
ii. Respirometer.

65. Name the lung volumes and capacities, which cannot be measured by spirometer.

i. Residual volume
ii. Functional residual capacity
iii. Total lung capacity.

66. How are residual volume and functional residual capacity measured?

i. Helium dilution technique
ii. Nitrogen washout method.

67. Which type of people have more vital capacity?

i. Heavily built persons
ii. Athletes
iii. People playing musical wind instruments like bugle.

68. Name the pathological conditions when vital capacity is reduced.

i. Asthma
ii. Emphysema
iii. Weakness or paralysis of respiratory muscle
iv. Congestion of lungs
v. Pneumonia
vi. Pneumothorax
vii. Hemothorax
viii. Pyothorax
ix. Hydrothorax
x. Pulmonary edema
xi. Pulmonary tuberculosis.

69. What is respiratory minute volume (RMV)? Give its normal value.
Respiratory minute volume is the amount of air that is breathed in and out of lungs during each minute
It is the product of tidal volume and respiratory rate.
Normal value: 6,000 mL (500 mL × 12).

70. What is maximum breathing capacity (MBC) or maximum ventilation volume (MVV)? What is its normal value?
It is the maximum amount of air that can be breathed in and out of lungs by forceful respiration (hyperventilation).
Normal value:
In healthy adult male: 150 to 170 liters/minute
In healthy adult females: 80 to 100 liters/minute.

71. What is forced expiratory volume (FEV) or timed vital capacity?
Forced expiratory volume is the amount of air that can be expired forcefully (after deep inspiration) in a given unit of time.

72. What is FEV_1?
Amount of air that can be expired forcefully after deep inspiration in the first second is called FEV_1 (1 stands for 'first second').

73. Give the normal values of FEV_1, FEV_2 and FEV_3.
FEV_1 : 83%
FEV_2 : 94%
FEV_3 : 97%.

74. What is the significance of determining FEV?
Vital capacity may be almost normal in some of the respiratory diseases. However, determination of FEV has greater diagnostic value, as it is decreased significantly in some respiratory disorders, particularly in obstructive diseases like asthma and emphysema.

75. Define and give normal value of peak expiratory flow rate (PEFR).
Maximum rate at which air can be expired after deep inspiration is known as peak expiratory flow rate (PEFR).
Normal value: About 400 liters/minute.

76. How is PEFR measured?
By using Wright's peak flow meter or mini peak flow meter.

77. What is the significance of measuring PEFR?
Measurement of PEFR is useful in assessing the respiratory diseases, especially to differentiate the obstructive and restrictive diseases. It is about 200 liters/ minute in restrictive diseases and it is only 100 liters/ minute in obstructive diseases.

78. What is the meaning of ventilation? What are the types of ventilation in respiratory physiology?
In general, the word 'ventilation' refers to circulation of air or replacement of stale (not fresh) air with fresh air in a space
In respiratory physiology, ventilation is the rate at which air enters or leaves the lungs. Ventilation in respiratory physiology is of two types:
i. Pulmonary ventilation
ii. Alveolar ventilation.

79. What is pulmonary ventilation? Give its normal value.
Pulmonary ventilation is defined as the amount of air breathed in and out of lungs in one minute.
It is the product of tidal volume and respiratory rate. It is otherwise known as respiratory minute volume.
Normal value: 6,000 mL/minute.

80. What is alveolar ventilation? Give its normal value.
Alveolar ventilation is the amount of air utilized for gaseous exchange every minute.
Alveolar ventilation = (Tidal volume – Dead space volume) × Respiratory rate.
Normal value: 4,200 mL.

81. What is dead space? Give normal value.
Part of respiratory tract where the gaseous exchange does not occur is known as dead space. The air present in the dead space is called dead space air.
Normal value: 150 mL.

82. What are the types of dead space?
i. Anatomical dead space, which includes the volume of respiratory tract from nose up to terminal bronchiole
ii. Physiological dead space which includes anatomical dead space and two additional volumes:
   a. The volume of air in those alveoli, which are not functioning
   b. The amount of air in those alveoli, which do not receive adequate blood flow.

83. Why the physiological dead space is equal to anatomical dead space in normal conditions?
Because all the alveoli of both lungs are functioning and all the alveoli receive adequate blood supply in normal conditions.

84. How is dead space measured?
By single breath nitrogen washout method.

85. What is ventilation perfusion ratio? Give its normal value.
It is the ratio of alveolar ventilation (VA) and the amount of blood (Q) flowing through the lungs.
Ventilation perfusion ratio = VA/Q = 4,200/5,000
Normal value: About 0.84.

86. What are the importance of alveolar air?
i. Alveolar air is different from inspired air or atmospheric air. It is partially replaced by the atmospheric air during each breath.
ii. Oxygen diffuses from the alveolar air into pulmonary capillaries constantly.
iii. Carbon dioxide diffuses from pulmonary blood into alveolar air constantly.
iv. Dry atmospheric air is humidified, while passing through respiratory passage before entering the alveoli.

87. What are the differences between inspired air and alveolar air?
i. Oxygen content is more in inspired air than in alveolar air
ii. Carbon dioxide is less in inspired air than in alveolar air
iii. Inspired air is dry whereas alveolar air is humid.

88. What is the composition of inspired or atmospheric air? Give values of content.
i. Oxygen : 20.84 mL% (159 mm Hg)
ii. Carbon dioxide : 0.04 mL% (0.30 mm Hg)
iii. Nitrogen : 78.62 mL% (596.90 mm Hg)
iv. Water vapor : 0.50 mL% (3.80 mm Hg)
(Value in parenthesis is the partial pressure).

89. What is the composition of alveolar air? Give values of content.
i. Oxygen : 13.60 mL% (104 mm Hg)
ii. Carbon dioxide: : 5.30 mL% (40 mm Hg)
iii. Nitrogen: : 74.90 mL% (569 mm Hg)
iv. Water vapor: : 6.20 mL% (47 mm Hg)
(Value in parenthesis is the partial pressure).

90. What is the composition of expired air? Give values of content.
i. Oxygen : 15.70 mL% (120 mm Hg)
ii. Carbon dioxide : 3.60 mL% (27 mm Hg)
iii. Nitrogen : 74.50 mL% (566 mm Hg)
iv. Water vapor : 6.20 mL% (47 mm Hg)
(Value in parenthesis is the partial pressure).

91. How is alveolar air collected?
By using Haldane-Priestley tube.

92. How is inspired air collected?
Since the inspired air is the atmospheric air, it can be drawn from the atmosphere through a syringe.

93. How is expired air collected?
By using Douglas bag.

94. What is respiratory membrane?
Respiratory membrane is a membranous structure through which exchange of respiratory gases takes place between air and blood. It is formed by epithelium of respiratory unit and endothelium of pulmonary capillary.

95. What are the layers of respiratory membrane?
From within outside:
i. Thin layer of surfactant
ii. Thin layer of alveolar fluid
iii. Layer of alveolar epithelial cells
iv. Basement membrane of epithelial cells
v. Interstitial space
vi. Basement membrane of capillary endothelial cells
vii. Capillary endothelial cells.

96. What is diffusing capacity?
Diffusing capacity is the volume of gas that diffuses through respiratory membrane each minute for a pressure gradient of 1 mm Hg.

97. Mention the diffusing capacity for oxygen and carbon dioxide.
Diffusing capacity for oxygen : 21mL/minute/mm Hg
Diffusing capacity for carbon dioxide : 400 mL/minute/mm Hg
Diffusing capacity for carbon dioxide is about 20 times more than that of oxygen.

98. What are the factors affecting the diffusing capacity?
Diffusing capacity is directly proportional to:
i. Pressure gradient of gases between alveoli and blood in pulmonary capillary
ii. Solubility of gas in fluid medium
iii. Total surface areas of respiratory membrane.
Diffusing capacity is inversely proportional to:
i. Molecular weight of the gas
ii. Thickness of respiratory membrane.

99. What is diffusion coefficient or diffusion constant?
Diffusion coefficient a constant (a factor of proportionality), which is the measure of a substance diffusing through the concentration gradient. It is related to size and shape of the molecules of the substance.

100. What is Fick law of diffusion?
According to this law, amount of a substance crossing a given area is directly proportional to area available for diffusion, concentration gradient and a constant known as diffusion coefficient.

101. What is the oxygen content and partial pressure of oxygen (PO_2) in blood?
Arterial blood:
Oxygen content: 19 mL%
PO_2 : 95 mm Hg
Venous blood:
Oxygen content: 14 mL%
PO_2 : 40 mm Hg.

102. What is the carbon dioxide content and partial pressure of carbon dioxide (PCO_2) in blood?
Arterial blood:
Carbon dioxide content: 48 mL%
PCO_2 : 40 mm Hg
Venous blood:
Carbon dioxide content: 52 mL%
PCO_2 : 45 mm Hg.

103. What is respiratory exchange ratio? Give its normal value.
It is the ratio between the amount of oxygen consumed (uptake) and the amount of carbon dioxide given out by the tissues. It is 1.00 if only carbohydrate is utilized.
Normal value:
If only carbohydrate is utilized : 1.00
If only fat is utilized : 0.7
If only protein is utilized : 0.8.

104. How is oxygen transported by blood?
i. As physical solution
ii. In combination with hemoglobin.

105. What is the oxygen carrying capacity of hemoglobin and blood?
Oxygen carrying capacity of hemoglobin : 1.34 mL/g of hemoglobin.
Oxygen carrying capacity of blood : 19 mL/100 mL of blood.
When the hemoglobin content in blood is 15 g%, oxygen carrying capacity of blood is only 19 mL% because the hemoglobin in the blood is saturated with oxygen only for about 95%.

106. What is P_{50}?
It is the partial pressure of oxygen at which the hemoglobin saturation is 50%. It is 25 mm Hg.

107. What is oxygen-hemoglobin dissociation curve? What is its normal shape?
It is the curve that demonstrates the relationship between the partial pressure of oxygen and percentage saturation of hemoglobin with oxygen. It explains hemoglobin's affinity for oxygen.
Normally, it is 'S' shaped or sigmoid shaped.

108. What is indicated by shift to the right of oxygen-hemoglobin dissociation curve? Name some factors causing it.
Shift to the right of oxygen dissociation curve indicates the dissociation or release of oxygen from hemoglobin.
It is caused by:
i. Decrease in partial pressure of oxygen in blood
ii. Increase in partial pressure of carbon dioxide
iii. Increase in hydrogen ion concentration and decrease in pH (acidity)
iv. Increase in body temperature
v. Excess of 2, 3 DPG (2,3, diphosphoglycerate).

109. What is indicated by shift to the left in O_2 dissociation curve? When does it occur?
Shift to the left of oxygen dissociation curve indicates the acceptance (association or retention) of more amount of oxygen by hemoglobin.
It occurs:
i. In fetal blood since fetal blood has more affinity for O_2 than the adult blood
ii. When hydrogen ion concentration in the blood decreases causing increase in pH (alkalinity).

110. What is Bohr effect?
Bohr effect is effect by which presence of carbon dioxide decreases the affinity of hemoglobin for oxygen. It enhances further release of oxygen to the tissues and oxygen-dissociation curve is shifted to right.

111. How is carbon dioxide transported in the blood?
i. As physical solution
ii. As carbonic acid
iii. As bicarbonate
iv. As carbamino compounds.

112. Name the method by which maximum amount of carbon dioxide is transported in the blood.
As bicarbonate (about 63%).

113. What is chloride shift or Hamburger phenomenon? What is its significance?
It is exchange of negatively charged chloride ion for negatively charged bicarbonate ion between RBC and plasma across RBC membrane.
It maintains the electrolyte equilibrium (ionic balance).

114. What is reverse chloride shift?
Reverse chloride shift is the process by which chloride ions are moved back from RBC into plasma when the blood reaches the alveoli of lungs. It is because of diffusion of bicarbonate ions from plasma into the RBC.

115. What is carbon dioxide dissociation curve?
It is the curve that demonstrates the relationship between the partial pressure of carbon dioxide and quantity of carbon dioxide combined with blood.

116. What is Haldane's effect? What is its cause?
Haldane's effect is the effect by which combination of oxygen with hemoglobin displaces carbon dioxide from hemoglobin. It shifts the carbon dioxide dissociation curve to right.
Cause for Haldane's effect: Due to combination of oxygen, hemoglobin becomes strongly acidic. This causes displacement of carbon dioxide from hemoglobin.

117. What is the significance of Haldane's effect?
Haldane's effect is essential for:
i. Release of carbon dioxide from blood into alveoli of lungs
ii. Uptake of oxygen by blood.

118. Name the mechanisms involved in the regulation of respiration.
i. Nervous mechanism
ii. Chemical mechanism.

119. What are the respiratory centers? Classify them.
Respiratory centers are group of neurons which control rate, rhythm and force of respiration. These centers are bilaterally situated in reticular formation of brain stem. Groups of respiratory centers depending upon situation:
i. Medullary centers situated in medulla oblongata:
   a. Dorsal respiratory group of neurons: All the neurons are collectively known as inspiratory center. Neurons of dorsal respiratory group are inspiratory neurons.
   b. Ventral respiratory group of neurons: All the neurons are collectively known as expiratory center. Ventral respiratory group has both inspiratory neurons and expiratory neurons.
ii. Two pontine centers situated in pons:
   a. Pneumotaxic center
   b. Apneustic center.

120. Mention the situation and functions of medullary centers.
Dorsal respiratory group of neurons:
Situation: In nucleus of tractus solitarius present in upper part of medulla
Function: Responsible for basic rhythm of respiration.
Ventral respiratory group of neurons:
Situation: in nucleus ambiguous and nucleus retroambiguous present in medulla anterior and lateral to nucleus of tractor solitarius.
Function: Normally, ventral respiratory group of neurons are inactive during quiet breathing. During forced breathing these neurons become activated and stimulate both inspiratory muscle and expiratory muscles.

121. Mention the situation and functions of pontine centers.
Apneustic center:
Situation: In nuclei reticular formation of lower pons.
Function: Increases depth of inspiration by directly stimulating dorsal group of respiratory neurons.
Pneumotaxic center:
Situation: In parabrachial nucleus and subparabrachial which are present in dorsolateral part of reticular formation in upper pons.
Function: Its primary function is to control medullary center particularly dorsal respiratory group of neurons by acting through apneustic center. It acts by inhibiting the apneustic center.
It increases rate of respiration by reducing duration of inspiration.

122. Briefly explain efferent nerve fibers from respiratory centers.
Nerve fibers from respiratory centers terminate on motor neurons cervical and thoracic segments of spinal cord
From motor neurons of spinal cord, two sets of nerve fibers arise:
i. Phrenic nerve fibers (C3 to C5), which supply the diaphragm
ii. Intercostal nerve fibers (T1 to T11), which supply the external intercostal muscles.
Vagus nerve also contains some efferent fibers from the respiratory centers.

123. Briefly explain afferent nerve fibers to respiratory centers.
Respiratory centers receive afferent impulses from:
i. Peripheral chemoreceptors and baroreceptors via branches of glossopharyngeal and vagus nerves
ii. Stretch receptors of lungs via vagus nerve.
By receiving afferent impulses from these receptors, respiratory centers modulate the movements of thoracic cage and lungs through efferent nerve fibers.

124. What is inspiratory ramp?
Inspiratory ramp is the pattern of impulse discharge from dorsal respiratory group of neurons. These impulses are characterized by steady increase in amplitude of the action potential. Impulse discharge from these neurons is not sudden and it is also not uniform.

125. Briefly explain inspiratory ramp signals?
To start with, the amplitude of action potential of inspiratory ramp is low due to the activation of only few neurons. Later, more and more neurons are activated, leading to gradual increase in the amplitude of action potential in a ramp fashion. Impulses of this type discharged from dorsal respiratory group of neurons are called inspiratory ramp signals.

Ramp signals are not produced continuously but only for a period of 2 seconds, during which inspiration occurs. After 2 seconds, ramp signals stop abruptly and do not appear for another 3 seconds. Switching off the ramp signals causes expiration. At the end of 3 seconds, inspiratory ramp signals reappear in the same pattern and the cycle is repeated.

126. What is the significance of inspiratory ramp signals?
Significance of inspiratory ramp signals is that there is a slow and steady inspiration so that, the filling of lungs with air is also steady.

127. What is pre-Bötzinger complex (pre-BötC)?
Pre-Bötzinger complex (pre-BötC) is an additional respiratory center found in animals. It is formed by a group of neurons called pacemaker neurons, located in the ventrolateral part of medulla. Pacemaker neurons generate the rhythmic respiratory impulses. Medullary centers send nerve fibers into this complex. Exact functioning mechanism of this complex is not known.

128. What are the higher centers which alter the respiration by acting on the respiratory centers?
i. Impulses from anterior cingulated gyrus, genu of corpus callosum, olfactory tubercle and posterior orbital gyrus of cerebral cortex inhibit respiration
ii. Motor area and Sylvian area of cerebral cortex cause forced breathing.

129. What are the various types of receptors in the lungs which alter the respiration?
i. Stretch receptors present in the wall of bronchi and bronchioles of lungs.
ii. 'J' receptors or juxtacapillary receptors situated in the wall of alveoli near the capillaries.
iii. Irritant receptors present in the wall of bronchi and bronchioles.

130. What is the function of stretch receptors present in lungs?
Stretch receptors present in lungs prevent overstretching of lungs by producing Hering–Breuer reflex.

131. What is Hering-Breuer reflex?
Hering-Breuer reflex is a protective reflex that restricts inspiration and prevents overstretching of lung tissues. It is initiated by the stimulation of stretch receptors of air passage.

132. What are Hering-Breuer inflation reflex and Hering-Breuer deflation reflex?
Hering-Breuer inflation reflex is the reflex which restricts the inspiration and limits the overstretching of lung tissues.

Hering-Breuer deflation reflex is reverse of Hering-Breuer inflation reflex. It takes place during expiration. During expiration, stretching of lungs is absent, so deflation occurs.

133. What is the function of 'J' receptors?
'J' receptors are responsible for hyperventilation in patients affected by pulmonary congestion and left heart failure.

134. What is the function of irritant receptors?
When harmful chemical agents like ammonia and sulfur dioxide enter the lungs, the irritant receptors are stimulated. The stimulation of irritant receptors results in reflex hyperventilation and bronchospasm so that further entry of harmful agents into the lungs is prevented.

135. What is the effect of stimulation of baroreceptors on respiration?
When arterial blood pressure increases, the baroreceptors are activated and send inhibitory impulses to respiratory centers. So, the respiration is inhibited.

136. What is the effect of stimulation of proprioceptors on respiration?
During exercise, the proprioceptors situated in muscles, tendons and joints are stimulated and send impulses to cerebral cortex. Cerebral cortex in turn, activates the respiratory centers causing hyperventilation.

137. What is the effect of stimulation of cold receptors (thermoreceptors) on respiration?
When body is exposed to cold, the cold receptors are activated and send impulses to cerebral cortex. Cerebral cortex in turn, activates the respiratory centers causing hyperventilation.

138. What is the effect of stimulation of pain receptors on respiration?
Whenever pain receptors are stimulated, the impulses from them are sent to cerebral cortex via somatic afferent fibers. Cerebral cortex in turn, activates the respiratory centers causing hyperventilation.

139. What are chemoreceptors?
Chemoreceptors are the receptors, which give response to change in chemical constituents of blood such as O_2, CO_2 and H^+.

140. Classify chemoreceptors.
Depending upon the situation, the chemoreceptors are classified into two types:
i. Central chemoreceptors situated in medulla oblongata near the inspiratory center and having close contact with blood and cerebrospinal fluid
ii. Peripheral chemoreceptors present in the carotid body and aortic body.

141. Explain the function of central chemoreceptors briefly.
Activation of central chemoreceptors causes stimulation of inspiratory center resulting in increased rate and force of respiration. Main stimulant for central chemoreceptors is the increased hydrogen ion concentration.

However, if the hydrogen ion concentration increases in blood, it cannot stimulate the central chemoreceptors because, the hydrogen ions cannot cross the blood-brain barrier. But, if the carbon dioxide increases in blood, it can cross the blood-brain barrier and enter interstitial fluid of brain or the cerebrospinal fluid. There, it combines with water forming carbonic acid that immediately dissociates into hydrogen ion and bicarbonate ion.

Now, the hydrogen ions stimulate the central chemoreceptors causing increase in rate and force of respiration.

142. Explain the function of peripheral chemoreceptors.
Main stimulant for peripheral chemoreceptors is hypoxia. During hypoxia, peripheral chemoreceptors are stimulated and send stimulatory impulses to inspiratory center. This causes increase in rate and force of respiration.

143. What are the types of respiratory diseases?
i. Obstructive diseases like asthma and emphysema
ii. Restrictive diseases like pneumothorax and pneumonia.

144. Define the following.

Eupnea: Normal respiration.

Tachypnea: Increase in rate of respiration.

Bradypnea: Decrease in rate of respiration.

Polypnea: Rapid shallow breathing resembling panting in dogs; the rate of respiration is increased significantly but the force is not increased significantly.

Apnea: Temporary arrest of breathing.

Hyperpnea: Increase in pulmonary ventilation due to increase in rate and force of respiration with more increase in rate.

Hypoventilation: Abnormal increase in rate and force of respiration, which often leads to dizziness and sometimes chest pain.

Hypoventilation: Decrease in rate and force of respiration.

Dyspnea: Difficulty in breathing.

Periodic breathing: Abnormal respiratory rhythm.

145. Define apnea.

Apnea is defined as the temporary arrest of breathing. Literally, apnea means absence of breathing.

146. What is breaking point? What is its cause?

At the end of voluntary apnea, the person is forced to breathe. The time when the person is forced to breathe is called breaking point. It is due to accumulation of CO_2.

147. What is breath holding or voluntary apnea? What is apnea time?

Breath holding or voluntary apnea is the apnea produced voluntarily.

Apnea time is the breath holding time. It is about 40 to 60 seconds in a normal person, after a deep inspiration.

148. List the conditions when apnea occurs.

i. By voluntary effort: Voluntary apnea or breath holding
ii. After hyperventilation
iii. During pharyngeal stage of deglutition: Deglutition apnea
iv. During vagal stimulation: Vagal apnea
v. After adrenaline injection: Adrenaline apnea.

149. Mention clinical classification of anemia.

i. Obstructive apnea: Occurs because of obstruction in respiratory tract. Common one is sleep apnea.
ii. Central apnea: Occurs due to brain disorders.
iii. Mixed apnea: Combination of central and obstructive apnea. Common in premature baby and in full-term born infants.

150. What is hyperventilation? When does it occur?

Hyperventilation means increased pulmonary ventilation due to forced breathing. It is also called **overventilation.** In hyperventilation, both rate and force of breathing are increased and a large amount of air moves in and out of lungs. Thus, pulmonary ventilation is increased to a great extent. Very often, hyperventilation leads to dizziness, discomfort and chest pain.

151. What are conditions when hyperventilation occurs?

Hyperventilation mostly occurs in conditions like exercise. Voluntarily also, hyperventilation can be produced. It is called voluntary hyperventilation.

152. What are the effects of hyperventilation?

Carbon dioxide is washed out during hyperventilation leading to reduction in the partial pressure of carbon dioxide in blood. This causes suppression of respiratory centers resulting in apnea. Apnea is followed by Cheyne-Stokes breathing. After a period of Cheyne-Stokes breathing, normal respiration is restored.

153. What is hypoventilation? When does it occur?

Hypoventilation is the decreased pulmonary ventilation caused by decreased rate or force of breathing.

It occurs in the following conditions:

i. Suppression of respiratory centers
ii. After administration of some drugs
iii. Partial paralysis of respiratory muscles.

154. What are the effects of hypoventilation?

Hypoventilation causes hypoxia and hypercapnea. So, there is increase in rate and force of respiration leading to dyspnea. Severe hypoventilation leads to lethargy, coma and death.

155. Define hypoxia.

Hypoxia is defined as reduced availability of oxygen to the tissues of the body.

156. Why the term hypoxia is preferred than anoxia?

Anoxia means the absence of oxygen. Since, there is no possibility for total absence of oxygen in living conditions, the term hypoxia is preferred.

157. Classify hypoxia.

i. Hypoxic hypoxia
ii. Anemic hypoxia
iii. Stagnant hypoxia
iv. Histotoxic hypoxia.

158. What is hypoxic hypoxia? What are the features of it?

Hypoxic hypoxia or arterial hypoxia is the hypoxia due to decreased oxygen content in the blood.

It is characterized by reduced partial pressure of oxygen. Oxygen carrying capacity of blood, rate of blood flow and utilization of oxygen are normal.

159. Name some important causes for hypoxic hypoxia.

i. Low oxygen tension in inspired air (in atmosphere)
ii. Respiratory disorders associated with decreased pulmonary ventilation
iii. Respiratory disorders associated with inadequate oxygenation in lungs
iv. Cardiac disorders.

160. What is anemic hypoxia? What are the features of it?

Anemic hypoxia is the hypoxia caused by anemic conditions.

It is characterized by reduced oxygen carrying capacity of blood. Partial pressure of oxygen, rate of blood flow and utilization of oxygen are normal.

161. What are the causes for anemic hypoxia?

Any condition that leads to anemia will cause anemic hypoxia such as:

i. Decreased red blood cell count
ii. Decreased hemoglobin content
iii. Presence of altered hemoglobin
iv. Combination of hemoglobin with gases other than oxygen and carbon dioxide (like carbon monoxide).

162. What is stagnant hypoxia? What are the features of it?

Stagnant hypoxia is the hypoxia due to decreased velocity of blood flow.

It is characterized by reduced rate of blood flow. Partial pressure of oxygen, oxygen carrying capacity of blood, and utilization of oxygen are normal.

163. What are the causes for stagnant hypoxia?

i. Congestive cardiac failure
ii. Hemorrhage
iii. Surgical shock
iv. Vasospasm

v. Thrombosis
vi. Embolism.

164. What is histotoxic hypoxia? What are the features of it?
Histotoxic hypoxia is the type of hypoxia produced by inability of tissue to utilize oxygen.

It is characterized by reduced utilization of oxygen. Partial pressure of oxygen, oxygen carrying capacity of blood and rate of blood flow are normal.

165. What are the causes for histotoxic hypoxia?
It is caused by cyanide or sulfate poisoning. These poisons destroy cellular oxidative enzymes. This leads to complete paralysis of cytochrome oxidase system.

166. What are the effects of acute and severe hypoxia?
Acute and severe hypoxia causes unconsciousness. If it is not treated immediately brain death occurs.

167. What are the immediate effects of hypoxia?
i. On blood:
Red blood cell count increases due to release of erythropoietin from kidney. This in turn, increases the oxygen carrying capacity of blood.
ii. On cardiovascular system:
Initially, there is an increase in rate and force of contraction of heart, cardiac output and blood pressure. Later, there is reduction in all these parameters.
iii. On respiratory system:
Initially, respiratory rate increases. Because of this, carbon dioxide is washed out leading to alkalemia. Later, the respiration tends to be shallow and periodic. Finally, the rate and force of breathing are reduced.
iv. On digestive system:
Hypoxia is associated with loss of appetite, nausea and vomiting. Mouth becomes dry and there is a feeling of thirst.
v. On kidneys:
Hypoxia causes increased secretion of erythropoietin from the juxtaglomerular apparatus. And alkaline urine is excreted.
vi. On central nervous system:
In mild hypoxia, the symptoms are similar to those of alcoholic intoxication.

Individual is depressed, apathetic with general loss of self-control. The person becomes talkative, quarrelsome, ill-tempered and rude. The person starts shouting, singing or crying.

There is disorientation and loss of discriminative ability and judgment.

Memory is impaired. Weakness, lack of coordination and fatigue of muscles are common in hypoxia.

168. What are the delayed effects of hypoxia?
Delayed effects appear depending upon the length and severity of the exposure to hypoxia.

The person becomes highly irritable and develops the symptoms of mountain sickness, such as nausea, vomiting, depression, weakness and fatigue

169. How is hypoxia treated?
Hypoxia is treated by oxygen therapy.

170. What is the efficacy of oxygen therapy in different type of hypoxia?
Oxygen therapy is not equally effective in all types of hypoxia.
Hypoxic hypoxia: Oxygen therapy is 100% useful
Anemic hypoxia: Oxygen therapy is moderately useful, i.e. about 70%
Stagnant hypoxia: Oxygen therapy is less than 50% useful
Histotoxic hypoxia: Oxygen therapy is of no use at all.

171. What is oxygen toxicity or oxygen poisoning? What are the causes for it?
Oxygen toxicity is the increased oxygen content in tissues, beyond certain critical level.

It occurs because of breathing pure oxygen with a high pressure of 2 to 3 atmosphere (hyperbaric oxygen).

172. What is hyperbaric oxygen?
Pure oxygen at a high pressure of about 1,500 mm Hg is known as hyperbaric oxygen.

173. What are the effects of oxygen toxicity?
i. Lung tissues are affected first with tracheobronchial irritation and pulmonary edema
ii. Metabolic rate increases in all the body tissues and the tissues are burnt out by excess heat
iii. When brain is affected, first hyperirritability occurs. Later, there is increased muscular twitching, ringing in ears and dizziness
iv. Finally, toxicity results in convulsions, coma and death.

174. What is hypercapnea? When does it occur?
Hypercapnea is increased carbon dioxide content in the blood.

It occurs in conditions leading to asphyxia and breathing air containing more amount of carbon dioxide.

175. What are the effects of hypercapnea?
i. Respiration: Respiratory centers are stimulated leading to dyspnea.
ii. Blood: pH of blood is reduced.
iii. Cardiovascular system: Heart rate and blood pressure are increased. There is flushing of skin due to peripheral vasodilatation.
iv. Central nervous system: Headache, depression, laziness, rigidity, fine tremors, generalized convulsions, giddiness and loss of consciousness occur.

176. What is hypocapnea? When does it occur?
Hypocapnea is decreased carbon dioxide content in the blood.

It occurs in conditions associated with hypoventilation and prolonged hyperventilation.

177. What are the effects of hypocapnea?
i. Respiration: Respiratory centers are depressed. Respiratory alkalosis occurs.
ii. Blood: pH of blood is increased.
iii. Central nervous system: Dizziness, mental confusion, muscular twitching and loss of consciousness occur.

178. What is asphyxia? When does it occur?
Asphyxia is the condition caused by lack of oxygen and excess of carbon dioxide that occur due to obstruction of air passage.

It occurs in conditions like strangulation and drowning.

179. What are the stages of effects of asphyxia?
i. Stage of hyperpnea
ii. Stage of convulsions
iii. Stage of collapse.

180. What is dyspnea or air hunger?
Dyspnea means difficulty in breathing. It is defined as the consciousness of necessity for increased respiratory effort.

181. What is dyspnea point?
Dyspnea point is the level at which there is increased ventilation with severe breathing discomfort.

182. Name the physiological and pathological conditions when dyspnea occurs.

Physiological condition:

Severe muscular exercise

Pathological conditions:

i. Respiratory disorders like hindrance to respiratory movements and obstruction of respiratory tract
ii. Cardiac disorders like left ventricular failure and mitral stenosis
iii. Metabolic disorders like diabetic acidosis, uremia and increased hydrogen ion concentration.

183. What is dyspneic index? What is the level of dyspneic index at which dyspnea occurs?

Dyspneic index is the index between breathing reserve and maximum breathing capacity. Breathing reserve is the difference between maximum breathing capacity (MBC) and respiratory minute volume (RMV).

Dyspnea occurs when the dyspneic index is reduced below 60%.

184. Define periodic breathing. Mention the types of periodic breathing.

Periodic breathing is the abnormal or uneven respiratory rhythm.

It is of two types:

i. Cheyne-Stokes breathing
ii. Biot breathing.

185. What is Cheyne-Stokes breathing?

Cheyne-Stokes breathing is the periodic breathing characterized by gradual increase in force (depth) (force) of breathing and decrease in force of breathing resulting in apnea.

186. What are the features of Cheyne-Stokes breathing?

During Cheyne-Stokes breathing is marked by two alternate patterns of respiration

i. Hyperpneic period:
At the beginning, breathing is shallow. Force of respiration increases gradually and reaches the maximum. Then, it decreases gradually and reaches the minimum. This is called waxing and waning.
ii. Apneic period:
When the force of respiration reaches the minimum apnea occurs. Then hyperpnea occurs and the cycle is repeated.

187. What are the causes for waxing and waning during Cheyne-Stokes breathing?

Initially, during forced breathing, excess of carbon dioxide is washed out of blood. When partial pressure of carbon dioxide tension decreases, respiratory centers become inactive and apnea occurs. During apnea, carbon dioxide is accumulated and oxygen tension is decreased. So, the respiratory centers are stimulated leading to gradual increase in force of breathing.

188. What are the conditions when Cheyne-Stokes breathing occurs?

Physiological conditions:

i. Sleep
ii. High altitude
iii. After prolonged hyperventilation
iv. During hibernation in animals
v. In newborn babies
vi. After severe muscular exercise.

Pathological conditions:

i. Increased intracranial pressure
ii. Cardiac failure
iii. Uremia
iv. Narcotic poisoning
v. In premature infants.

189. What is Biot breathing?

Biot breathing is a type of periodic breathing characterized by period of apnea and period of hyperpnea. There is no waxing and waning. After apneic period hyperpnea occurs abruptly.

190. What are the conditions when Biot breathing occurs?

Biot breathing occurs only in pathological conditions. It is caused by lesions in respiratory centers.

191. Define cyanosis. What is its cause?

Cyanosis is defined as the diffused bluish discoloration of skin and mucous membrane. It is due to the presence of large amount of reduced hemoglobin in blood. At least 5 g% of reduced hemoglobin must be present to cause cyanosis.

192. What are the areas of the body where cyanosis is seen markedly?

Though cyanosis is distributed all over the body, it is more marked in areas where the skin is thin like lips, cheeks, ear lobes, nose and fingertips above the base of nail.

193. What are the conditions when cyanosis occurs?

Cyanosis occurs in:

i. Arterial hypoxia and stagnant hypoxia. Cyanosis does not occur in anemic hypoxia
ii. Conditions when altered hemoglobin is formed in blood.
iii. Polycythemia
iv. Cyanosis develops in many other conditions such as heart failure, hypotension, obstruction of blood vessels, hypovolemic shock, thrombosis in deeper veins and hypothermia.

194. Why cyanosis does not occur in anemia?

Cyanosis usually occurs only when the amount of reduced hemoglobin is more than 5 to 7 g% but in anemia the hemoglobin content itself is less. So, cyanosis cannot occur in anemia.

195. What is carbon monoxide poisoning?

Carbon monoxide poisoning is the dangerous condition leading to death caused by excess breathing of carbon monoxide.

196. What are the sources of carbon monoxide?

i. Exhaust of gasoline engines
ii. Coal mines
iii. Gases from guns
iv. Deep wells
v. Underground drainage system.

197. What is the difference between the affinity of hemoglobin for carbon monoxide and oxygen?

Hemoglobin has got 200 times more affinity for carbon monoxide than for oxygen.

198. What are the toxic effects of carbon monoxide?

i. Carbon monoxide combines with hemoglobin and forms carboxy hemoglobin. This cannot take up oxygen so, anemic hypoxia occurs. Presence of carboxyhemoglobin decreases release of oxygen from hemoglobin and the oxygen dissociation curve shifts to left
ii. Carbon monoxide destroys the cytochrome system in the cells.

199. What are the symptoms of carbon monoxide poisoning?
i. Breathing air with 1% carbon monoxide causes headache and nausea
ii. Breathing air with more than 1% carbon monoxide causes convulsions, cardiorespiratory arrest, loss of consciousness and coma
iii. When the percentage of carbon monoxide in the air is high, death occurs.

200. What is atelectasis? What are its causes?
Atelectasis partial or complete collapse of lungs.
Causes:
i. Deficiency or inactivation of surfactant
ii. Obstruction of bronchus or bronchiole
iii. Presence of air (pneumothorax), fluid (hydrothorax), blood (hemothorax) or pus (pyothorax) in pleural space.

201. What are the effects of atelectasis?
i. Decrease in the partial pressure of oxygen
ii. Dyspnea.

202. What is pneumothorax? When does it occur?
Pneumothorax is the resence of air in pleural space resulting in collapse of lungs. Intrapleural pressure, which is always negative, becomes positive in pneumothorax and it causes collapse of lungs.

Pneumothorax occurs during injury to chest wall or lungs during accidents, bullet injury or stab injury.

203. What are the effects of pneumothorax?
In pneumothorax, intrapleural pressure becomes positive leading to collapse (atelectasis) of lungs, hypoxia and dyspnea.

204. What is hydrothorax? What are its effects?
Accumulation of fluid in intrapleural space is called hydrothorax. In hydrothorax, the intrapleural pressure becomes positive resulting in collapse (atelectasis) of lungs.

205. What is hemothorax? What are its effects?
Accumulation of blood in intrapleural space is called hemothorax. In the hemothorax, intrapleural pressure becomes positive resulting in collapse (atelectasis) of lungs.

206. Define pneumonia. What are its causes?
Pneumonia is the inflammation of lung tissues followed by accumulation of blood cells, fibrin and exudates in alveoli leading to consolidation of affected part of the lung.
Causes:
i. Bacterial or viral infection
ii. Inhaling noxious chemical agents.

207. What are the effects of pneumonia?
i. Fever
ii. Compression of chest and chest pain
iii. Shallow breathing
iv. Cyanosis
v. Sleeplessness
vi. Delirium.

208. What is delirium? What are its features?
Delirium is the extreme mental state due to cerebral hypoxia.
Features:
i. Confused mental state
ii. Illusion
iii. Hallucination
iv. Disorientation
v. Hyperexcitability and restlessness.
vi. Loss of memory.

209. What is bronchial asthma?
Bronchial asthma is the respiratory disease characterized by difficulty in breathing with wheezing.

210. What is wheezing? What is it due to?
Wheezing means whistling type of respiration noticed in bronchial asthma. It is marked during expiration.
It is due to obstruction of air passage by:
i. Bronchiolar constriction
ii. Edema of mucous membrane in bronchioles
iii. Accumulation of mucus.

211. What are the causes of bronchial asthma?
i. Inflammation of air passage
ii. Hypersensitivity due to allergic substances
iii. Pulmonary edema.

212. What are the features of bronchial asthma?
i. Increase in residual volume and functional residual capacity
ii. Reduction in tidal volume, vital capacity, FEV_1, alveolar ventilation and partial pressure of oxygen in blood
iii. Acidosis
iv. Dyspnea
v. Cyanosis.

213. What is pulmonary edema?
Pulmonary edema is the accumulation of serous fluid in alveoli and interstitial tissue of lungs.

214. What are the causes for pulmonary edema?
i. Increased pulmonary capillary pressure
ii. Pneumonia.
iii. Breathing harmful chemicals like chlorine or sulfur dioxide.

215. What are the effects of pulmonary edema?
i. Severe dyspnea, cough with frothy bloodstained expectoration, cyanosis and cold extremities
ii. Chronic interstitial edema leads to asthma
iii. Alveolar edema is fatal and causes sudden death due to suffocation.

216. What is pleural effusion? What are its causes?
Pleural effusion is the accumulation of large amount of fluid in pleural cavity.
Causes for pleural effusion:
i. Blockage of lymphatic drainage
ii. Excessive transudation of fluid from pulmonary capillaries
iii. Inflammation of pleural membrane

217. What is pulmonary tuberculosis?
It is the disease caused by tubercle bacilli.

218. What are the features of pulmonary tuberculosis?
Initially, alveoli in the affected part become non-functioning, due to thickness of respiratory membrane.

If a large part of lungs is involved, the diffusing capacity is very much reduced.

In severe conditions, the destruction of the lung tissue is followed by formation of large abscess cavities.

219. What is emphysema?
Emphysema is an obstructive respiratory disease in which lung tissue especially alveolar membrane is damaged. Damage of lung tissues results in loss of alveolar walls and loss of recoiling of lungs.

220. What are the various factors affecting the body at high altitude?

i. Hypoxia
ii. Expansion of gases
iii. Reduced atmospheric temperature
iv. Light rays.

221. Why does hypoxia develop at high altitude?

Because of low atmospheric pressure (barometric pressure) in high altitude, the partial pressure of oxygen decreases causing hypoxia.

222. What are the effects of hypoxia at high altitude?

Refers questions 167 and 168 of this Chapter for answer.

223. What is mountain sickness?

Mountain sickness is the condition characterized by adverse effects of hypoxia at high altitude. It is common in persons going to high altitude for the first time.

224. What are the symptoms of mountain sickness?

i. Digestive system: Loss of appetite, nausea and vomiting.
ii. Cardiovascular system: Heart rate and force of contraction of heart increase.
iii. Respiratory system: Breathlessness caused by pulmonary edema due to hypoxia.
iv. Nervous system: Headache, depression, disorientation, irritability, lack of sleep, weakness and fatigue.

225. What is acclimatization?

Acclimatization refers to adaptations or the adjustments of the body to high altitude.

226. What are the important changes in the body during acclimatization?

i. Blood: Increase in red blood cell count, hemoglobin content and oxygen carrying capacity of blood.
ii. Cardiovascular system: Increase in blood flow to vital organs like heart, brain and muscles due to increased heart rate and cardiac output.
iii. Respiration: Increase in rate and force of respiration, pulmonary ventilation, pulmonary blood flow, diffusing capacity of gases in alveoli and uptake of oxygen in blood.
iv. Tissues: Increase in the quantity of oxidative enzyme necessary for metabolism.

227. What is nitrogen narcosis? When does it occur?

Narcosis refers to unconsciousness or stupor produced by drugs. Stupor refers to lethargy with suppression of sensations and feelings.

Nitrogen narcosis means narcotic effect produced by nitrogen at high pressure.

It occurs in persons like deep sea divers or underwater tunnel workers who breathe pressurized air under high pressure.

228. What are the symptoms of nitrogen narcosis?

First symptom starts appearing at a depth of 120 feet. The person becomes very jovial, careless and does not understand the seriousness of the conditions.

At the depth of 150 to 200 feet, the person becomes drowsy.

At 200 to 250 feet depth, the person becomes extremely fatigued and weak. There is loss of concentration and judgment. Ability to perform skilled work or movements is also lost.

Beyond the depth of 250 feet, the person becomes unconscious.

229. Define decompression sickness. What are its other names?

Decompression sickness is the disorder that occurs when a person returns rapidly to normal surroundings (atmospheric pressure) after staying for a long time in a place with high atmospheric pressure like deep sea.

Other names of this disease:

i. Compressed air sickness
ii. Caisson sickness
iii. Bends
iv. Divers palsy.

230. Explain the cause for decompression sickness briefly.

High barometric pressure at deep sea compresses the gases causing reduction in the volume of the gases. Oxygen is utilized and carbon dioxide is expired. But since nitrogen is an inert gas it is neither utilized nor expired. So, after compression it escapes from blood and gets dissolved in fat of the tissues and tissue fluid.

When the person ascends rapidly to atmospheric pressure, nitrogen is decompressed and escapes from tissues in the form of bubbles. The bubbles obstruct the blood flow producing the embolism and decompression sickness.

231. What are the symptoms of decompression sickness?

i. Severe pain in tissues, particularly the joints, produced by nitrogen bubbles in the myelin sheath of sensory nerve fibers
ii. Sensation of numbness, tingling or pricking (paresthesia) and itching
iii. Temporary paralysis due to nitrogen bubbles in myelin sheath of motor nerve fibers
iv. Muscle cramps associated with severe pain
v. Occlusion of coronary arteries followed by coronary ischemia, caused by bubbles in the blood
vi. Occlusion of blood vessels in brain and spinal cord also
vii. Damage of tissues of brain and spinal cord because of obstruction of blood vessels by the bubbles
viii. Dizziness, paralysis of muscle, shortness of breath and choking
ix. Finally, fatigue, unconsciousness and death.

232. How is decompression sickness prevented?

While ascending from deep sea, ascent should be very slow with short stay at regular intervals. The person affected by decompression sickness is treated by recompression first and then he is brought slowly to atmospheric pressure.

233. What is SCUBA?

SCUBA or self-contained underwater breathing apparatus is the apparatus used by deep sea divers and the underwater tunnel workers to prevent the ill effects of increased barometric pressure in deep sea or tunnels.

234. What are the effects of sudden exposure of the body to cold?

When body is exposed to cold, large amount of heat is produced by increased metabolic activities and shivering.

When the body is exposed to severe cold, the temperature regulating mechanism fails causing frostbite. And sleep or coma occurs.

235. What is frostbite?

Frostbite is freezing of surface of the body due to exposure to severe cold. It is common in ear lobes and digits of hands and feet.

236. What are the effects of exposure of the body to heat?
i. Heat exhaustion
ii. Dehydration
iii. Heat cramps
iv. Heat stroke.

237. What is heat stroke?
Heat stroke is an abnormal type of hyperthermia that occurs during exposure to extreme heat. It is characterized by increased body temperature increases above 41°C (106°F), accompanied by some physical and neurological symptoms.

238. What are the effects of heat stroke?
Effects of heat stroke are dizziness, abdominal pain and unconsciousness.

If not treated immediately, damage of brain tissue occurs resulting in death.

239. What is sunstroke?
Sunstroke is the hyperthermia caused by prolonged exposure of the body to sun during summer in desert or tropical areas.

240. What are the conditions (indications) when artificial respiration is required?
Artificial respiration is required whenever there is arrest of breathing without cardiac failure.
Arrest of breathing occurs during:
i. Accidents
ii. Drowning
iii. Gas poisoning
iv. Electric shock
v. Anesthesia.

241. What are the methods of artificial respiration?
i. Manual methods:
   a. Mouth to mouth breathing method
   b. Holger Nielsen (back pressure arm lift) method.
ii. Mechanical methods:
   a. Drinker's method
   b. Ventilator method.

242. What are the effects of exercise on respiratory system?
i. Increase in pulmonary ventilation
ii. Increase in diffusing capacity of oxygen
iii. Increase in the amount of oxygen consumption
iv. Increase in oxygen debt
v. Increase in VO_2 max.

243. What is oxygen debt?
Oxygen debt is the extra amount of oxygen required by the muscles during recovery from severe muscular exercise.

244. What is VO_2 max? Give values.
VO_2 max is the amount of oxygen consumed under maximal aerobic metabolism is called. It is the product of cardiac output and maximal amount of oxygen consumed by the muscles.

245. Give values of VO_2 max?
During resting condition:
In males : 35 to 40 mL/kg body weight/minute
In females : 30 to 35 mL/kg body weight/minute
During exercise:
It increases by 50%.

246. What is respiratory quotient?
Respiratory quotient is the ratio between the volume of carbon dioxide expired and volume of oxygen consumed.

247. Give values of respiratory quotient?
In resting condition : 0.8
During exercise : 1.5 to 2.00.

Section 10 Nervous System

1. **What are the divisions of nervous system?**
   i. Central nervous system (CNS) that includes brain and spinal cord.
   ii. Peripheral nervous system (PNS) that includes:
      a. Somatic nervous system that is concerned with movements
      b. Autonomic nervous system (ANS) that is concerned with visceral functions

2. **What are the parts of the brain?**
   i. Prosencephalon (fore forebrain) that is divided into:
      a. Telencephalon which includes two cerebral hemispheres
      b. Diencephalon which includes thalamus, hypothalamus, metathalamus and subthalamus.
   ii. Mesencephalon (midbrain).
   iii. Rhombencephalon (hindbrain) that is divided into:
      a. Metencephalon which includes pons and cerebellum
      b. Myelencephalon or medulla oblongata.

3. **What are the coverings of brain and spinal cord?**
   Brain and spinal cord are covered by three layers of meninges called the outer dura mater, middle arachnoid mater and inner pia mater.
   The space between arachnoid mater and pia mater is known as subarachnoid space. This space is filled with a fluid called cerebrospinal fluid. Brain and spinal cord are actually suspended in the cerebrospinal fluid.

4. **What are the coverings of nerve?**
   i. Epineurium: Tubular sheath which covers the whole nerve. Epineurium is formed by an areolar membrane.
   ii. Perineurium: Covering of each fasciculus of nerve fibers.
   iii. Endoneurium: Covering of each nerve fiber.

5. **What are the parts of brainstem?**
   i. Midbrain
   ii. Pons
   iii. Medulla oblongata.

6. **Define neuron or nerve cell.**
   Neuron or nerve cell is defined as the structural and functional unit of the nervous system.

7. **Classify the neurons.**
   Neurons are classified by three different methods:
   i. Depending upon number of poles:
      a. Unipolar neurons
      b. Bipolar neurons.
      c. Multipolar neurons.
   ii. Depending upon the function:
      a. Motor neurons
      b. Sensory neurons.
   iii. Depending upon length of axon:
      a. Golgi type I neurons
      b. Golgi type II neurons.

8. **Name the coverings of nerve.**
   i. Epineurium: A tubular sheath which covers the whole nerve. Epineurium is formed by an areolar membrane.
   ii. Perineurium: Covering of each fasciculus.
   iii. Endoneurium: Covering of each nerve fiber.

9. **Name the parts of a neuron.**
   i. Nerve cell body or soma
   ii. Dendrite
   iii. Axon.

10. **What are the important structures present in nerve cell body of the neuron?**
    Nucleus, Nissl bodies, neurofibrills, mitochondria and Golgi apparatus.

11. **What are Nissl bodies? What is their function?**
    Nissl bodies are the small granules present throughout the soma of neuron and dendrites but not in axon hillock and axon. Nissl bodies are responsible for the tigroid or spotted appearance of soma.
    Nissl bodies contain ribosomes and are concerned with synthesis of proteins in the neuron.

12. **What are the processes of neuron?**
    i. Dendrite: Short process that carries the impulses towards the cell body.
    ii. Axon: Long process that carries the impulses away from the cell body.

13. **What are the nerves fibers?**
    Nerve fibers are the processes of a neuron i.e. dendrites and axons.

14. **Mention the number of axon and dendrite in each neuron.**
    Each neuron has only one axon. Dendrite may be absent or present. If present, it may be one or many in number.

15. **What is axoplasm?**
    Axoplasm is the long central core of cytoplasm of the axon.

16. **What is axolemma?**
    Axolemma is the tubular sheath like membrane that covers the axon. It is the continuation of membrane of nerve cell body.

17. **What is axis cylinder?**
    Axoplasm and the axolemma that covers the axon are together called axis cylinder.

18. **What is myelin sheath?**
    Myelin sheath is a thick tubular sheath covering the axis cylinder.

19. **What is node of Ranvier? And what is internode?**
    Node of Ranvier is the part of axon where myelin sheath is absent.
    Internode is the segment of axon between the two nodes.

20. What are the functions of myelin sheath?

i. It is responsible for faster rate of conduction of impulses through nerve fiber. In myelinated nerve fiber, the impulses are conducted by means of saltatory conduction.

ii. It has a high insulating capacity. Because of this it restricts the nerve impulse within the single nerve fiber and prevents stimulation of neighboring nerve fibers.

21. What is myelinogenesis?

Myelinogenesis is the process by which myelin sheath is formed around axon.

22. What are the Schwann cells? What is their function?

Schwann cells are a type of cells present in neurilemma close to axolemma.

Schwann cells are responsible for the development of the myelin sheath.

23. What is neurilemma? What is its function?

Neurilemma (neurilemmal sheath or Schwann sheath) is the thin membrane that forms the outer most covering of the nerve fibers of peripheral nervous system. It contains Schwann cells and so it is essential for myelinogenesis.

24. What are dendritic spines? What is their function?

Dendrites have many small neuronal protrusions called dendritic spines from their surfaces. Dendritic spines form the site on contract in a synapse. The shape of dendritic spines constantly changes. It is suggested the change in shape of the spines may form the basis of memory.

25. Which cells are responsible for myelinogenesis?

Peripheral nervous system: Schwann cells present in neurilemma.

Central nervous system: Neuroglial cells called oligodendroglia since neurilemma is absent in central nervous system.

26. What are neurotrophins or neurotrophic factors?

Neurotrophins or neurotrophic factors are the protein substances which play an important role in growth and functioning of nerve tissue.

27. What are sources of neurotrophins secretion?

Neurotrophins are secreted by many tissues in the body particularly muscles, neurons and neuroglial cells called astrocytes.

28. What are the functions of neurotrophins?

i. Facilitate initial growth and development of nerve cells in central and peripheral nervous system

ii. Promote survival and repair of the nerve cells

iii. Play an important role in the maintenance of nervous tissue and neural transmission.

29. Name some neurotrophins?

i. Nerve growth factor

ii. Brain-derived neurotrophic growth factor

iii. Ciliary neurotrophic factor

iv. Glial cell line-derived neurotrophic factor

v. Fibroblast growth factor

vi. Neurotrophin-3.

30. What is nerve growth factor (NGF) ? What are its functions?

Nerve growth factor (NGF) is a neurotrophin found in peripheral tissues.

Functions:

i. NGF promotes early growth and development of neurons.

ii. Commercial preparation of NGF extracted from snake venom and submaxillary glands of male mouse is used to treat sympathetic neuron diseases.

iii. NGF plays an important role in treating many nervous disorders such as Alzheimer's disease, neuron degeneration in aging and neuron regeneration in spinal cord injury.

31. Classify the nerve fibers.

Nerve fibers are classified by six different methods:

i. Depending upon the structure:
   a. Myelinated nerve fibers
   b. Nonmyelinated nerve fibers.

ii. Depending upon distribution:
   a. Somatic nerve fibers
   b. Autonomic nerve fibers.

iii. Depending upon source of origin:
   a. Cranial nerve fibers
   b. Spinal nerve fibers.

iv. Depending upon the functions:
   a. Motor nerve fibers
   b. Sensory nerve fibers.

v. Depending upon neurotransmitter secreted by them:
   a. Adrenergic nerve fibers
   b. Cholinergic nerve fibers.

vi. Depending upon the diameter and rate of conduction of impulse: Erlanger- Gasser classification.
   a. Type A fibers
   b. Type B fibers
   c. Type C fibers.

Type A fibers are again divided into A alpha, A beta, A gamma and A delta nerve fibers.

32. Name the nerve fibers conducting the impulse with maximum and minimum velocity.

Type A alpha nerve fibers conduct the impulse with maximum velocity (70 to 120 meters/second)

Type C fibers conduct the impulse with minimum velocity (0.5 to 2 meters/second).

33. Name the properties of nerve fibers.

i. Excitability

ii. Conductivity

iii. Refractory period

iv. Summation

v. Adaptation

vi. Infatigability

vii. All or none law.

34. What are the two types of potentials noticed in nerve fibers?

i. Action potential (nerve impulse): Produced when the nerve is stimulated with adequate strength of stimulus (threshold or minimal stimulus). It is propagated and nongraded.

ii. Electrotonic potential or local response: Produced when the strength of stimulus is not adequate (subthreshold or subminimal stimulus). It is nonpropagated and graded.

35. How much is the resting membrane potential in a nerve fiber?

About – 70 mV.

36. Name the properties of action potential.

i. Propogative

ii. Biphasic

iii. All or none law

iv. No summation

v. Refractory period.

37. What is saltatory conduction? In which nerve fiber does it occur?

Saltatory conduction is the form of conduction of nerve impulse in which the impulse jumps from one node of Ranvier to another node of Ranvier (saltare = jumping).

It occurs in myelinated nerve fiber.

38. What is the significance of saltatory conduction?

Because of saltatory conduction, the conduction of impulse through a myelinated nerve fiber is 50 times faster than in non-myelinated nerve fiber.

39. Explain the mechanism of saltatory conduction briefly.

Myelin sheath is not permeable to ions. So, during conduction of action potential, the entry of sodium ions from extracellular fluid into nerve fiber occurs only at the node of Ranvier, where the myelin sheath is absent. This causes depolarization only in successive node and not in internode. So, the action potential jumps from one node to another.

40. Why is the nerve fiber not fatigued?

Nerve fiber is not fatigued because it can conduct only one action potential at a time. At that time, it is completely refractory and cannot conduct another action potential.

41. What are the conditions when nerve fiber is injured?

i. Obstruction of blood flow
ii. Local injection of toxic substances
iii. Crushing of nerve fiber
iv. Transection of nerve fiber.

42. Mention Sunderland's classification of injury to nerve fibers?

First degree injury or Seddon neuropraxia: Caused by applying pressure over a nerve for short period leading to occlusion of blood flow and hypoxia. It is not a true degeneration. Axon loses function temporarily for a short time. Function returns within few hours to few weeks.

Second degree injury or axonotmesis: It is to prolonged severe pressure, which causes Wallerian degeneration. Endoneurium is intact. Repair and restoration of function take about 18 months.

Third degree injury: Edoneurium is interrupted. After degeneration, the recovery is slow and poor or incomplete.

Fourth degree injury: It is more severe. Epineurium and perineurium are also interrupted. Fasciculi of nerve fibers are disturbed and disorganized. Regeneration is poor or incomplete.

Fifth degree of injury: Involves complete transaction of the nerve trunk with loss of continuity. Useful regeneration is not possible unless the cut ends are rearranged and approximated quickly by surgery.

Third, fourth and fifth degrees of injury are called neurotmesis.

43. Define degenerative changes? Classify degenerative changes in neuron.

Degeneration refers to deterioration or impairment or pathological changes of an injured tissue. When a nerve fiber is injured, the degenerative changes occur in the nerve cell body and the nerve fiber of same neuron and the adjoining neuron.

Degenerative changes are classified into three types:

i. Wallerian degeneration
ii. Retrograde degeneration
iii. Transneuronal degeneration.

44. What is Wallerian degeneration or orthograde degeneration?

Wallerian degeneration is the pathological change that occurs in distal cut end of nerve fiber (axon).

45. Explain the changes during Wallerian degeneration briefly.

i. Axis cylinder swells and breaks up into small pieces. After few days, the debris is seen in the space that was occupied by the axis cylinder
ii. Myelin sheath disintegrates into fat droplets
iii. Neurilemmal sheath is not affected but the cells of Schwann multiply rapidly. Macrophages invade remove the debris of axis cylinder and fat droplets. So neurilemmal tube becomes empty and it is filled with cytoplasm of Schwann cell.

46. What is retrograde degeneration or orthograde degeneration?

Wallerian degeneration is the pathological change that occurs in nerve cell body and axon proximal to cut end.

47. What are the changes, which take place in nerve cell body during degeneration of nerve fiber?

i. Nissl granules disintegrate by chromatolysis
ii. Golgi apparatus disintegrates
iii. Cell body swells due to accumulation of fluid and becomes round
iv. Neurofibrils disappear
v. Nucleus is displaced towards the periphery. In extreme conditions, nucleus is extruded out of the cell.

48. What are the changes, which take place in proximal cut end of axon during degeneration?

In axon, changes occur only up to first node of Ranvier from the site of injury. Degenerative changes that occur in proximal cut end of axon are similar to those changes occurring in distal cut end of the nerve fiber.

49. What is transneuronal degeneration?

If an afferent nerve fiber is cut, the degeneration occurs in the neuron with which the afferent nerve fiber synapses. This is called transneuronal degeneration.

50. Give examples of retrograde degeneration?

i. Chromatolysis in the cells of lateral geniculate body occurs due to sectioning of optic nerve.
ii. Degeneration of cells in dorsal horn of spinal cord occurs when the posterior nerve root is cut.
iii. Degeneration of cells in ventral horn of spinal cord occurs when there is tumor in cerebral cortex.

51. What is regeneration?

Regeneration refers to regrowth of lost or destroyed part of a tissue.

52. What are the criteria for regeneration of nerve fiber?

i. Gap between the cut ends of the nerve fiber should not exceed 3 mm
ii. Neurilemma should be present
iii. Nucleus must be intact
iv. Both the cut ends should remain in the same line.

53. Why regeneration does not occur in central nervous system?

Neurilemma is necessary for regeneration. But neurilemma is absent in central nervous system, so regeneration cannot take place.

54. Define neuroglial cell, neuroglia or glia.

Neuroglial cell, neuroglia or glia is the supporting cell of the nervous system.

55. Classify neuroglial cells.

i. Central neuroglial cells in nervous system:
   a. Astrocytes, which are divided into two subtypes, fibrous astrocytes and protoplasmic astrocytes
   b. Microglia
   c. Oligodendrocytes.
ii. Peripheral neuroglial cells:
   a. Schwann cells
   b. Satellite cells.

56. What are the functions of astrocytes?

i. Form the blood–brain barrier
ii. Form the supporting network in brain and spinal cord
iii. Maintain the chemical environment of ECF around CNS neurons
iv. Provide calcium and potassium ions in brain
v. Regulate neurotransmitter level in synapses and regulate recycling of neurotransmitter during synaptic transmission.
vi. Secrete neurotrophins which promote growth and function of nervous tissue.

57. What are the functions of microglia?

i. Migrate to the injured or infected area of CNS and act as miniature macrophages
ii. Engulf and destroy the microorganisms and cellular debris by phagocytosis
iii. Provide immune and inflammatory response during damage of brain tissues.

58. What are the functions of oligodendrocytes?

i. Provide myelination around the nerve fibers in CNS
ii. Provide support to the CNS neurons by forming a semi-stiff connective tissue between the neurons.

59. What are the functions of Schwann cells?

i. Provide myelination (insulation) around the nerve fibers in peripheral nervous system
ii. Play important role in nerve regeneration
iii. Scavenge cellular debris during regeneration by phagocytosis.

60. What are the functions of satellite cells?

i. Provide physical support to the neurons of peripheral nervous system
ii. Help in regulation of chemical environment of ECF around the neurons of peripheral nervous system.

61. Define receptors.

Receptors are sensory (afferent) nerve ending that give response to sensory stimuli. The sensory nerve endings terminate in periphery as bare unmyelinated ending or in the form of specialized capsulated structures.

Receptors are often defined as the biological transducers, which convert various forms of energy (stimuli) in the environment into action potentials in nerve fiber.

62. Classify receptors.

i. Exteroceptors which give response to stimuli arising from outside the body.
   Divided into three types:
   a. Cutaneous receptors
   b. Chemoreceptors
   c. Telereceptors.
ii. Interoceptors which give response to stimuli arising from within the body.
   Divided into two types:
   a. Visceroreceptors
   b. Proprioceptors.

63. Define and classify cutaneous receptors or mechanoreceptors?

Cutaneous receptors are the receptors situated in the skin. These receptors are mechanoreceptors because of their response to mechanical stimuli.

Cutaneous receptors are of four types:

i. Touch receptors: Meissner's corpuscle and Merkel's disc
ii. Pressure receptors: Pacinian corpuscle
iii. Temperature or thermoceptors: Krause's end organ for cold and Raffini's end organ for warm
iv. Pain receptors or nociceptors: Free (naked) nerve ending.

64. What are chemoreceptors, which belong to the group of exteroceptors?

Chemoreceptors are the receptors giving response to chemical stimuli. Chemoreceptors, which belong to the group of exteroceptors are taste receptors in taste buds and olfactory receptors for smell in the nose.

65. Define and classify teleceptors or distant receptors?

Teleceptors or distant receptors are the receptors, which give response to stimuli arising away from the body are called telereceptors.

Telereceptors are: of two types:

i. Hair cells of organ of Corti in the ear for hearing
ii. Rods and cones of retina in the eye for vision.

66. Define and classify visceroreceptors?

Visceroreceptors are the receptors situated in the viscera. These receptors are situated in heart, blood vessels, lungs, gastrointestinal tract, urinary bladder and brain.

Visceroreptors are of four types:

i. Stretch receptors
ii. Baroreceptors
iii. Chemoreceptors
iv. Osmoreceptors.

67. Define and classify the proprioceptors.

Proprioceptors are the receptors, which give response to change in the position of different parts of the body.

Proprioceptors are of two types:

i. The receptors in labyrinthine apparatus
ii. Muscle spindle, Golgi tendon organ, Pacinian corpuscles and free nerve endings, which are situated in muscle, tendon, ligament, fascia and joints.

68. Enumerate the properties of receptors.

i. Specificity of response: Müller law
ii. Adaptation
iii. Response to increase in strength of stimulus: Weber-Fechner law
iv. Sensory transduction
v. Receptor potential.

69. What is specificity of response or Müller law?

Specificity of response or Müller law refers to response given by a particular type of receptor to a specific sensation. For example, pain receptors give response only to pain sensation. In addition, each type of sensation depends upon the part of the brain in which its fibers terminate.

70. What is adaptation?

Adaptation is the decline in discharge of sensory impulses when a receptor is stimulated continuously with constant strength. It is also called sensory adaptation or desensitization.

71. How receptors are classified based on adaptation? Give examples.

On the basis of adaptation, receptors are classified into two types:

i. Phasic receptors which get adapted rapidly
Examples: Touch and pressure receptors
ii. Tonic receptors, which adapt slowly
Examples: Pain receptors and muscle spindle are tonic receptors.

72. How will you explain the response to increase in strength of stimulus? What is Weber-Fechner law?

During stimulation of a receptor, if the response given by the receptor is to be doubled, strength of stimulus must be increased 100 times. This phenomenon is called Weber-Fechner law, which states that intensity of response (sensation) of a receptor is directly proportional to logarithmic increase in the intensity of stimulus.

73. What is sensory transduction?

Sensory transduction in a receptor is a process by which the energy (stimulus) in the environment is converted into electrical impulses (action potentials) in nerve fiber (transduction = conversion of one form of energy into another).

When a receptor is stimulated, it gives response by sending information about the stimulus to CNS. Series of events occur to carry out this function such as the development of receptor potential in the receptor cell and development of action potential in the sensory nerve.

74. What is receptor potential or generator potential?

Receptor potential or generator potential is a non-propagated transmembrane potential difference that develops when a receptor is stimulated.

75. Enumerate the properties of receptor potential.

i. Non-propagated.
ii. Does not obey all or none law.

76. What is law of projection? Give example. What is phantom limb?

When a sensory pathway from receptor to cerebral cortex is stimulated on any particular site along its course, the sensation caused by stimulus is always felt (referred) at the location of receptor, irrespective of site stimulated. This phenomenon is known as law of projection.

Examples:

i. If somesthetic area in right cerebral cortex, which receives sensation from left hand, is stimulated, sensations are felt in left hand and not in head.
ii. Sensation complained by amputated patients in the missing limb (phantom limb) is the best example of law of projection. For example, if a leg has been amputated, the cut end heals with scar formation. The cut ends of nerve fibers are merged within the scar.

If the cut ends of sensory fibers are stimulated during movement of thigh, the patient feels as if the sensation is originating from non-existent leg. Sometimes, the patient feels pain in non- existent limb. This type of pain is called phantom limb pain.

77. What is synapse?

Synapse is the junction between two neurons through which the nerve impulse passes from one neuron to another neuron. It is only a physiological continuity between two nerve cells and not the anatomical continuation.

78. Classify synapse?

Synapse is classified by two methods:

i. Anatomical classification: Synapse is divided into three types depending upon the axon ending:
   a. Axosomatic synapse
   b. Axodendritic synapse
   c. Axoaxonic synapse.
ii. Functional classification: Synapse is divided into two types depending upon the transmission of impulses:
   a. Electrical synapse
   b. Chemical synapse.

79. What is electrical synapse?

Electrical synapse is the synapse in which the physiological continuity between the presynaptic and postsynaptic neurons is provided by gap junction between two neurons.

80. What is chemical synapse?

Chemical synapse is the junction between a nerve fiber and a muscle fiber or between two nerve fibers, through which the signals are transmitted by the release of chemical transmitter.

81. Explain the structure of axosomatic (chemical) synapse briefly.

Axon of presynaptic neuron divides into many presynaptic terminals. This has a covering membrane called presynaptic membrane. Presynaptic terminal contains mitochondria and the synaptic vesicles. Synaptic vesicles contain neurotransmitter substance. Membrane of postsynaptic neuron is called postsynaptic membrane. It contains receptor proteins. Space between presynaptic and postsynaptic membrane is called synaptic cleft. Basal lamina of synaptic cleft contains cholinesterase.

82. What is the function of synapse?

Main function of synapse is to transmit the impulses, i.e. action potential from one neuron to another. However, some of the synapses inhibit the transmission of impulses. Thus, synapses are of two types:

i. Excitatory synapse that transmits the impulses: Excitatory function
ii. Inhibitory synapse that inhibits the transmission of impulses: Inhibitory function.

83. Explain the synaptic transmission briefly.

When action potential reaches the presynaptic axon terminal, voltage gated calcium channels at the pre-synaptic membrane open and calcium ions enter the terminal. This causes release of acetylcholine from synaptic vesicles.

Acetylcholine passes through pre-synaptic membrane and synaptic cleft and binds with receptor protein present on postsynaptic membrane. Acetylcholine receptor complex opens ligand gated sodium channels so that, sodium ions enter the synapse, i.e. soma. This produces excitatory postsynaptic potential (EPSP), which in turn causes development of action potential in the initial segment of axon of postsynaptic neuron.

84. What is excitatory postsynaptic potential (EPSP)?

Excitatory postsynaptic potential is a non-propagated electrical potential that develops during the process of synaptic transmission.

85. What are the properties of EPSP?

i. Non-propagated
ii. Does not obey all or none law.

86. What is the significance of EPSP?
EPSP causes development of action potential in the initial segment of axon of postsynaptic neuron. Actually, EPSP opens sodium channels in the initial segment of axon so that sodium ions enter the axon from ECF resulting in development of action potential.

87. Name the types of synaptic inhibition.
i. Postsynaptic or direct inhibition
ii. Presynaptic or indirect inhibition
iii. Renshaw cell or negative feedback inhibition
iv. Feedforward inhibition
v. Reciprocal inhibition.

88. What is postsynaptic inhibition?
Postsynaptic inhibition is a type of synaptic inhibition that occurs due to the release of an inhibitory neurotransmitter from presynaptic terminal instead of an excitatory neurotransmitter substance.

89. What is inhibitory postsynaptic potential (IPSP)?
Inhibitory postsynaptic potential (IPSP) is the electrical potential in the form of hyperpolarization that develops during postsynaptic potential. Hyperpolarized state in synapse inhibits synaptic transmission.

90. What is presynaptic or indirect inhibition?
Presynaptic or indirect inhibition is a type of synaptic inhibition that occurs due to failure of presynaptic axon terminal to release sufficient quantity of excitatory neurotransmitter substance.

91. What is Renshaw cell or negative feedback inhibition?
Renshaw cell or negative feedback inhibition is a type of synaptic inhibition that is caused by Renshaw cells in spinal cord.

Renshaw cell is a type of motor neuron situated near alpha motor neuron in anterior gray horn. When alpha motor neuron of spinal cord sends motor impulses via anterior nerve root fibers, some of the impulses reach the Renshaw cell by passing through collateral fibers. Renshaw cell in turn sends inhibitory impulses to alpha motor neuron so that, the discharge from motor neuron is reduced.

92. What is feedforward inhibition?
Feedforward inhibition is a type of synaptic inhibition that occurs in cerebellum. It controls the neuronal activity in cerebellum.

93. What is reciprocal inhibition?
Reciprocal inhibition is the inhibition of antagonistic muscle when a group of muscles are activated. It is because of reciprocal innervation.

94. What is the significance of synaptic inhibition?
Synaptic inhibition in limits the number of impulses going to muscles and enables the muscles to act appropriately. Thus, the inhibition helps to select exact number of impulses and to omit or block the excess ones so that, various movements in the body are performed properly and accurately.

95. List the properties of synapse.
i. One way conduction: Bell-Magendie law
ii. Synaptic delay
iii. Fatigue
iv. Summation
v. Electrical property: EPSP or IPSP.

96. What is Bell-Magendie law?
According to Bell-Magendie law, the impulses are transmitted only in one direction in synapse, i.e. from presynaptic neuron to postsynaptic neuron.

97. What is synaptic delay? And, what is its cause?
Synaptic delay is a short delay that occurs during the transmission of impulses through synapse. It is one of the causes for reaction time of reflex activity.
Synaptic delay is due to the time taken for:
i. Release of neurotransmitter
ii. Movement of neurotransmitter from axon terminal to postsynaptic membrane
iii. Action of neurotransmitter to open ionic channels in postsynaptic membrane.

98. What is the normal duration of synaptic delay?
Normal duration of synaptic delay: 0.3 to 0.5 milliseconds.

99. What is the cause for fatigue in synapse?
Fatigue at synapse is due to depletion of neurotransmitter substance acetylcholine.

100. What are the causes for depletion of acetylcholine during fatigue in synapse?
i. Soon after its action, acetylcholine is destroyed by acetylcholinesterase
ii. Due to continuous action, new acetylcholine is not synthesized.

101. What is summation in synapse?
Summation in a synapse is the fusion or aggregation of many similar impulses or stimuli. Single impulse cannot produce any response in the synapse. But many impulses can collectively cause a response.

In other words, it is the fusion of effects or progressive increase in the excitatory postsynaptic potential in postsynaptic neuron.

102. What are the types of summation?
i. Temporal summation that occurs when one presynaptic terminal is stimulated repeatedly
ii. Spatial summation that occurs when many presynaptic terminals are stimulated simultaneously.

103. Define neurotransmitter.
Neurotransmitter is chemical substance that acts as a mediator for transmission of nerve impulse from one neuron to another neuron through a synapse.

104. Classify neurotransmitters depending upon their chemical nature.
Neurotransmitters are classified into three types depending upon their chemical nature:
i. Amino acids:
   a. GABA
   b. Glycine
   c. Glutamate
   d. Aspartate.
ii. Amines:
   a. Noradrenaline
   b. Adrenaline
   c. Dopamine
   d. Serotonin
   e. Histamine.
iii. Others:
   a. Nitric oxide
   b. Acetylcholine.

105. Classify neurotransmitters depending upon their function.

Neurotransmitters are classified into two types depending upon their function:

i. Excitatory neurotransmitters
ii. Inhibitory neurotransmitters.

106. Name some excitatory neurotransmitter substances.

i. Acetylcholine
ii. Nitric oxide
iii. Histamine
iv. Glutamate
v. Aspartate.

107. Name some inhibitory neurotransmitter substances.

i. Gamma-amino butyric acid (GABA)
ii. Glycine
iii. Dopamine
iv. Serotonin.

108. Name the neurotransmitters having both excitatory and inhibitory actions.

i. Noradrenaline
ii. Adrenaline.

109. Define neuromodulator.

Neuromodulator is a chemical messenger, which modifies and regulates the activities that take place during the synaptic transmission. It does not propagate nerve impulses like neurotransmitters.

110. What are the functions of neuromodulators?

i. Regulation of synthesis, breakdown or reuptake of neuromodulators
ii. Excitation or inhibition of membrane receptors by acting independently or together with neurotransmitter
iii. Control of gene expression
iv. Regulation of local blood flow
v. Promotion of synaptic formation
vi. Control of glial cell morphology
vii. Regulation of behavior.

111. Classify neuromodulators.

i. Non-opioid neuromodulators
ii. Opioid neuromodulators.

112. Name some non-opioid neuromodulators.

i. Bradykinin
ii. Substance P
iii. Secretin
iv. Cholecystokinin
v. Ghrelin
vi. Gastrin.

113. Name some opioid neuromodulators.

i. Enkephalins
ii. Dynorphins
iii. Endorphins.

114. What are the differences between neurotransmitters and neuromodulators?

Neuromodulators are distinct from neurotransmitters. However, both the terms are wrongly interchanged. Neurotransmitters propagate nerve impulses through synapse, whereas neuromodulators modify and regulate the activities of synaptic transmission.

Neurotransmitters are packed in small vesicles in axon terminals only. But neuromodulators are generally packed in large synaptic vesicles, which are present in all parts of neuron like soma, dendrite, axon and nerve endings. Many neurons have one conventional neurotransmitter and one or more neuromodulators.

Few peptides like substance P (see above) act as neurotransmitters and neuromodulators.

115. What is cotransmission?

Cotransmission is the release of many neurotransmitters from a single nerve terminal.

116. What are cotransmitters? Give examples.

Cotransmitters are the neurotransmitter substances that are released in addition to primary transmitter at the nerve endings.

Examples:

i. Calcitonin
ii. Dopamine
iii. Dynorphin
iv. GABA
v. Glutamate.

117. Define reflex activity.

Reflex activity is the involuntary response to a stimulus.

118. What is reflex arc? Enumerate its components (parts).

Reflex arc is the anatomical neural pathway for a reflex action.

It has five components:

i. Receptor
ii. Afferent or sensory nerve
iii. Center
iv. Efferent or motor nerve
v. Effector organ.

119. What are the methods of classification of reflexes?

Reflexes are classified by five different methods:

i. Depending upon whether inborn or acquired
ii. Depending upon the situation of center
iii. Depending upon the purpose or functional significance
iv. Depending upon number of synapses
v. Depending upon whether somatic or visceral reflexes
vi. Depending upon clinical basis.

120. Classify the reflexes depending upon whether inborn or acquired. Give examples.

i. Inborn or unconditioned reflexes: Natural reflexes which are present at the time of birth. Such reflexes do not require previous learning or training or conditioning. Example: Secretion of saliva when any object is kept in mouth.
ii. Acquired or conditioned reflexes: Reflexes that are developed after training or conditioning. Example: Secretion of saliva by the sight, smell, thought or hearing of a known edible substance.

121. Classify the reflexes depending upon the situation of center (anatomical classification).

i. Cerebellar reflexes
ii. Cortical reflexes
iii. Midbrain reflexes
iv. Bulbar or medullary reflexes
v. Spinal reflexes.

122. Classify the reflexes depending upon the purpose or functional significance (physiological classification).

i. Protective or flexor reflexes or withdrawal reflexes: These are the reflexes which protect the body from nociceptive stimuli.
ii. Antigravity or extensor reflexes: These are the reflexes that protect the body against gravitational force.

123. Classify the reflexes depending upon number of synapses.
i. Monosynaptic reflexes (stretch reflexes)
ii. Polysynaptic reflexes.

124. Classify the reflexes depending upon whether somatic or visceral reflexes.
i. Somatic reflexes: Reflexes, for which the reflex arc is formed by somatic nerve fibers. Such reflexes involve participation of skeletal muscles.
ii. Visceral or autonomic reflexes: Reflexes, for which at least a part of reflex arc is formed by autonomic nerve fibers. These reflexes involve participation of smooth muscle or cardiac muscle.

125. Classify the reflexes depending upon clinical basis.
i. Superficial reflexes: Reflexes, which are elicited from the surface of the body. These reflexes are elicited from:
   a. Cornea or conjunctiva of eye ball
   b. Mucous membrane (mucous membrane reflexes)
   c. Skin (cutaneous reflexes).
ii. Deep reflexes or tendon reflexes: Reflexes elicited from deeper structures beneath skin like tendon
iii. Visceral reflexes: Reflexes arising from pupil and visceral organs
iv. Pathological reflexes: Reflexes elicited only in pathological conditions.

126. Briefly describe superficial reflexes, which are elicited from eyes and mucous membrane.
i. Corneal reflex: Closing of eyelids while touching cornea by a cotton wisp.
ii. Conjunctival reflex: Closing of eyelids while touching conjunctiva by a cotton wisp.
iii. Nasal reflex or sneezing reflex: Sneezing when nasal mucosa is stimulated by a cotton wisp.
iv. Pharyngeal reflex or gag reflex: Elevation of soft palate and retching while touching roof of mouth, back of tongue, uvula, tonsils and back of pharynx by a cotton wisp.

127. Briefly describe superficial reflexes, which are elicited from skin (cutaneous reflexes).
i. Scapular reflex: Contraction of scapular muscles and drawing in of both scapulae due to stimulation of skin at interscapular space.
ii. Upper abdominal reflex: Contraction of abdominal muscle and movement of umbilicus towards site of stimulus, when skin over abdominal wall is stimulated below the costal margin.
iii. Middle abdominal reflex: Contraction of abdominal muscle and movement of umbilicus towards site of stimulus, when skin over abdominal wall is stimulated near umbilicus.
iv. Lower abdominal reflex: Contraction of abdominal muscle and movement of umbilicus towards site of stimulus, when skin over abdominal wall is stimulated at umbilical and iliac level.
v. Cremasteric reflex: Contraction of ipsilateral cremasteric muscle and upward movement of testicle while stroking the skin at upper and inner aspect of thigh.
vi. Gluteal reflex: Contraction of gluteal muscle due to stoking skin over the muscle.
vii. Plantar reflex: Plantar flexion and adduction of toes while stroking the sole from heal towards little toe by a blunt instrument.
viii. Bulbocavernous reflex: Contraction of bulbocavernous muscle due to stroking dorsum of glans penis.
ix. Anal reflex: Contraction of anal sphincter due to stroking the skin over perianal region.

128. Briefly describe deep reflexes (tendon reflexes).
i. Jaw jerk: Closure of mouth by tapping the middle of chin with slightly opened mouth.
ii. Biceps jerk: Contraction of biceps muscle and slight flexion at elbow by tapping biceps tendon.
iii. Triceps jerk: Contraction of triceps muscle and slight extension of forearm by tapping triceps tendon.
iv. Supinator jerk or brachioradialis reflex: Supination and slight flexion of forearm by taping tendon of the muscle over distal end (styloid process) of radius.
v. Knee jerk or patellar tendon reflex: Contraction of quadriceps muscle and extension of leg by taping the patellar tendon.
vi. Ankle jerk or Achilles tendon reflex: Plantar flexion of food by tapping the Achilles tendon.

129. Classify visceral reflexes.
i. Pupillary reflexes
ii. Oculocardiac reflex: Decrease in heart rate by pressure applied over eyeball
iii. Carotid sinus reflex.

130. What is oculocardiac reflex?
Oculocardiac reflex is the reflex in which heart rate decreases by applying pressure over eyeball.

131. What are the pathological reflexes?
i. Babinski reflex
ii. Clonus
iii. Pendular movements.

132. What is Babinski reflex or Babinski sign?
Babinski reflex is the extension of great toe and fanning (abduction) of other toes caused by stroking the sole from heal towards little toe by a blunt instrument. It is the abnormal plantar reflex.

133. What are the conditions when Babinski sign appears?
i. Upper motor neuron lesion
ii. Deep sleep
iii. Infants up to 2 years.

134. What is clonus? When does it occur? What are the common types of clonus?
Clonus is a series of rapid and repeated involuntary jerky movements, which occur while eliciting a deep reflex. It occurs in upper motor neuron lesion, multiple sclerosis, Huntington disease, meningitis, cerebral palsy and stroke.
Common types of clonus:
i. Ankle clonus
ii. Patellar clonus.

135. What are pendular movements? When do the pendular movements occur?
Pendular movements are slow oscillatory movements that are developed which eliciting a tendon reflex. It occurs during cerebellar lesion.

136. Mention the properties of reflexes.
i. One way conduction
ii. Reaction time
iii. Summation
iv. Occlusion
v. Subliminal fringe
vi. Recruitment
vii. After discharge

viii. Rebound phenomenon
ix. Fatigue.

137. What is reaction time?

Reaction time is the time interval between application of stimulus and the onset of reflex.

138. What are the types of summation in reflex activity?

i. Spatial summation: When two afferent nerve fibers supplying a muscle are stimulated separately with subliminal stimuli, there is no response. But the muscle contracts when both nerve fibers are stimulated together with same strength of stimulus, the muscle contracts. This is called spatial summation.
ii. Temporal summation: When one nerve is stimulated repeatedly with subliminal stimuli, these stimuli are summed up to give response in the muscle. This is called temporal summation.

139. What is occlusion?

Occlusion is a phenomenon in reflex activity during which, the tension developed in a muscle by simultaneous stimulation of two nerves of the muscle is less than the sum of tension developed by stimulation of these nerves separately.

It is demonstrated in a muscle which is innervated by two motor nerves called A and B.

For example, if nerve A is stimulated alone, the arbitrary unit of tension developed is 9. If nerve B is stimulated the tension developed is 9 units. So, the sum of tension developed when nerves A and B are separately stimulated = 9 + 9 = 18 units. But when, both A and B are stimulated together, the tension produced is (A+B) = 12 units only.

This phenomenon is the occlusion and it is due to the overlapping of the nerve fibers during the distribution.

140. What is subliminal fringe?

Subliminal fringe is another phenomenon in reflex activity during which, the tension developed in the muscle by simultaneous stimulation of two nerves is greater than the sum of tension developed by the stimulation of these nerves separately.

It is demonstrated in a muscle which is innervated by two motor nerves called A and B.

For example, if nerve A or B is stimulated alone, the arbitrary unit of tension developed by muscle = 3 units. So, the sum of tension developed if nerves A and B are stimulated separately is 3+3 = 6 units. But, when both the nerves are stimulated together, the tension developed = (A +B) = 12 units. So, the tension here is greater than the sum of tension produced if A and B are separately stimulated.

This phenomenon is called subliminal fringe and it is due to effect of spatial summation.

141. What is recruitment?

Recruitment is defined as the successive activation of additional motor units with progressive increase in force of muscular contraction. It is similar to the effect of temporal summation.

142. What is after discharge?

After discharge is the persistence or continuation of response for some time even after cessation of stimulus. When a reflex action is elicited continuously for some time, and then the stimulation is stopped, the reflex activity (contraction) may continue for some time even after the stoppage of stimulus.

This is because of internuncial neurons, which continue to transmit afferent impulses even after stoppage of stimulus.

143. What is rebound phenomenon?

Rebound phenomenon is a phenomenon, during which a sudden removal of inhibition to a reflex activity results in great increase in force of the action than it was before inhibition.

Reflex activities can be forcefully inhibited for some time. But, when the inhibition is suddenly removed, the reflex activity becomes more forceful than before inhibition.

144. Which is the first seat of fatigue in reflex arc?

Center or the synapse of the reflex arc is the first seat of fatigue.

145. What is reciprocal inhibition?

Reciprocal inhibition is the inhibition of one group of muscles when the opposite group of muscles are excited while eliciting a reflex activity.

For example, when a flexor reflex is elicited, the agonist muscles (muscles causing movement) i.e. flexor muscles are excited (contracted) and the antagonist muscles (muscles opposing movement) i.e. extensor muscles are inhibited (relaxed).

Reciprocal inhibition occurs because of reciprocal innervation.

146. What is reciprocal innervation?

Reciprocal innervation is a type of innervation of muscles, by which contraction of a group of muscles is accompanied by relaxation of their antagonistic muscles.

147. What is Sherrington law of reciprocal innervation?

According to this law, the reciprocal inhibition is due to segmental arrangement of afferent and efferent connections in the spinal cord. Afferent nerve fibers, which evoke flexor reflex in a limb, have connections with motor neurons supplying flexors and the motor neurons supplying the extensors of same side. Afferent nerve excites the motor neurons, which supply the flexors.

Simultaneously, it also inhibits the motor neurons supplying extensors through an interneuron. Accordingly, the flexor muscles contract and extensor muscles relax resulting in flexion of the limb.

148. What is crossed extensor reflex? What is the cause for it?

Crossed extensor reflex is a withdrawal reflex in which the flexors of withdrawing limb are excited (contracted) and extensors are inhibited (relaxed) while the opposite occurs in the other limb.

It is due to reciprocal innervation.

149. What are the effects of upper and lower motor neuron lesion on reflexes?

During upper motor neuron lesion:
i. All the superficial reflexes are lost
ii. Deep reflexes are exaggerated
iii. Babinski's sign is positive.

During lower motor neuron lesion:
All superficial and deep reflexes are lost.

150. What are the segments of spinal cord?

Spinal cord is made up of 31 segments viz.

Cervical segments	= 8
Thoracic segments	= 12
Lumbar segments	= 5
Sacral segments	= 5
Coccygeal segment	= 1

151. What are the neural substances of spinal cord?
Spinal cord has two types of neural substances:
i. Inner gray matter: Consists of nerve cell bodies, dendrites and parts of axons.
ii. Outer white matter: Consists of myelinated and nonmyelinated nerve fibers.

152. What are the parts of gray matter?
Gray matter is 'H' shaped structure with a canal in the center called spinal canal. Each lateral half of gray matter is divided into ventral (anterior) gray horn and dorsal (posterior) gray horn.

In thoracic segments and first two lumbar segments, the gray matter has lateral horns. Part of gray matter anterior to spinal canal is called anterior gray commissure and the part of gray matter posterior to central canal is called posterior gray commissure.

153. What are the neurons present in gray horns of spinal cord?
Anterior gray horn: Motor neurons.
Posterior gray horn: Sensory neurons.
Lateral gray horn: Intermediolateral horn cells, which give rise to sympathetic preganglionic fibers.

154. Name the types of neurons present in the anterior gray horn.
i. Alpha motor neurons
ii. Gamma motor neurons
iii. Renshaw cells.

155. Name the types of neurons present in the posterior gray horn.
i. Marginal cells
ii. Substantia gelatinosa of Rolando
iii. Chief sensory cells
iv. Clarke's column of cells.

156. What are the white columns of spinal cord?
i. Anterior white column: Between the anterior median fissure on one side and anterior nerve root and anterior gray horn on the other side.
ii. Lateral white column: Between the anterior nerve root and anterior gray horn on one side and posterior nerve root and posterior gray horn on the other side.
iii. Posterior gray column: In between posterior nerve root and posterior gray horn on one side and posterior median septum on the other side.

157. Briefly classify tracts of spinal cord.
i. Short tracts: Connecting different parts of spinal cord itself.
Short tracts are of two types:
a. Association or intrinsic tracts which connect the adjacent segments of spinal cord on the same side
b. Commissural tracts, which connect the opposite halves in the same segment of spinal cord.
ii. Long tracts or projection tracts connecting spinal cord with other parts of central nervous system.
Long tracts are of two types:
a. Ascending tracts which carry sensory impulses from spinal cord to brain
b. Descending tracts, which carry motor impulses from brain to the spinal cord.

158. Enumerate the ascending tracts in spinal card.
i. Anterior white funiculus:
a. Anterior spinothalamic tract.
ii. Lateral white funiculus:
a. Lateral spinothalamic tract
b. Ventral spinocerebellar tract
c. Dorsal spinocerebellar tract
d. Spinotectal tract
e. Fasciculus dorsolateralis
f. Spinoreticular tract
g. Spino-olivary tract
h. Spinovestibular tract
iii. Posterior white funiculus:
a. Fasciculus gracilis or tract of Goll
b. Fasciculus cuneatus or Tract of Burdach
c. Comma tract of Schultze.

159. Name the type of fibers forming ascending tracts of spinal cord.
All ascending tracts of spinal cord except posterior column tracts are formed by the fibers of second order neurons (crossed fibers) except posterior column tracts. Posterior column tracts are formed by the fibers of first order neurons (uncrossed fibers).

160. What are the functions of spinothalamic tracts?
Anterior spinothalamic tract: Carries impulses of crude touch (protopathic) sensation.

Lateral spinothalamic tract: Carries impulses of pain and temperature sensations.

161. What is the function of spinocerebellar tracts?
Ventral and dorsal spinocerebellar tracts carry impulses subconscious kinesthetic sensation to cerebellum.

162. What are non-sensory impulses?
Impulses of subconscious kinesthetic sensation are called non-sensory impulses.

163. What is the function of spinotectal tract?
Spinotectal tract is concerned with spinovisual reflex.

164. What is the function of fasciculus dorsolateralis?
Fasciculus dorsolateralis carries impulses of pain and temperature sensations.

165. What is the function of spinoreticular tract?
Fibers of spinoreticular tract are the components of ascending reticular activating system and are concerned with consciousness and awareness.

166. What is the function of spino-olivary tract?
Spino-olivary tract is concerned with proprioception.

167. What is the function of spinovestibular tract?
Spinovestibular tract is concerned with proprioception.

168. What are the functions of posterior column tracts?
Posterior column tracts carry the impulses of:
i. Fine touch or epicretic tactile sensation
ii. Tactile localization
iii. Tactile discrimination
iv. Sensation of vibration
v. Conscious kinesthetic sensation
vi. Stereognosis.

169. What are the functions of comma tract of Schultze?
This tract establishes intersegmental communications and forms short reflex arc.

170. Classify the descending tracts of spinal cord.
i. Pyramidal tracts
ii. Extrapyramidal tracts.

171. Why the pyramid tracts are called so?
Because pyramidal tracts give the appearance of a pyramid on the upper part of anterior surface of medulla oblongata while running from cerebral cortex towards spinal cord.

172. Name the pyramidal tracts.

i. Anterior corticospinal tract
ii. Lateral corticospinal tract.

173. Mention the origin of fibers of pyramidal tracts.

i. Primary motor area of frontal lobe of cerebral cortex
ii. Premotor area of frontal lobe
iii. Supplementary motor area of frontal lobe
iv. Somatosensory areas of parietal lobe.

Among the fibers of pyramidal tract:
30% arise from primary motor area and supplementary motor area.
30% arise from premotor area.
40% arise from somatosensory areas.

174. Briefly describe the course of pyramidal tracts.

i. After taking origin from cerebral cortex, fibers of pyramidal tracts descend down through corona radiata, internal capsule, midbrain and pons and enter medulla
ii. While running down through upper part of anterior surface of medulla, these fibers give the appearance of a pyramid
iii. At lower border of medulla, 80% of fibers from each side cross to opposite side forming pyramidal decussation or motor decussation. After crossing, these fibers descend through the lateral white column of spinal cord as lateral corticospinal tract
iv. Remaining 20% fibers descend down in the same side through the anterior white column as anterior corticospinal tract.

175. What is pyramidal or motor decussation?

Pyramidal or motor decussation is the crossing of 80% of pyramidal tract fibers of both sides to opposite side at lower border of medulla.

176. What are the functions of pyramidal tracts?

Pyramidal tracts are concerned with voluntary movements of the body and are responsible for fine and skilled movements.

177. What are the effects of lesion of pyramidal tracts?

Lesion in pyramidal tracts is called upper motor neuron lesion. It causes:

i. Loss of voluntary movements
ii. Increase in muscle tone leading to spastic paralysis of muscles
iii. Loss of all the superficial reflexes
iv. Exaggeration of deep reflexes
v. Babinski's sign.

178. Name the extrapyramidal tracts.

i. Medial longitudinal fasciculus
ii. Anterior vestibulospinal tract
iii. Lateral vestibulospinal tract
iv. Reticulospinal tract
v. Tectospinal tract
vi. Rubrospinal tract
vii. Olivospinal tract.

179. What are the functions of medial longitudinal fasciculus?

Medial longitudinal fasciculus helps in the coordination of reflex ocular movements and the integration of ocular and neck movements.

180. What is the function of vestibulospinal tracts?

Vestibulospinal tracts are concerned with adjustment of position of head and body during angular and linear acceleration.

181. What are the functions of reticulospinal tract?

Reticulospinal tract is concerned with control of movements, maintenance of muscle tone, respiration and control of diameter of blood vessels.

182. What is the function of rubrospinal tracts?

Rubrospinal tract exhibits facilitatory influence on flexor muscle tone.

183. What are the effects of complete transection of spinal cord?

Complete transection of spinal cord causes immediate loss of sensation and voluntary movements below the level of lesion.

Effects occur in three stages:

i. Stage of spinal shock
ii. Stage of reflex activity
iii. Stage of reflex failure.

184. What is paraplegia in flexion?

During the stage of reflex activity after complete transection of spinal cord, the tone returns to flexor muscles first. And the limbs in this condition tend to adopt a position of slight flexion. This type of paralysis is known as paraplegia in flexion.

185. What are the effects of incomplete transection of spinal cord?

Effects of incomplete transection of spinal cord are similar to the effects of complete transection except that, during the stage of reflex activity, the tone returns to extensor muscles first.

186. What is paraplegia in extension?

During the stage of reflex activity after incomplete transection of spinal cord, the tone returns to extensor muscles first. The limbs in this condition tend to adopt a position of slight extension. This is called paraplegia in extension.

187. What is hemisection of spinal cord?

Hemisection is the injury to one lateral half of spinal cord.

188. What is Brown–Séquard syndrome?

Brown–Séquard syndrome refers to signs and symptoms, which occur after hemisection of spinal cord.

189. What are the effects of hemisection of spinal cord on the same side of the body below the lesion?

Sensations carried by uncrossed fibers of posterior column tracts namely, fine touch sensation, tactile localization, tactile discrimination, sensation of vibration, conscious kinesthetic sensation and stereognosis are lost.

Sensations carried by crossed spinothalamic tracts such as crude touch, pain and temperature sensations are not affected. Motor changes resemble the effects of upper motor lesion.

190. What are the effects of hemisection of spinal cord on the opposite side of the body below the lesion?

Sensations carried by crossed spinothalamic tracts such as crude touch, pain and temperature sensations are lost.

Sensations carried by uncrossed fibers of posterior column tracts namely, fine touch sensation, tactile localization, tactile discrimination, sensation of vibration, conscious kinesthetic sensation and stereognosis are not affected.

Motor functions are not affected. If affected, it would be mild and the effects resemble the effects of upper motor lesion.

191. What are the effects of hemisection of spinal cord on the same side of the body at the level of the lesion?
There is complete anesthesia, i.e. all the sensations are lost. Motor changes resemble the effects of lower motor lesion.

192. What are the effects of hemisection of spinal cord on the opposite side of the body at the level of the lesion?
Sensations carried by crossed spinothalamic tracts such as crude touch, pain and temperature sensations are lost.

Sensations carried by uncrossed fibers of posterior column tracts namely, fine touch sensation, tactile localization, tactile discrimination, sensation of vibration, conscious kinesthetic sensation and stereo- gnosis are not affected.

Motor functions are not affected. If affected, it would be mild and the effects resemble the effects of lower motor lesion.

193. What is syringomyelia? What is its cause?
Syringomyelia is a disease of spinal cord characterized by the presence of fluid filled cavities in the spinal cord. It occurs due to overgrowth of neruoglial cells in spinal cord accompanied by cavity formation and accumulation of fluid.

194. What are the features of syringomyelia?
Characteristic features of syringomyelia are the loss of pain and temperature sensations and muscular weakness. The severity of the effects depends upon the extent of the disease in the spinal cord.

195. What is tabes dorsalis? What is its cause?
Tabes dorsalis is a disease of spinal cord. It occurs due to degeneration of dorsal nerve roots. Degeneration of dorsal nerve roots is common in syphilis.

196. What is the feature of tabes dorsalis?
Characteristic feature of tabes dorsalis is the slow progressive nervous disorder affecting the motor and sensory functions of spinal cord.

197. What is the multiple sclerosis? What are its causes?
Multiple sclerosis (MS) is a chronic and progressive inflammatory disease characterized by demyelination in brain and spinal cord. It occurs due to combination and interaction of environmental factors (chemicals, bacteria and virus) and genetic factors.

198. What is spinal disk. What is disk prolapse?
Spinal disk or intervertebral is the cartilaginous structure of vertebral column that separates each vertebra. It is made up of a tough outer fibrous layer and a soft inner part. Inner part acts as a shock absorber and cushions the vertebrae while moving. A small gap in between the adjacent vertebrae allows nerve roots to enter or leave the spinal cord.

Disk prolapse is the rupture of spinal disk. During disk prolapse, the soft inner material bulges out through a weak area in the hard, outer layer. The bulged disk material may irritate or compress or damage the nerve root that passes through the gap between the vertebrae. Severity of the condition depends upon the degree of bulging.

199. Classify sensations.
i. Somatic sensations:
   a. Epicretic or light sensations
   b. Protopathic or crude sensations
   c. Deep sensations.
ii. Special sensations:
   a. Visual sensation
   b. Auditory sensation
   c. Gustatory or taste sensation
   d. Olfactory sensation or sensation of smell.

200. Name the epicretic sensations.
i. Fine touch or tactile sensation
ii. Tactile localization
iii. Tactile discrimination
iv. Temperature sensation with finer range between 25°C and 40°C.

201. Name the protopathic sensations.
i. Pressure sensation
ii. Pain sensation
iii. Temperature sensation with wider range below 25°C and above 40°C.

202. Name the deep sensations.
i. Sensation of vibration or pallesthesia
ii. Kinesthetic sensation or kinesthesia
iii. Visceral pain sensation.

203. How are the sensations from the face transmitted to the brain?
Through the ophthalmic, maxillary and mandibular divisions of trigeminal nerve.

204. What is somatosensory system?
Somatosensory system is the sensory system involving the pathways, which convey the information from the sensory receptors present in skin, skeletal muscles and joints.

205. Name the components of somotosensory pathways.
i. Receptor
ii. First order neurons
iii. Second order neurons
iv. Third order neurons in some cases
v. Center in the brain.

206. What is lemniscus or fillet? What are the types of lemniscus?
Lemniscus or fillet is the prominent bundle of sensory nerves in brain.
Lemniscus is of four types:
i. Spinal lemniscus : Formed by spinothalamic tracts in medulla
ii. Lateral lemniscus : Formed by fibers carrying sensation of hearing from cochlear nuclei to inferior colliculus and medial geniculate body
iii. Medial lemniscus : Formed by fibers from nucleus cuneatus and nucleus gracilis
iv. Trigeminal lemniscus : Formed by fibers from sensory nuclei of trigeminal nerve which carry sensations from head, neck, face, mouth, eyeballs and ears.

207. Define the following.
i. Anesthesia: Loss of all sensations
ii. Hyperesthesia: Increased sensitivity to sensory stimuli
iii. Hypoesthesia: Reduction in the sensitivity to sensory stimuli
iv. Hemianesthesia: Loss of all sensations in one side of the body
v. Paresthesia: Abnormal sensations such as tingling, burning, prickling, and numbness
vi. Hemiparesthesia: Abnormal sensations in one side of the body
vii. Dissociated anesthesia: Loss of some sensations while other sensations are intact
viii. General anesthesia: Loss of all sensations with loss of consciousness produced by anesthetic drugs
ix. Local anesthesia: Loss of sensations in a restricted area of the body without loss of consciousness produced by local anesthetic drugs

x. Spinal anesthesia: Loss of sensations in lower part of body without loss of consciousness produced by anesthetic drugs into subarachnoid space, usually in lumbar region
xi. Tactile anesthesia: Loss of tactile sensation
xii. Tactile hyperesthesia: Increased sensitivity for tactile sensation
xiii. Analgesia: Loss of pain sensation
xiv. Hyperalgesia: Increased sensitivity to pain stimulus
xv. Paralgesia: Disordered sensitivity to pain stimulus such as excess sensitivity or loss of pain sensitivity
xvi. Thermanesthesia: Loss of temperature sensation
xvii. Pallanesthesia: Loss of vibratory sensation
xviii. Astereognosis: Loss of ability to recognize known object with closed eyes due to loss of cutaneous sensations
xix. Illusion: Mental depression due to misinterpretation of a sensory stimulus
xx. Hallucination: Feeling of a sensation without any stimulus.

208. What are the types of motor activities of the body?
Motor activities are of two types:
i. Activities of skeletal muscles: Voluntary functions involving posture and movement. Controlled by somatomotor system
ii. Activities of smooth muscles cardiac muscles and other tissues: Involuntary functions involving functions of various visceral organs. Controlled by visceral or autonomic nervous system.

209. What are the types of activities of skeletal muscles?
Activities of skeletal muscles are of two types:
i. Execution of smooth, precise and accurate voluntary movements
ii. Coordination of movements responsible for skilled activities
iii. Coordination of movements responsible for maintenance of posture and equilibrium.

210. Where are the motor neurons situated?
Brain : in nuclei of many cranial nerves. These nuclei are situated in brainstem.
Spinal cord : In anterior gray horn of spinal cord.

211. What is the role of motor neurons of cranial nerve nuclei?
Motor neurons of cranial nerve nuclei situated in brain-stem send motor impulses to muscles of neck and upper part of trunk via cranial nerves.

212. What are the spinal motor neurons and what are their role?
Two types of motor neurons in spinal cord:
i. Alpha motor neurons: Innervate extrafusal fibers of skeletal muscles and are responsible for contraction of muscles in upper limbs, trunk and lower part of the body.
ii. Gamma motor neurons: Innervate intrafusal fibers of skeletal muscles and are responsible for maintenance of muscle tone.

213. What is final common pathway of motor system?
Alpha motor neurons in spinal cord or cranial nerve nuclei are called 'final common pathway' of motor system because the motor impulses from different parts of nervous system reach the muscles only through them.

214. What is lateral motor system? Name its components.
Lateral motor system is the part of motor system formed by motor nerve fibers, which terminate on motor neurons situated in lateral part of ventral gray horn in spinal cord and also on the corresponding motor neurons of cranial nerve nuclei in brainstem.
It includes:
i. Lateral corticospinal tract
ii. Rubrospinal tract
iii. Part of corticobulbar tract.

215. What are the functions of lateral motor system?
i. Lateral corticospinal tract: Activates the muscles in distal portions of limbs and skilled voluntary movements
ii. Rubrospinal tract: Facilitates tone of flexor muscles
iii. Corticobulbar tracts: Concerned with the movements of expression in lower part of face and movements of tongue.

216. What is medial motor system? Name its components.
Medial motor system is the part of motor system formed by motor nerve fibers, which terminate on motor neurons situated in the medial part of ventral gray horn of spinal cord and on corresponding motor neurons of cranial nerve nuclei in brainstem.
It includes:
i. Anterior corticospinal tract
ii. Part of corticobulbar tracts not belonging to lateral motor system
iii. Lateral and medial vestibular tracts
iv. Reticulospinal tract
v. Tectospinal tract.

217. What are the functions of medial motor system?
i. Maintenance of posture and equilibrium, chewing movements and eyebrow movements
ii. Movements of head in response to visual and auditory stimuli.

218. What are upper motor neurons? Name them.
Neurons in the higher center of brain, which control the lower motor neurons are called upper motor neurons.
Upper motor neurons are:
i. Motor neurons in cerebral cortex
ii. Neurons in basal ganglia and brainstem
iii. Neurons in cerebellum.

219. What are the lower motor neurons? Name them.
Lower neurons are the motor neurons of the cranial nerve nuclei situated in brainstem and anterior horns cells in the spinal cord which innervate the skeletal muscles directly. These neurons constitute the 'Final common pathway" of motor system. The lower motor neurons are neurons of nuclei of III, IV, V, VI, VII, IX, X, XI and XII cranial nerve and alpha motor neurons in anterior gray horns of spinal cord.

220. What are the effects of upper motor neuron lesion?
i. Hypertonia
ii. Spastic paralysis of muscles without wastage
iii. Loss of superficial reflex
iv. Appearance of Babinski's sign
v. Exaggeration of deep reflexes
vi. Clonus.

221. What are the effects of lower motor neuron lesion?
i. Hypotonia
ii. Flaccid paralysis with wastage of muscles
iii. Loss of all reflexes.

222. Define paralysis? What are the causes for paralysis?
Paralysis is defined as complete loss of strength and functions of muscle group or a limb.
Causes for paralysis:
i. Trauma
ii. Tumor
iii. Stroke
iv. Cerebral palsy
v. Multiple sclerosis
vi. Neurodegenerative diseases

223. Define different types of paralysis?
i. Monoplegia: Paralysis of one limb
ii. Diplegia: Paralysis of both upper limbs or both lower limbs
iii. Hemiplegia: Paralysis of upper limb and lower limb on one side of the body
iv. Paraplegia: Paralysis of lower half of the body
v. Quadriplegia: Paralysis of all four limbs.

224. Define pain.
Pain is defined as an unpleasant and emotional experience associated with or without actual tissue damage.

225. What are the different methods to classify pain?
i. Depending upon duration
a. Acute pain: Sudden sharp and intense (severe) pain of short duration
b. Chronic pain: Intermittent or continuous pain with different intensities.
ii. Pathophysiological classification
a. Nociceptive pain: Produced due to activation of nociceptors during tissue injury.
Two types of nociceptive pain: Somatic pain and visceral pain.
b. Neuropathic pain: Occurs due to dysfunction or damage, compression or disease of nervous structures.
iii. Anatomical classification
Classified on the basis of location of body or affected tissue such as headache, neck pain, back pain, stomach pain, muscle pain etc.
iv. Classification depending upon components
a. Fast pain: First sensation whenever a pain stimulus is applied. Experienced as bright, sharp and localized pain sensation
b. Slow pain: Sensation felt after fast pain. Experienced as dull, diffused and unpleasant pain.

226. What is the cause for somatic pain?
Stimulation of pain receptors located on skin, mucous membrane and deeper tissues such as bones, muscles, ligaments, tendons, joints and connective tissue.

227. What are the causes for visceral pain?
Stimulation of pain receptors due to:
i. Ischemia
ii. Chemical substances
iii. Spasm of muscles in hollow organs
iv. Over distention of hollow organs.

228. What is referred pain? Which types of pain are referred?
Referred pain is the pain that is perceived at a site adjacent to or away from the site of origin Deep pain and some visceral pain are referred to other areas. Superficial pain is not referred.

229. Give examples of referred pain.
i. Cardiac pain referred to inner part of left arm and shoulder
ii. Pain in ovary referred to umbilicus
iii. Pain in testis referred to abdomen
iv. Pain in diaphragm referred to right shoulder
v. Pain in gallbladder referred to epigastric region
vi. Renal pain referred to loin.

230. What is dermatomal rule?
According to dermatomal rule, pain is referred to a structure which is developed from the same dermatome from which the pain producing structure is developed.

231. Name the nerve fibers transmitting pain sensation.
Fast pain: Transmitted by type A delta afferent fibers
Slow pain: Transmitted by type C fibers.

232. Name the neurotransmitter involved in pain sensation.
Type Aδ delta fibers secrete glutamate
Type C fibers secrete substance P.

233. What is analgesia system?
Analgesia system is the pain control system of central nervous system.

234. What are the pain control systems in brain and spinal cord?
Brain: In gray matter surrounding aqueduct of Sylvius and raphe magnus nuclei in pons.
Spinal cord: In posterior gray horn which is considered as gateway for pain impulses.

235. Name the neurotransmitters released by the fibers of analgesic pathway.
i. Serotonin
ii. Opiate substances viz. enkephalin, dynorphin and endorphin.

236. What is gate theory of pain?
According gate theory, pain stimuli transmitted by afferent pain fibers are blocked by gate mechanism located at the posterior gray horn of spinal cord. If the gate is opened, pain is felt. If the gate is closed, pain is suppressed.

237. Name important centers or nuclei present in medulla oblongata.
i. Respiratory centers
ii. Vasomotor center
iii. Deglutition center
iv. Vomiting center
v. Superior and inferior salivatory nuclei
vi. Nuclei of 12th, 11th, 8th and 5th cranial nerves
vii. Vestibular nuclei.

238. What are the important structures present in pons?
i. Pyramidal tract fibers
ii. Medial lemniscus
iii. Nuclei of 8th, 7th and 5th cranial nerves
iv. Pneumotaxic and apneustic centers for regulation of respiration
v. Vestibular nuclei.

239. What are the important structures present in midbrain?
i. Tectum, which includes superior colliculus and inferior colliculus.
ii. Cerebral peduncles which include basis pedunculus, substantia nigra, tegmentum which includes red nucleus.

240. What is red nucleus? What are its parts?
Red nucleus is a large oval or round mass of gray matter extending between superior colliculus and hypothalamus.
Parts of red nucleus
i. Nucleus magnocellularis which is formed by large cells
ii. Nucleus parvocellularis, which is formed by smaller cells.

241. What are the functions of red nucleus?
i. Control of muscle tone
ii. Control of complex muscular movements
iii. Control of righting reflexes
iv. Control of eyeball movements
v. Control of skilled movements.

242. What is thalamus?
Thalamus is a large ovoid mass of gray matter, situated bilaterally in diencephalon.

243. Name the different anatomical groups of thalamic nuclei.
i. Midline nuclei
ii. Infralaminar nuclei
iii. Medial mass nuclei
  a. Anterior nucleus
  b. Dorsomedial nucleus
iv. Lateral mass nuclei
  a. Dorsal group of lateral mass
    1. Dorsolateral nucleus
    2. Posterolateral nucleus
  b. Ventral group of lateral mass
    1. Ventral anterior nucleus
    2. Ventral lateral nucleus
    3. Ventral posterior nucleus
v. Posterior group nuclei
  a. Pulvinar
  b. Metathalamus
    1. Medial geniculate body
    2. Lateral geniculate body

244. What is thalamic reticular nucleus?
Thalamic reticular nucleus is a thin layer of neurons covering the lateral aspect of thalamus.

245. Name the different physiological groups (Bondok classification) of thalamic nuclei.
i. Specific sensory relay nuclei
ii. Specific motor nuclei
iii. Association or less specific nuclei
iv. Non-specific nuclei
v. Limbic system nuclei

246. What are thalamic radiation?
Thalamic radiation is the collection of nerve fibers connecting thalamus and cerebral cortex. It contains both thalamocortical and corticothalamic fibers which pass through internal capsule. Fibers of thalamic radiation are divided into four groups:
i. Anterior or frontal thalamic radiation
ii. Superior or centroparietal thalamic radiation
iii. Posterior or occipital thalamic radiation
iv. Inferior or temporal thalamic radiation.

247. What are the functions of thalamus?
Thalamus form:
i. Relay center for sensations
ii. Center for processing of sensory information
iii. Center for determining quality of sensations
iv. Center for sexual sensations
v. Area for arousal and alertness reactions
vi. Center for many reflex activity
vii. Center for integration of the motor functions.

248. What is cause for thalamic lesion? What are its features?
Thalamic lesion occurs mainly because of blockage in thalamogeniculate branch of posterior cerebral artery. During this condition, mostly, posteroventral nuclei of thalamus is affected.

249. What is thalamic syndrome? What are its features?
Thalamic syndrome is the neurological disease caused by infarction of posteroventral part of thalamus.
Features of thalamic syndrome:
i. Anesthesia: Loss of sensations
ii. Astereognosis: Inability to recognize a known object by touch with closed eyes
iii. Sensory ataxia: Incoordination of voluntary movements due to loss of sensations.
iv. Thalamic phantom limb: Inability to locate the position of a limb with closed eyes. Illusion felt by the patient that his limb is absent.
v. Anosognosia: Lack of awareness or denial of existence of a neurological defect.
vi. Spontaneous pain.
vii. Involuntary movements: Athetosis, chorea and intention tremor.
viii. Thalamic hand or athetoid hand: Abnormal attitude of hand characterized by moderate flexion at wrist and hyperextension of all fingers.

250. What is athetosis?
Athetosis refers to slow writhing and twisting movements.

251. What is chorea?
Chorea means quick, jerky, involuntary movements.

252. What is tremor? Which type of tremor occurs in thalamic syndrome?
Tremor is the rapid alternate rhythmic and involuntary movement of flexion and extension in the joints of fingers and wrist or elbow.
In thalamic syndrome, intension tremor (tremor while attempting to do any voluntary act) occurs.

253. What is internal capsule? Where is it situated?
Internal capsule is a broad and compact band of afferent and efferent fibers connecting cerebral cortex with brainstem and spinal cord.
It is situated in between thalamus and caudate nucleus on the medial side and lenticular nucleus on the lateral side.

254. What are the divisions of internal capsule?
i. Anterior limb: Short and situated between lenticular and caudate nuclei.
ii. Posterior limb: Long and situated between thalamus and lenticular nucleus.
iii. Genu: Situated between anterior and posterior limbs.
iv. Caudal portion or retrolenticular portion.

255. What are the effects of lesion in different divisions of internal capsule?
Lesion in anterior limb:
Widespread disability of body with loss of both motor and sensory functions.
Lesion in posterior limb:
i. Contralateral hemianesthesia
ii. Contralateral hemihypesthesia
iii. Hemiplegia
Lesion in genu:
Alteration in motor activities
Caudal portion:
i. Contralateral hemianesthesia
ii. Hemianopia
iii. Deafness

256. What are the nuclei of hypothalamus?
i. Anterior or preoptic group:
  a. Preoptic nucleus
  b. Paraventral nucleus

c. Anterior nucleus
d. Supraoptic nucleus

ii. Middle or tuberal group:
a. Dorsomedial nucleus
b. Ventromedial nucleus
c. Lateral nucleus
d. Arcuate (tuberal) nucleus

iii. Posterior or mamillary group:
a. Posterior nucleus
b. Mammillary body.

257. Enumerate the functions of hypothalamus.

i. Secretion of posterior pituitary hormones
ii. Control of:
a. Anterior pituitary
b. Adrenal cortex
c. Adrenal medulla
d. Autonomic nervous system
e. Heart rate
f. Blood pressure
g. Body temperature
h. Hunger and food intake
i. Water balance
j. Sleep and wakefulness
k. Behavior and emotional changes
l. Sexual function
m. Response to smell
n. Circadian rhythm.

258. What is the role of hypothalamic centers for regulation of body temperature?

i. Heat loss center: When body temperature increases, heat loss center causes cutaneous vasodilatation and secretion of large amount of sweat so that heat is lost directly from skin or through sweat.
ii. Heat gain center: When body temperature decreases, heat gain center causes increased production of heat by shivering and prevents loss of heat by causing cutaneous vasoconstriction.

259. What is the role of hypothalamus in regulation of food intake?

Hypothalamus has two centers to regulate the food intake, feeding center and satiety center. Normally, feeding center is active and it is controlled by satiety center.

260. Name the theories of feeding.

i. Glucostatic theory
ii. Lypostatic theory
iii. Peptide theory
iv. Hormonal theory
v. Thermostatic theory.

261. What is the role of hypothalamus in regulation of water balance?

Hypothalamus regulates water balance by two mechanisms:

i. By thirst mechanism: When body water reduces the thirst center in hypothalamus is stimulated leading to water intake
ii. When body water reduces, osmolarity of body fluids increases. This, in turn stimulates ADH secretion from hypothalamus. ADH increases reabsorption of water from renal tubules.

262. Name the hypothalamic centers concerned with behavior and emotional changes.

i. Reward center
ii. Punishment center.

263. What is rage?

Rage refers to violent and aggressive emotional expression with extreme anger. It is caused by stimulation of punishment center.

264. What is sham rage?

Sham rage means false rage. It is an extreme emotional condition that resembles rage and occurs in pathological conditions in animals.

265. What is circadian rhythm? What is biological clock?

Circadian rhythm is the regular recurrence of physiological processes or activities, which occur in cycles of 24 hours. It is also called diurnal rhythm. The term circadian is a Latin word, meaning 'around the day'.

Circadian rhythm develops in response to recurring daylight and darkness. The cyclic changes taking place in various physiological processes are set by means of a hypothetical internal clock that is often called biological clock.

266. Name the disorders caused by hypothalamic lesion.

i. Diabetes insipidus.
ii. Dystrophia adiposogenitalis
iii. Kallmann syndrome
iv. Laurence–Biedl–Moon syndrome
v. Narcolepsy
vi. Cataplexy.

267. What is diabetes insipidus? What is its cause?

Diabetes insipidus is the disease characterized by excretion of large quantity of dilute urine.

It is due to the failure of water reabsorption from renal tubules. It occurs due to deficiency or absence of antidiuretic hormone.

268. What is Kallmann syndrome?

It is a genetic disorder characterized by hypogonadism, associated with anosmia or hyposmia. Symptoms are caused by deficiency of gonadotropin-releasing hormone secreted by hypothalamus.

269. What is Laurence–Biedl–Moon syndrome?

It is a disorder of hypothalamus characterized by moon face, obesity, polydactylism, mental retardation and hypogenitalism.

270. What is narcolepsy?

Narcolepsy is a hypothalamic disorder with abnormal sleep pattern. There is sudden attack of uncontrollable desire for sleep and the person suddenly falls asleep. It occurs in day time.

271. What is cataplexy?

Cataplexy is sudden uncontrollable outburst of emotion associated with narcolepsy.

272. Name the parts of cerebellum.

i. Vermis
ii. Two cerebellar hemispheres.

273. What are the phylogenetic divisions of cerebellum?

i. Paleocerebellum, which includes two divisions:
a. Archicerebellum
b. Paleocerebellum proper
ii. Neocerebellum.

274. Name the functional divisions of cerebellum.

i. Vestibulocerebellum
ii. Spinocerebellum
iii. Corticocerebellum.

275. What are the histological structures of cerebellum?
i. Gray matter or cerebellar cortex: Made up of nervous structures arranged in three layers:
   a. Molecular or plexiform layer
   b. Purkinje layer
   c. Granular layer.
ii. White matter: Formed by nerve fibers and gray masses called cerebellar nuclei.

276. Name the afferent nerve fibers to cerebellar cortex.
i. Climbing fibers
ii. Mossy fibers.

277. Name the cerebellar nuclei.
i. Fastigial nucleus
ii. Globosus nucleus
iii. Emboliform nucleus
iv. Dentate nucleus.

278. What are the nerve fibers of white mater of cerebellum?
i. Projection fibers: Connect cerebellum with other parts of central nervous system.
ii. Association fibers: Connect different regions of same cerebellar hemisphere.
iii. Commissural fibers: Connect the areas of both halves of cerebellar cortex.

279. How are the projection fibers of cerebellum arranged?
Projection fibers of cerebellum are arranged in three bundles:
i. Inferior peduncles: Between cerebellum and medulla oblongata.
ii. Middle peduncles: Between cerebellum and pons.
iii. Superior peduncles: Between cerebellum and midbrain.

280. What are the components of vestibulocerebellum?
Vestibulocerebellum includes flocculonodular lobe which is formed by nodulus of vermis and the lateral extension on either side called flocculus.

281. What are the functions of vestibulocerebellum?
Vestibulocerebellum regulates tone, posture and equilibrium because of its connections with vestibular apparatus, vestibular nuclei and spinal motor neurons.

282. Name the components of spinocerebellum.
i. Lingula
ii. Central lobe
iii. Culmen
iv. Lobulus simplex
v. Declive
vi. Tuber
vii. Pyramid
viii. Uvula
ix. Paraflocculi
x. Medial portions of cerebellar hemispheres.

283. What are the functions of spinocerebellum?
i. Spinocerebellum forms the receiving area for tactile, proprioceptive, auditory and visual impulses. It also receives the cortical impulses via pons.
ii. Spinocerebellum regulates the postural reflexes by modifying muscle tone
iii. Spinocerebellum also receives impulses form optic and auditory pathway and helps in adjustment of posture and equilibrium in response to visual and auditory impulses.

284. What are the components of corticocerebellum?
Lateral portions of cerebellar hemispheres.

285. What are the functions of corticocerebellum?
Corticocerebellum is concerned with integration and regulation of muscular activities because of its afferent and efferent connections with cerebral cortex through cerebro–cerebello–cerebral circuit. Cerebellum also receives feedback signals from the muscles during muscular activity.

286. Name the mechanisms of action of corticocerebellum.
Corticocerebellum acts by:
i. Damping action
ii. Controlling ballistic movements
iii. Timing and programming the movements
iv. Servomechanism
v. Comparator function.

287. What is cerebro–cerebello–cerebral circuit or afferent–efferent circuit? What are its components?
It is an important neuronal pathway involved in cerebellar control of voluntary movements, initiated by the motor area of cerebral cortex.
It's components:
i. Cerebropontocerebellar tract
ii. Dentatorubrothalamocortical tract.

288. What is damping action of cerebellum?
Damping action refers to prevention of exaggerated muscular activity by cerebellum. It helps in making the voluntary movements smooth and accurate.

289. What is damping action of corticocerebellum?
Damping action refers to prevention of exaggerated muscular activity. This action of corticocerebellum helps in making voluntary movements smooth and accurate.

290. What are ballistic movements?
Ballistic movements are the rapid and alternate movements, which take place in different parts of the body while doing any skilled or trained work like typing, cycling, dancing etc.

291. What is servomechanism of corticocerebellum?
Servomechanism is the correction of any disturbance or interference while performing skilled work. Once the skilled works are learnt, the sequential movements are executed without any interruption. However, if there is any disturbance or interference, corticocerebellum immediately influences the cortex and corrects the movements.

292. What is comparator function corticocerebellum?
It is the function of corticocerebellum by which it receives information from cerebral cortex about cortical impulses sent to muscles and also the feedback information (proprioceptive impulses) from muscles about their actions. Then, corticocerebellum compares these messages, and if any correction is needed it sends instructions to cerebral cortex.

293. What are the effects of cerebellar lesion?
i. Disturbances in tone and posture
ii. Disturbances in equilibrium
iii. Disturbances in movements.

294. What are the disturbances in tone and posture during cerebellar lesion?
i. Atonia
ii. Change in attitude
iii. Deviation movement
iv. Change in the response of deep reflexes.

295. What are the disturbances in equilibrium during cerebellar lesion?
i. While standing: Legs are spread to provide a broad base and the body sways from side to side with oscillation of head.

ii. While moving: Staggering, reeling and drunken like gait is observed.

296. What are the disturbances in movements during cerebellar lesion?
i. Ataxia
ii. Asynergia
iii. Asthenia
iv. Dysmetria
v. Intention tremor
vi. Astasia
vii. Nystagmus
viii. Rebound phenomenon
ix. Dysarthria
x. Adiadochokinesis.

297. What is ataxia?
Ataxia is the lack of coordination of movements.

298. What is asynergia?
Asynergia is the lack of coordination between different groups of muscles such as protagonists, antagonists and synergists.

299. What is asthenia?
Astheniameans weakness, easy fatigability and slowness of muscles.

300. What is dysmetria?
Dysmetria is the inability to check exact strength and duration of muscular contractions required for any voluntary act. While reaching any object, the arm may overshoot or it may fall short of the object.

301. What is astasia?
Astasia is the unsteady voluntary movements.

302. What is adiadochokinesis?
Adiadochokinesis is the inability to do rapid alternate successive movements.

303. What are basal ganglia?
Basal ganglia are the scattered masses of gray matter submerged in subcortical substances of cerebral hemisphere.

Basal ganglia form the part of extrapyramidal system, which is concerned with integration and regulation of motor activities.

304. What are the primary components of basal ganglia?
i. Corpus striatum
ii. Substantia nigra
iii. Subthalamic nucleus of Luys.

305. What are the parts of corpus striatum?
Corpus striatum includes:
i. Caudate nucleus
ii. Lenticular nucleus which is divided into outer putamen and inner globus pallidus.

306. What are the functions of basal ganglia?
i. Control of voluntary motor activity
ii. Control of muscle tone
iii. Control of reflex muscular activity
iv. Control of automatic associated movements
v. Role in arousal mechanism.

307. What are automatic associated movements?
Automatic associated movements are the movements of the body, which take place along with some motor activities.

308. Name the disorders of basal ganglia.
i. Parkinson's disease
ii. Wilson's disease
iii. Chorea
iv. Athetosis
v. Choreoathetosis
vi. Huntington's chorea
vii. Hemiballismus
viii. Kernicterus.

309. What is Parkinson's disease or Parkinsonism?
Parkinson's disease is a slowly progressive degenerative disease of nervous associated with destruction of brain cells which produce dopamine.

310. What are the causes for Parkinson's disease?
Parkinson's disease due to lack of dopamine caused by damage of basal ganglia. It is mostly due to destruction of substantia nigra and nigrostriatal pathway, which has dopaminergic fibers.
Damage of basal ganglia is caused by:
i. Viral infection of brain
ii. Cerebral arteriosclerosis
iii. Injury to basal ganglia
iv. Destruction of removal of dopamine due to long-term use of antihypertensive drugs
v. Unknown causes.

311. What are the symptoms of Parkinson's disease?
i. Resting tremor, drum-bating movements and pill-rolling movements
ii. Slowness of movements: Bradikinesia, akinesia and hypokinesia
iii. Poverty of movements: Statue-like body and mask-like face
iv. Rigidity: Lead-pipe rigidity
v. Gait: Fastinant gait
vi. Speech problems
vii. Emotional changes
viii. Dementia.

312. What is Wilson disease or progressive hepatolenticular degeneration?
Wilson disease or hepatolenticular degeneration is an inherited disorder characterized by excess of copper in body tissues.

313. What is the cause for Wilson disease?
Wilson disease is caused by damage of lenticular nucleus, particularly, putamen.

314. What is choreoathetosis?
Choreoathetosis is the condition characterized by aimless involuntary muscular movements. It is due to combined effects of chorea and athetosis.

315. What is Huntington chorea?
Huntington chorea is an inherited progressive neural disorder due to degeneration of neurons secreting GABA in corpus striatum and substantia nigra. It is characterized by chorea, hypotonia and dementia.

316. What is hemiballismus?
Hemiballismus is a disorder characterized by violent involuntary abnormal movements on one side of the body involving mostly the arm. It is due to degeneration of subthalamic nucleus of Luys.

317. What is kernicterus?
Kernicterus is a form of brain damage in infants caused by severe jaundice.

318. What is cerebrum?
Cerebrum is the largest part of brain. It is formed by two hemispheres that are separated anteriorly and posteriorly

by a deep vertical fissure. But the middle portions are connected by corpus callosum. Cerebrum is responsible for perception of all sensations and initiation of various movements of the body.

319. What are the structures of cerebrum?

Cerebrum is formed by two structures:

i. Outer layer of gray matter called cerebral cortex: Consists of nerve cell bodies
ii. Inner layer of white matter: Consists of nerve fibers.

320. What are the layers of cerebral cortex?

Cerebral cortex has six layers of structures.

Layers from outside to inside:

i. Molecular or plexiform layer
ii. External granular layer
iii. Outer pyramidal layer
iv. Internal granular layer
v. Ganglionic layer or inner pyramidal layer
vi. Fusiform cell layer.

321. What are the structures of white matter of cerebrum?

White mater of cerebrum is formed by nerve fibers which are of three types:

i. Projection fibers: Connect the different parts of cerebral cortex and subcortical areas
ii. Association fibers: Connect different parts of cerebral cortex within same hemisphere
iii. Commissural fibers which form corpus collosum: Connect right and left hemispheres.

322. What is corpus callosum?

Corpus callosum is the broad bundle of commissural fibers connecting the two cerebral hemispheres.

323. What are the phylogenetical divisions of cerebral cortex?

i. Neocortex or isocortex or neopallium
ii. Allocortex which is divided into two subdivisions:
   a. Archicortex
   b. Paleocortex.

324. Name the lobes of each hemispheres.

i. Frontal lobe
ii. Parietal lobe
iii. Temporal lobe
iv. Occipital lobe.

325. Name different fissures and sulci which demarcate the lobes of each hemispheres.

i. Central sulcus or Rolandic fissure: Between frontal and parietal lobes
ii. Parieto-occipital sulcus: Between parietal and occipital lobes
iii. Sylvian fissure or lateral sulcus: Between Parietal and temporal lobes
iv. Callosomarginal fissure: Between temporal lobe and limbic area.

326. What are the functional divisions of frontal lobe?

Frontal lobe is divided into two parts on the basis of functions:

i. Precentral cortex situated anteriorly
ii. Prefrontal cortex situated posteriorly.

327. What are the parts of precentral cortex or excitomotor cortex?

i. Primary motor area, which has area 4 and area 4S
ii. Premotor area, which has areas 6, 8, 44 and 45. Areas 44 and 45 are together called Broca's area
iii. Supplementary motor area.

328. What are the functions of different areas of precentral cortex?

i. Primary motor area: Concerned with initiation of voluntary movements and speech
   Area 4: It is the center for movements. Activates lower motor neurons in spinal cord
   Area 4S or suppressor area: Suppresses extra impulses from are 4 and inhibits exaggeration of movements.
ii. Premotor area: Responsible for movements of tongue, lips and larynx, which are involved in speech
   Area 6a: Coordinates movements initiated by area 4 so the skilled movements become accurate and smooth
   Area 8 or frontal eye field: Concerned with conjugate movements of eyeballs
   Broca's area (areas 44 and 45): Responsible for movements of tongue, lips and larynx, which are involved in speech
iii. Supplementary motor area: Concerned with coordinated skilled movements.

329. How is the localization or homunculus in motor area designed?

Muscles of various parts of the body are represented in area 4 in an inverted way from medial to lateral surface. Lower parts of the body are represented in medial surface and upper parts of the body are represented in lateral surface.

Order of representation from medial to lateral surface is toe, ankle, knee, hip, trunk, shoulder, arm, elbow, wrist, hand, fingers and face. However, the face is not represented in inverted manner.

330. What are the areas present in prefrontal cortex or orbitofrontal cortex?

Areas 9, 10, 11, 12, 13, 14, 23, 24, 29, and 32.

331. What are the functions of prefrontal cortex?

i. It forms the center for higher functions like emotion, learning, memory and social behavior
ii. It is the center for planned actions
iii. It is the seat of intelligence and hence, it is called organ of mind
iv. It is responsible for personality of the individuals
v. It is responsible for various autonomic changes during emotional conditions.

332. What is frontal lobe syndrome? What are its important features?

Frontal lobe syndrome is a disorder caused by disease, damage due to head injury or ablation of prefrontal cortex.

Important features:

i. Emotional instability
ii. Lack of concentration and fixing attention
iii. Lack of initiation and planning any action
iv. Impairment of recent memory
v. Loss of moral and social sense
vi. Failure to realize the seriousness of condition
vii. Functional abnormalities.

333. Name the functional areas of parietal lobe.

i. Somesthetic area I or primary somesthetic or primary sensory area which has areas 3, 1 and 2
ii. Somesthetic area II
iii. Somesthetic association area which has areas 5 and 7.

334. What are the functions of somesthetic area I of parietal lobe?

i. Responsible for perception and integration of cutaneous and kinesthetic sensations

Area 1: Concerned with sensory perception
Areas 2 and 3: Involved in integration of these sensations
ii. Send sensory feedback to premotor area
iii. Concerned with movements of head and eyeballs.

335. What are the functions of somesthetic area II of parietal lobe?
Somesthetic area II is concerned with perception of sensation.

336. What are the functions of somesthetic association area of parietal lobe?
Somesthetic association area is concerned synthesis of various sensations perceived by somesthetic area I and formation of combined sensations like stereognosis.

337. What is sensory motor area? What is its function?
Sensory motor area is the area of cerebral cortex in which the precentral gyrus of frontal lobe (where motor areas are located) and postcentral gyrus of parietal lobe (where sensory areas are located) are knit together by association nerve fibers.

Function of this area is to store the timing and programming of various sequential movements of complicated skilled movements which are planned by neocerebellum.

338. How is the localization or homunculus in primary sensory area designed?
Sensory areas of the body are represented in primary sensory area in an inverted manner. The toes are represented in lower part of medial surface, legs at the upper border, then from above downwards, knee, thigh, hip, trunk, upper limb, neck and face. Face is not represented in inverted manner.

339. Name the areas of temporal lobe.
i. Primary auditory area, which includes areas 41, 42 and Wernicke's area
ii. Auditopsychic area, which includes area 22
iii. Area for equilibrium.

340. What are the functions of primary auditory area?
Primary auditory area is concerned with perception and interpretation of auditory impulses.
Areas 41 and 42: Concerned with perception of auditory impulses
Wernicke's area along with auditopsychic area (area 22): Responsible for the interpretation of sound.

341. What is temporal lobe syndrome or Kluver–Bucy syndrome?
This is the condition that occurs in animals particularly in monkeys after the bilateral ablation of temporal lobe along with amygdaloid and uncus. It occurs in human beings also during bilateral lesion of these structures.

342. What are the manifestations of temporal lobe syndrome?
i. Aphasia.
ii. Auditory disturbances like tinnituts and auditory hallucinations
iii. Disturbances in smell and taste sensations
iv. Dreamy states
v. Visual hallucinations.

343. What are the areas of visual cortex?
i. Primary visual area: Area 17
ii. Visual association area: Area 18
iii. Occipital eye field: Area 19.

344. What are the functions of areas of visual cortex?
Primary visual area (17): Concerned with perception of visual impulses
Visual association area (18): Concerned with interpretation of visual impulses
Occipital eye field (19): Concerned with movement of eyeballs.

345. Define limbic system.
Limbic system is a complex group of cortical and subcortical structures, which form a limbus or ring around the hilus of cerebral hemisphere.

346. What are the structures of limbic system?
i. Archicortex structures:
   a. Hippocampus
   b. Dentate gyrus.
ii. Paleocortical structures:
   a. Pyriform cortex
   b. Olfactory lobe
   c. Olfactory tubercle.
iii. Juxtallocortical structures:
   a. Cingulate gyrus of limbic cortex
   b. Orbitoinsulotemporal cortex
iv. Subcortical structures:
   a. Amygdaloid
   b. Septal nuclei
   c. Thalamic nuclei
   d. Hypothalamic nuclei
   e. Caudate nucleus.
   f. Reticular formation of midbrain.

347. What is Papez circuit?
Papez circuit is a closed circuit formed by interconnections between the various structures of limbic system.
It includes: Hippocampus → mammillary bodies → thalamus → cingulate gyrus of cortex → hippocampus.

348. What are the functions of limbic system?
i. Role in olfaction.
ii. Regulation of endocrine glands.
iii. Regulation of autonomic functions.
iv. Regulation of food intake.
v. Control of circadian rhythm.
vi. Regulation of sexual function.
vii. Role in emotional state.
viii. Role in memory.
ix. Role in motivation.

349. Define reticular formation.
Reticular formation is a diffused mass of neurons and nerve fibers which form an ill-defined meshwork of reticulum in central portion of brainstem.

350. Name different groups of nuclei which constitute reticular formation.
i. Raphe group
ii. Paramedian group
iii. Lateral group
iv. Medial group
v. Intermediate group.

351. Name the divisions of reticular formation.
i. Ascending reticular activating system
ii. Descending reticular system which includes:
   a. Descending inhibitory reticular formation
   b. Descending facilitatory reticular formation.

352. What are the functions of ascending reticular activating system (ARAS)?
i. Concerned with arousal phenomenon, alertness, maintenance of attention and wakefulness.

ii. Causes emotional reactions
iii. Plays an important role in regulating the learning processes and development of conditioned reflexes.

353. How impulses of all sensations reach cerebral cortex?
By two channels:
i. Classical sensory pathways
ii. Ascending reticular activating system.

354. What are the classical or specific sensory pathways?
Classical or specific sensory pathways are the pathways which transmit the sensory impulses from receptors to cerebral cortex via thalamus.

355. What are the subdivisions of descending reticular formation?
i. Descending facilitatory reticular system
ii. Descending inhibitory reticular system.

356. What are the functions of descending facilitatory reticular system?
i. Facilitation of somatomotor activities:
a. Muscle tone
b. Movements of body
c. Wakefulness and alertness.
ii. Facilitation of autonomic functions such as cardiac function, blood pressure, respiration, gastrointestinal function and body temperature.

357. What are the functions of descending inhibitory reticular system?
i. Control of somatomotor activities:
a. Muscle tone
b. Smoothness and accuracy of movements
c. Reflex movements
ii. Control of autonomic functions such as cardiac function, blood pressure, respiration gastrointestinal function and body temperature.

358. What is decorticate animal?
Decorticate animal is the one without cerebral cortex. It is prepared by removing whole cerebral cortex leaving basal ganglia intact. It is also prepared by removing all the connections of cerebral cortex.

359. What is decorticate rigidity?
Decorticate rigidity is the abnormal postural changes in decorticate condition. It involves rigid extension of lower limbs and flexion of upper limbs at elbow joint across the chest. Wrists and fingers also flexed. Posture may develop on one side or both the sides of the body.

360. What is decerebrate animal?
Decerebrate animal is the one in which all the connections of cerebral hemispheres are removed at the level of midbrain by sectioning between superior and inferior colliculi.

361. What is decerebrate rigidity?
Decerebrate rigidity is the rigid extension of all the limbs due to decerebration. It is characterized by opisthotonus.

362. What is opisthotonus?
Opisthotonus is the attitude of an animal after decerebration. It involves rigid extension all the four limbs, extension of tail and arching of back or hyperextension of the spine.

363. What is thalamic animal?
Thalamic animal is the one in which all the connections of thalamus with cerebral cortex are removed by sectioning at the level of midbrain.

364. What is spinal animal?
Spinal animal is the one in which the spinal cord is transected completely.

365. What are proprioceptors or kinesthetic receptors? Mention their situations.
Proprioceptors or kinesthetic receptors are the receptors, which detect and give response to movement and change in position of different parts of the body.
Proprioceptors are situated in muscles, joints, ligaments and facia.

366. Mention the different proprioceptors.
i. Muscle spindle
ii. Golgi tendon organ
iii. Pacinian corpuscle
iv. Free nerve ending
v. Proprioceptors in labyrinth.

367. What is muscle spindle? How is it formed?
Muscle spindle is a spindle-shaped proprioceptive sensory end organ that gives response to stretch of skeletal muscle.

368. What are intrafusal fibers?
Intrafusal fibers are the modified fibers if skeletal muscle which are called extrafusal fiber. Intrafusal fibers form the muscle spindle.

369. What are the types of intrafusal fibers?
i. Nuclear bag fiber
ii. Nuclear chain fiber.

370. What is the unique feature of muscle spindle?
Muscle spindle is the only receptor in the body, which is innervated both by sensory nerve fibers and motor nerve fibers.

371. Brief the innervation of muscle spindle.
Sensory nerve supply:
By two types of sensory nerve ending:
i. Primary sensory nerve ending belonging to type A alpha fiber
ii. Secondary sensory nerve ending belonging to type A beta fiber.
Motor nerve supply:
By gamma motor neuron belonging to type A gamma fibers.

372. What are the functions of muscle spindle?
Muscle spindle gives response to change in the length of the muscle fiber.
It has two functions:
i. It forms the receptor for stretch reflex and thereby, it prevents damage of muscle due to overstretching.
ii. It plays an important role in maintenance of muscle tone.

373. What is stretch reflex or myotatic reflex? What are the unique features of it?
Stretch reflex is the reflex contraction of muscle when it is stretch.
Unique features:
i. It is a monosynaptic reflex
ii. It is quickest of all the reflexes.

374. What is physiological tremor? What is its importance?
Physiological tremor is the continuous discharge of action potentials with low voltage and ineffective frequency from primary and secondary sensory nerve fibers of muscle spindle at resting condition. Physiological tremor plays an important role in feedback regulation of muscle length.

375. What is Golgi tendon organ? What is its nerve supply?
Golgi tendon organ is a proprioceptive sensory end organ within a tendon that gives response changes in muscle tension. It is supplied by sensory nerve fiber belonging to A beta type.

376. What are the functions of Golgi tendon organ?
Golgi tendon organ gives response to change in muscle tension and has three functions:
i. It inhibits forceful contraction of muscle and thereby, it prevents the damage of muscle from forceful contraction.
ii. It forms the receptor for inverse stretch reflex and thereby prevents damage of muscle due to overstretching.
iii. It forms the receptor for lengthening reaction.

377. What is inverse stretch reflex?
Inverse stretch reflex is the sudden decrease in resistance due to relaxation (instead of contraction) when a muscle is stretched excessively. It is the inhibition of contraction of extrafusal fibers due to excessive stretching. So, it is called autogenic inhibition.

378. What is lengthening reaction?
Lengthening reaction is reflex elongation (relaxation) of extensor muscles which allow flexion of limb. And it is due to activation of Golgi tendon organ.

379. What is clasp knife phenomenon or reflex?
Clasp knife phenomenon or reflex is a manifestation process of corticospinal spasticity in which spasticity of extensor muscles of joint such as elbow joint, gives initial resistance to flexion but abruptly gives away the resistance resulting in quick flexion.

In a decerebrate animal, some resistance is offered when the arm is flexed passively at elbow joint. That is, the arm cannot be flexed easily. This type of resistance is offered because of the stretch reflex developed in extensor (triceps) muscle. However, if forearm is flexed forcefully, resistance to flexion is abolished suddenly. Now the extensor muscle relaxes leading to quick flexion of arm.

Clasp knife reflex is a lengthening reaction that occurs due to the activation of Golgi tendon organ.

380. Define posture.
Posture is defined as the position or attitude of the body while standing or sitting.

381. What is the significance of maintenance of posture?
Significance of maintenance of posture is to make the movement smooth and accurate to keep the body in equilibrium with line of gravity.

382. Name the basic phenomena of posture.
Muscle tone and stretch reflex.

383. Define muscle tone or tonus.
Muscle tone is defined as state of continuous and passive partial contraction of muscle with certain vigor and tension. It is also defined as resistance offered by the muscle to stretch.

384. What is the significance of muscle tone?
Muscle tone plays an important role in maintenance of posture since change in muscle tone enables movement of different parts of the body.

385. What is α-γ coactivation?
The α-γ coactivation is the simultaneous stimulation of α-motor and γ-motor neurons influenced by motor area of cerebral cortex. Motor impulses from cerebral cortex pass through the pyramidal tract fibers and stimulate both α-motor neurons and γ-motor neurons simultaneously.

Stimulation of α-motor neurons causes contraction of extrafusal fibers. Stimulation of γ- motor neurons causes contraction of intrafusal fibers, which leads to increase in muscle tone.

386. Which motor neurons are responsible for development of muscle tone in skeletal muscle?
Gama motor neurons.

387. What are the types of postural reflexes?
i. Static reflexes which occur at rest
ii. Statokinetic reflexes which occur during movement.

388. Name the types of static postural reflexes.
i. General static or righting reflexes
ii. Local static or supporting reflexes
iii. Segmental static reflexes
iv. Statotonic or attitudinal reflexes.

389. Define general static or righting reflexes. What is the significance of righting reflexes.
General static or righting reflexes are the postural reflexes, that help to maintain the upright position of the body.

These reflexes help to govern the orientation of the head in space, position of the head in relation to the body and appropriate adjustment of the limbs and eyes in relation to the position of the head, so that upright position of the body is maintained.

390. Name the righting reflexes.
i. i Labyrinthine righting reflexes acting upon the neck muscles
ii. Neck righting reflexes acting upon the body
iii. Body righting reflexes acting upon the head
iv. Body righting reflexes acting upon the body
v. Optical righting reflexes.

391. Where are the centers for righting reflexes situated?
Centers for all the righting reflexes except optic righting reflexes are in midbrain. Center for optical righting reflexes is in the cerebral cortex.

392. Define local static or supporting reflexes?
Local static or supporting reflexes are the static postural reflexes which support the body against the gravity in different positions and also protect the limbs against hyperextension or hyperflexion.

393. Name the supporting reflexes. Where is their center situated?
i. Positive supporting reflexes
ii. Negative supporting reflexes.
Center for supporting reflexes is in spinal cord.

394. Name the segmental static reflex.
Crossed extensor reflex is the segmental static reflex. (Refer Question 148 of this section for details).

395. Define statotonic or attitudinal reflexes.
Statotonic or attitudinal reflexes are the postural reflexes developed according to the attitude of the body.

396. What are the types of statotonic reflexes? Where is their center situated?
i. Tonic labyrinthine and neck reflexes acting upon limbs
ii. Tonic labyrinthine and neck reflexes acting upon eyes.
Center is in the medulla oblongata.

397. What are the statokinetic reflexes?
Postural reflexes concerned with angular (rotatory) and linear (progressive) movements are known as statokinetic reflexes.

398. What are the parts of labyrinth or inner ear?
i. Vestibular apparatus
ii. Cochlea.

399. What is vestibular apparatus? What are its parts?
Vestibular apparatus is a part of inner ear concerned with maintenance of posture and equilibrium. It consists of semicircular canals and otolith organ.

400. Name the semicircular canals of vestibular apparatus.
i. Anterior or superior canal
ii. Posterior canal
iii. Lateral or horizontal canal.

401. How are the semicircular canals situated?
Anterior and posterior semicircular canals are situated vertically. Lateral semicircular canals are situated horizontally.

402. What is ampulla?
Enlarged portion of each semicircular canal is known as ampulla.

403. What is crista ampullaris?
Crista ampullaris is the receptor organ in the ampulla of semicircular canal.

404. Name the receptor cells of crista ampullaris?
Type I and type II hair cells.

405. What are stereocilia?
Stereocilia are the cilia arising from cuticular plate in the apex of hair cells of crista ampullaris.

406. What is kinocilium?
Kinocilium is the largest cilium of hair cells of crista ampullaris.

407. What is cupula?
Cupula is the dome-shaped gelatinous structure that extends from crista ampullaris up to roof of ampulla of semicircular canal.

408. What is otolith organ?
Otolith organ is the part of vestibular apparatus. It is formed by utricle and saccule.

409. What is macula?
Macula is the receptor organ of otolith organ.

410. How is macula of otolith organ situated?
Macula of utricle is situated in horizontal plane so that, the hair cells are in vertical position. The macula of saccule is situated in vertical plane so that, the hair cells are in horizontal position.

411. Name the nerve supplying the vestibular apparatus.
Vestibular division of vestibulocochlear nerve.

412. What are the functions of vestibular apparatus?
i. It is responsible for detecting the position of head during different movements
ii. It causes reflex adjustments in the position of eyeballs, head and body during postural changes.

413. What is the function of semicircular canals?
Semicircular canals are responsible for the maintenance of posture and equilibrium during rotatory movements or angular acceleration of the head.
Superior semicircular canal: Gives response to rotation in anteroposterior plane (transverse axis).
Horizontal semicircular canal: Gives response to rotation in horizontal plane (vertical axis).
Inferior semicircular canal: Gives response to rotation in vertical plane (anteroposterior axis).

414. What is the function of otolith organ?
Otolith organ is responsible for the maintenance of posture and equilibrium during linear acceleration or progressive movements.

Utricle responds to linear acceleration in horizontal plane (horizontal acceleration). It detects position of head in relation to gravity and its side-to-side tilts during horizontal acceleration and sends information (impulses) to brain centers.

Macula responds to linear acceleration in vertical plane (vertical acceleration). It detects position of head in relation to gravity and its forward and backward tilts during vertical acceleration and sends information (impulses) to brain centers.

415. What is nystagmus?
Nystagmus is the involuntary and rapid movements of eye ball. It is common in rotation of head.

416. What are the components of nystagmus?
i. Slow component: At the beginning of the rotation of head, the eyeballs rotate in the opposite direction of head slowly.
ii. Quick component: When slow movements of eyeballs stop, the eyeballs move quickly to the new fixation point in the direction of rotation of head.

417. What are the causes for the slow and quick components of nystagmus?
Slow component: Due to vestibulo-ocular reflex which is produced when the labyrinthine impulses reach the ocular muscles.
Quick component: Due to the activation of some centers in brainstem.

418. What is vestibulo-ocular reflex? What is its importance?
Vestibulo-ocular reflex is the movements of eyeballs in response to stimulation of vestibular apparatus. It is responsible for slow component of nystagmus.

419. What is postrotatory nystagmus?
Postrotatory nystagmus is the nystagmus that occurs immediately after stoppage of rotation.

420. What are the effects of labyrinthectomy?
Bilateral labyrinthectomy: Removal of labyrinthine apparatus on both sides causes loss of equilibrium and loss of hearing sensation.
Unilateral labyrinthectomy: Removal of labyrinthine apparatus on one side causes less effect on postural reflexes. Some autonomic symptoms like nausea, vomiting and diarrhea occur.

421. What is motion sickness? What is it due to?
Motion sickness is the syndrome of physiological response during travel to which the person is not adapted. It is due to excessive and repeated stimulation of vestibular apparatus.

422. What is seasickness?
Seasickness is the motion sickness that occurs while travelling in a watercraft.

423. Define electroencephalogram or EEG.
Record or graphical registration of electrical activities of the brain is known as electroencephalogram or EEG.

424. What are Berger waves?
Waves of EEG are called Berger waves.

425. What is the significance of EEG?
EEG is useful in the diagnosis of neurological disorders and sleep disorders.

426. Name the waves of EEG.
i. Alpha rhythm.
ii. Beta rhythm.
iii. Delta rhythm.
iv. Theta rhythm.

427. What is alpha block?
Alpha block is the disappearance of synchronized alpha waves in EEG and appearance of desynchronized and low voltage waves when eyeballs are opened.

428. Name the physiological conditions when delta waves appear in EEG.
Delta waves are common in early childhood during waking hours. In adults, deep sleep is the only physiological condition when delta waves appear in EEG.

429. Name the pathological conditions when delta waves appear in EEG.
i. Brain tumor
ii. Epilepsy
iii. Increased intracranial pressure
iv. Mental deficiency or depression.

430. What are theta waves of EEG?
Theta waves are the low frequency and low voltage waves appearing in EEG in children below five years of age.

431. Define sleep.
Sleep is the natural state of rest for mind and body with closed eyes characterized by partial or complete loss of consciousness.

432. What are the important physiological changes during sleep?
i. Decreased plasma volume
ii. Reduced heart rate and blood pressure
iii. Reduced rate and force of respiration and appearance of Cheyne-Stoke's breathing
iv. Decreased salivary secretion
v. Decreased urine formation of urine and increased specific gravity of urine
vi. Increased sweet secretion
vii. Reduced lacrimal secretion
viii. Reduced muscle tone
ix. Absence of some reflexes like knee jerk and appearance of Babinski's sign
x. Constriction of pupil and movement of eyeballs up and down.

433. Name the types of sleep.
i. Nonrapid eye movement sleep or NREM sleep (non-REM sleep)
ii. Rapid eye movement sleep or REM sleep or paradoxical sleep.

434. What is REM sleep?
This is a type of deep sleep during which the eyeballs move frequently and dreams may appear. This occupies 20 to 30% of total sleeping period.

435. What are the changes noticed in EEG during REM sleep?
EEG shows irregular waves (desynchronized waves) with high frequency and low amplitude.

436. What is NREM sleep?
This is the type of sleep during which the eyeballs do not move. This occupies 70 to 80% of total sleeping period.

437. What are the stages of NREM sleep?
NREM sleep is divided into four stages based on EEG pattern:
i. Stage of drowsiness
ii. Stage of light sleep
iii. Stage of medium sleep
iv. Stage of deep sleep.

438. What are the changes noticed in EEG during different stages of NREM sleep?
i. Stage of drowsiness: Alpha waves appear
ii. Stage of light sleep: Alpha waves are diminished and abolished. Low voltage fluctuations and infrequent delta waves appear
iii. Stage of medium sleep: Spindle bursts superimposed by low voltage delta waves appear
iv. Stage of deep sleep: More prominent delta waves appear.

439. What is the mechanism of sleep?
Sleep occurs due to activation of sleep-inducing centers (raphe nucleus and locus ceruleus) and inhibition of ascending reticular activating system (ARAS).

440. What are the neurotransmitters causing sleep?
Serotonin secreted by nerve fibers from raphe nucleus of pons: Induces non-REM sleep. Noradrenaline secreted by nerve fibers from locus ceruleus: Induces REM sleep.

441. Name the theories of sleep.
i. Repair and restoration theory
ii. Information consolidation theory
iii. Evolutionary or adaptive or inactivity theory
iv. Clean up theory
v. Brain plasticity theory.

442. What is insomnia? What is the cause for it?
Insomnia is the inability to sleep or abnormal wakefulness.
It occurs due to:
i. Systemic illness
ii. Psychiatric problems
iii. Alcoholic intoxication
iv. Drug addiction.

443. What is hypersomnia? What is the cause for it?
Hypersomnia is the excess sleep or excess need for sleep.
It occurs due to:
i. Lesion of third ventricle
ii. Brain tumors
iii. Encephalitis
iv. Chronic bronchitis
v. Disease of muscles
vi. Myxedema
vii. Diabetes insipidus.

444. What is sleep apnea? What is sleep apnea syndrome?
Sleep apnea is the temporary stoppage of breathing repeatedly during sleep. Sleep apnea syndrome is the disorder that involves fluctuations in the rate and force of respiration during REM sleep with short apneic episode.

445. What is nightmare? What is the cause for it?
Nightmare is a condition during sleep that is characterized by a sense of uneasiness or discomfort or by frightful dreams.

446. What is nightmare? What is the cause for it.
Nightmare is a condition during sleep that is characterized by a sense of uneasiness or discomfort or by frightful dreams.
It occurs due to:
i. Improper food intake
ii. Digestive disorders
iii. Nervous disorders
iv. Drug withdrawal
v. Alcohol withdrawal.

447. What is night terror?
Night terror is a disorder similar to nightmare and it is common in children.

448. What is somnambulism or sleep walking?
Somnambulism or sleep walking is getting up from bed and walking in the state of sleep.

449. Define epilepsy?
Epilepsy is a brain disorder characterized by convulsive seizures of loss of consciousness or both.

450. What is convulsion and what is convulsive seizure?
Convulsion refers to uncontrolled involuntary muscular contraction. Convulsive seizure is sudden attack of uncontrolled involuntary muscular contractions.

451. What is the cause for epilepsy?
Epilepsy is due to excessive discharge of impulses from neurons of brain particularly cerebral cortex.

452. What are the types of epilepsy?
i. Generalized epilepsy or general onset epilepsy or general onset seizure due to excessive discharge of impulses from all parts of brain
ii. Localized epilepsy or local epilepsy or focal epilepsy or local seizure due to discharge of impulses from one part of brain.

453. Name the types of generalized epilepsy.
i. Grand mal epilepsy
ii. Petit mal epilepsy
iii. Psychomotor epilepsy.

454. What is grand mal? What is the cause for it?
Grand mal is a generalized type of epilepsy characterized by sudden loss of consciousness, followed by convulsion. It is due to excess neural activity in all parts of brain.

455. What is petit mal? When does it occur?
Petit mal is a generalized type of epilepsy characterized by sudden loss of consciousness without any warning. It occurs in conditions such as head injury, stroke, brain tumor and brain infection.

456. What is psychomotor epilepsy? What is the cause for it?
Psychomotor epilepsy a generalized type of epilepsy characterized by emotional outbursts such as abnormal rage, sudden anxiety, fear or discomfort. It is due to abnormalities of temporal lobe and tumor in hypothalamus, amygdala and hippocampus.

457. What localized or focal or local epilepsy? What is the cause for it?
Localized epilepsy is the epilepsy characterized by muscular contractions in any part of the body such as mouth regions due to excess discharge of impulses form one part of the brain.

458. Define learning.
Learning is defined as process by which new information is acquired.

459. What are the types of learning.
i. Associative learning: Involves response of a person to only one type of stimulus.
ii. Non-associative learning: A complex process involving learning about relations between two of more stimuli at a time.

460. What is habituation?
Habituation means getting used with something, to which a person is constantly exposed. When a person is exposed to a stimulus repeatedly, he starts ignoring the stimulus slowly.

461. What is sensitization?
Sensitization is a process by which the body is made to become more sensitive to a stimulus. It is called amplification of response When a stimulus is applied repeatedly, habituation occurs. But if the same stimulus is combined with another type of stimulus, which may be pleasant or unpleasant, the person becomes more sensitive to original stimulus.

462. Define memory.
Memory is defined as the ability to recall the past experience. It is also defined as retention of learned materials.

463. What is anatomical basis of memory?
Anatomical basis of memory is the synapse in brain. Synapse for memory coding is slightly different from other synapses having two separate presynaptic terminals.

464. What is facilitation?
Facilitation is the process by which memory storage is enhanced. It involves increase in synaptic transmission and increased postsynaptic activity.

465. What is habituation?
Habituation is the process by which memory storage is attenuated. It involves reduction in synaptic transmission and slow stoppage of postsynaptic activity.

466. Classify memory on physiological basis.
i. Explicit memory that involves conscious recollection of past experience
ii. Implicit memory in which the past experience is utilized without conscious awareness.

467. Define short-term and long-term memories.
Short-term memory is the recalling of events of hours or days.

Long-term memory is the recalling of events of weeks, months or years.

468. What is the basic mechanism of short-term memory?
Basic mechanism of short-term memory is the development of new neural circuits by the formation of new synapses and facilitation of synaptic transmission.

469. What is the basic mechanism of long-term memory?
Basic mechanism of long-term memory is reinforcement of newly formed neuronal circuits resulting in consolidation and encoding of memory in different areas of brain.

470. Name the sites of encoding of memory.
Hippocampus, Papez circuit, frontal and parietal areas.

471. What is memory engram or memory tracing?
It is the process by which the memory is facilitated and stored in brain by means of structural and biochemical changes.

472. What is consolidation of memory?
It is the process by which a short-term memory is crystallized into a long-term memory.

473. Name the drugs, which facilitate memory.
Caffeine, physostigmine, amphetamine, nicotine, strychnine and pentylenetetrazol.

474. What is amnesia?
Amnesia is the loss of memory.

475. What is dementia?
Dementia is the progressive deterioration of intellect, emotional control, social behavior and motivation associated with loss of memory.

476. What is Alzheimer's disease?
It is a progressive neurodegenerative disease due to degeneration, loss of function and death of neurons in many parts of brain particularly cerebral cortex. Dementia is the common feature of this disease.

477. Define conditioned reflex.
Conditioned reflex is the acquired reflex that requires learning, memory and recall of previous experience.

478. Classify the conditioned reflexes.
i. Classical conditioned reflexes: Established by a conditioned stimulus followed by an unconditioned stimulus.
ii. Instrumental or operant conditioned reflexes: Established by conditioned stimulus followed by reward or punishment (behavior of the person is instrumental).

479. How are the properties of classical conditioned reflexes demonstrated?
By classical salivary secretion experiments devised by Ivan Pavlov.

480. Classify the classical conditioned reflexes.
i. Positive conditioned reflexes:
   a. Primary conditioned reflex: With one conditioned stimulus
   b. Secondary conditioned reflex: With two conditioned stimuli
   c. Tertiary conditioned reflex: With three conditioned stimuli.
ii. Negative conditioned reflexes:
   a. External or indirect inhibition
   b. Internal or direct inhibition.

481. What is the significance of instrumental conditioned reflexes?
Instrumental conditioned reflexes play an important role in the development of behavior pattern in an individual particularly during learning process in childhood.

482. What is the physiological basis of conditioned reflexes?
Learning and memory form the physiological basis of conditioned reflexes.

483. Define speech.
Speech is the expression of thought by production of articulate sound, bearing a definite meaning.

484. What is the mechanism of speech?
Speech is performed by the coordinated activities of central speech apparatus and peripheral speech apparatus.

Central speech apparatus consists of higher centers, i.e. the cortical and subcortical centers. Peripheral speech apparatus includes larynx or sound box, pharynx, mouth, nasal cavities, tongue, and lips. All the structures of peripheral speech apparatus work in coordination with respiratory system.

485. What are the cortical areas concerned with speech?
i. Motor areas:
   a. Broca's area (areas 44 and 45) or speech center or motor speech area: It controls the movements of structures involved in vocalization
   b. Upper frontal area: It controls the coordinated movements concerned with writing.
ii. Sensory areas:
   a. Secondary auditory are or auditopsychic area (area 22): It is concerned with interpretation of auditory sensations and storage of memories of spoken words.
   b. Secondary visual area visuopsychic area (area 18): It is concerned interpretation of visual sensation and storage of memories of visual symbols.
   c. Wernicke's area: Concerned with interpretation of auditory sensations.

486. Define aphasia? What is its cause?
Aphasia is defined as loss or impairment of speech due to brain damage.

487. Name the types of aphasia.
i. Broca's aphasia
ii. Wernicke's aphasia
iii. Global aphasia
iv. Nominal aphasia
v. Other types of aphasia: Motor aphasia, sensory aphasia and agraphia.

488. What is dysarthria or anarthria? What is it due to?
Dysarthria or anarthria is the difficulty or inability to speak because of paralysis or ataxia (lack of coordination) of muscles involved in speech.

489. What is cerebrospinal fluid or CSF?
Cerebrospinal fluid or CSF is the fluid that circulates through ventricles of brain, subarachnoid space and central canal of spinal cord. It is a part of ECF.

490. Which is the site of formation of CSF?
CSF is formed by the choroid plexus, which is situated in the ventricles of cerebral hemispheres. Major portion of CSF is formed in lateral ventricles.

491. What are choroid plexuses?
Choroid plexuses are tufts of capillary projections present inside the ventricles and are covered by pia mater and ependymal covering.

492. What is the mechanism of formation of CSF?
CSF is formed by process of secretion that involves active transport mechanism.

493. What are the properties of CSF?
Volume : 150 mL (100 to 200 mL)
Rate of formation: 0.3 mL/min
Specific gravity : 1.005
Reaction : Alkaline.

494. What is the composition of CSF?
CSF consists of 99.13% of water and 0.87% of solids.
Solids:
i. Organic substances such as proteins, amino acids, sugar, cholesterol, urea, uric acid, creatinine and lactic acid

ii. Inorganic substances such as sodium, potassium, calcium, magnesium, chlorides, phosphates, bicarbonates and sulfates
iii. Blood cells: Lymphocytes (5/cumm).

495. Describe the circulation of CSF briefly.
Major quantity of CSF is formed in lateral ventricles and enters third ventricle through foramen of Monro. From here, it passes to fourth ventricle through aqueductus Sylvius. From fourth ventricle, CSF enters cisterna magna and cisterna lateralis through foramen of Magendie (central opening) and foramen of Luschka (lateral opening).

From cisterna magna and cisterna lateralis, CSF circulates through subarachnoid space over spinal cord and cerebral hemispheres. It also flows into central canal of spinal cord.

496. How is CSF absorbed?
CSF is mostly absorbed by the arachnoid villi into dural sinuses and spinal veins. Small amount is absorbed along the perineural spaces into cervical lymphatics and into perivascular spaces.

497. What is the mechanism of absorption of CSF?
CSF is absorbed by means of filtration due to the gradient between hydrostatic pressure in subarachnoid space and the pressure exerted by blood in dural sinus.

498. What is the normal pressure exerted by CSF?

Lateral recumbent position	: 10 to 18 cm H_2O
Lying position	: 13 cm H_2O
Sitting position	: 30 cm H_2O.

499. What are the functions of CSF?
i. Protects of brain against severe blow
ii. Regulates of cranial content volume
iii. Forms medium for exchange of nutritive substances, respiratory gases and waste products between the blood and brain tissues.

500. What is countercoup injury?
Countercoup injury is the injury to brain, in which the damage is on the side opposite to the side on which head receives a severe blow.

501. How is CSF collected?
CSF is mostly collected by lumbar puncture by passing a needle into the subarachnoid space between 3rd and 4th lumbar spines. It is also collected by cisternal puncture by passing a needle into cisterna magna between occipital bone and atlas.

502. What is blood-brain barrier?
Blood-brain barrier is a neuroprotective structure that prevents the entry of many substances and pathogens into brain tissue from blood.

503. How is blood-brain barrier developed?
Blood-brain barrier is developed by the formation of tight junctions between the endothelial cells of capillaries and development of foot processes of astrocytes (neuroglia) around the capillaries.

504. Name some substances, which can pass through blood-brain barrier.
i. Oxygen
ii. Carbon dioxide
iii. Water
iv. Glucose
v. Amino acids
vi. Electrolytes
vii. Drugs such as L-dopa
viii. 5-hydroxygryptamine
ix. Sulfonamides
x. Tetracycline
xi. Other lipid soluble substances.

505. Name some substances, which cannot pass through blood-brain barrier.
i. Injurious chemical substances
ii. Pathogens such as bacteria
iii. Drugs such as penicillin and catecholamines
iv. Bile pigments.

506. What are the functions of blood-brain barrier?
i. Acts as a mechanical barrier and prevents potentially harmful chemical substances
ii. Provides healthy environment for brain tissues by preventing injurious materials and organisms
iii. Permits metabolic and essential materials into brain tissues.

507. What is blood cerebrospinal fluid barrier?
Cerebrospinal fluid barrier is the barrier between the blood and cerebrospinal fluid that exists at choroid plexus.

508. What is hydrocephalus?
Hydrocephalus is the abnormal accumulation of CSF in the skull associated with enlargement of head.

509. What are the types of hydrocephalus?
i. Internal hydrocephalus or non-communicating hydrocephalus: It is the accumulation of CSF in ventricles of brain caused by blockage of cerebral aqueduct. It causes dilatation of ventricles resulting in enlargement of head and cortical atrophy.
ii. External hydrocephalus or communicating hydrocephalus: It is the accumulation of CSF in subarachnoid space. There is dilatation of ventricles and widening of subarachnoid space resulting in enlargement of head. It is due to blockage of arachnoid villi.

510. What are the effects of hydrocephalus?
Along with increased intracranial pressure, hydrocephalus causes headache and vomiting. In severe conditions, it causes atrophy of brain tissues, mental weakness and convulsions.

511. What is autonomic nervous system (ANS)?
ANS is the part of peripheral nervous system that is concerned with regulation of visceral or vegetative function of the body. It is also called vegetative or involuntary nervous system.

512. What are the divisions of ANS?
i. Sympathetic division or thoracolumbar outflow: It includes the nerve fibers arising from lateral gray horns of all the 12 thoracic segments and the first two lumbar segments of spinal cord
ii. Parasympathetic division or craniosacral outflow: It includes some cranial nerve fibers and fibers arising from sacral segments of spinal cord.

513. Name the ganglia present in sympathetic division of ANS.
i. Paravertebral ganglia or sympathetic ganglia
ii. Prevertebral or collateral ganglia
iii. Terminal or peripheral ganglia.

514. What are the different groups of ganglia present in sympathetic chain?
i. Cervical ganglia : 8 in number
ii. Thoracic ganglia : 12 in number

iii. Lumbar ganglia : 5 in number
iv. Sacral ganglia : 5 in number

515. What are the different portions of parasympathetic division of ANS?
i. Cranial outflow or cranial portion: Nerve fibers arising from brainstem (cranial nerves)
ii. Sacral outflow or sacral portion: Nerve fibers arising from sacral segments of spinal cord.

516. Name the nerves, which constitute the parasympathetic division of ANS.
i. Cranial outflow: Cranial nerves: III, VII, IX and X nerves.
ii. Sacral outflow: Pelvic nerve formed by sacral nerve fibers arising from I, II and III sacral segments of spinal cord.

517. What are the functions of ANS?
ANS is concerned with regulation of vegetative functions in the body, which are beyond voluntary control. By regulating various vegetative functions, ANS plays an important role in homeostasis.

518. What are the neurotransmitters secreted by sympathetic fibers?
Preganglionic sympathetic fibers: Acetylcholine
Postganglionic sympathetic adrenergic fibers: Noradrenaline
Postganglionic sympathetic cholinergic fibers: Acetylcholine.

519. Name the structures innervated by sympathetic cholinergic nerve fibers.
Blood vessels to:
i. Heart
ii. Skeletal muscles
iii. Sweat glands.

520. What is the neurotransmitter secreted by parasympathetic fibers?
Both preganglionic and postganglionic fibers of parasympathetic nerves secrete acetylcholine.

521. What are sympathomimetic drugs? Give examples.
Sympathomimetic drugs are the drugs, which produce the effects similar to the effects of stimulation of sympathetic nerves are called sympathomimetic drugs.
Examples: Phenylephrine, isoproterenol, albuterol, ephedrine, tyramine and amphetamine.

522. What are sympathetic blockers? Give examples.
Sympathetic blocker are the drugs, which prevent the actions of sympathetic neurotransmitters.
Examples: Reserpine, quanethidine, benzamine, phentolamine, metaprolal and hexamethonium.

523. What are parasympathomimetic drugs? Give examples.
Parasympathomimetic drugs are the drugs, which produce the effects similar to the effects of stimulation of parasympathetic nerves.
Examples: Pylocarpine, methacholin, neostigmine and physostigmine.

524. What are parasympathetic blockers? Give examples.
Parasympathetic blockers are the drugs, which prevent the actions of parasympathetic nerve fibers. Examples: Hematopine and scopolamine.

525. What are ganglionic blockers? Give examples.
Ganglionic blockers are the drugs, which prevent the transmission of impulses from preganglionic neurons to postganglionic neurons.
Examples: Tetraethyl ammonium, hezmethonium and pentolinium.

Section 11 Special Senses

1. **Define special senses or special sensations.**
   Special senses or special sensations are the complex sensations which involve specialized sense organs.
2. **Name the special senses.**
   i. Visual sensation
   ii. Auditory sensation
   iii. Gustatory or taste sensation
   iv. Olfactory sensation or sensation of smell.
3. **What is optic axis?**
   Optic axis is the line joining the anterior pole and posterior pole of the eyeball.
4. **What is visual axis?**
   Visual axis is the line joining a point in cornea little medial to anterior pole and fovea centralis (which is situated little lateral to posterior pole).
5. **What is the significance of visual axis?**
   Significance of visual axis is that the light rays from the object passes through this axis and reach the retina of eye.
6. **What is conjunctiva? What are its parts?**
   Conjunctiva is a thin mucous membrane that covers the exposed part of eye. Its parts:
   i. Bulbar portion that covers the anterior surface of eyeball
   ii. Palpebral portion that covers the inner surface of eyelids.
7. **What is lacrimal gland? Where is it situated?**
   Lacrimal gland is the glandular structure that secretes tear. It is situated in the bone that forms upper and outer border of eye socket.
8. **What is tear?**
   Tear is a hypertonic fluid, which is secreted by lacrimal gland.
9. **What are the functions of tear?**
   i. It keeps the conjunctiva moist and protects it from infection by washing and lubricating it continuously
   ii. Tear contains the enzyme lysozyme that kills bacteria.
10. **How is tear drained?**
    From lacrimal gland, tear flows over the surface of conjunctiva and drains into nose via lacrimal ducts, lacrimal sac and nasolacrimal duct.
11. **What are the layers of wall of eyeball?**
    i. Outer layer or tunica externa or tunica fibrosa that includes cornea and sclera
    ii. Middle layer or tunica media or tunica vasculosa that includes choroid, ciliary body and iris
    iii. Inner layer or tunica interna or tunica nervosa or retina.
12. **What is cornea?**
    Cornea is the transparent structure that forms the anterior 1/6th of outer layer of eyeball.
13. **What is sclera?**
    Sclera is the posterior 5/6th of outer layer of eyeball.
14. **What is choroid? How is it formed?**
    Choroid is the posterior 1/6th of middle layer of eyeball. It is formed by capillary plexus, small arteries and veins.
15. **What is ciliary body?**
    Ciliary body is a ring like structure formed by anterior part of middle layer of eyeball.
16. **Name the parts of ciliary body.**
    i. Orbiculus ciliaris
    ii. Ciliary body proper
    iii. Ciliary processes.
17. **What is iris? And what is pupil?**
    Iris is a circular diaphragm formed by anterior most portion of middle layer of eyeball and it is placed in front of lens.
    Pupil is the circular opening in the center or iris. The anterior and posterior chambers communicate through the pupil.
18. **What is retina? Name the layers of retina.**
    Retina is the layer of eyeball that forms the sensory part. It contains the receptors for vision.
    Layers of retina:
    i. Layer of pigment epithelium
    ii. Layer of rods and cones
    iii. External limiting membrane
    iv. Outer nuclear layer
    v. Outer plexiform layer
    vi. Inner nuclear layer
    vii. Inner plexiform layer
    viii. Ganglion cell layer
    ix. Layer of nerve fibers
    x. Internal limiting membrane.
19. **What is fundus oculi or fundus? How is it examined?**
    Fundus oculi or fundus is the posterior part of interior of eyeball. It is examined by using ophthalmoscope.
20. **Name the important structures of fundus oculi.**
    i. Optic disk
    ii. ii Macula lutea.
21. **What is optic disk?**
    Optic disk is a pale disk like structure situated near the center of the posterior wall of eyeball. It is formed by convergence of optic nerve fibers. It is also called blind spot because it is insensitive to light since there are no rods and cones here.
22. **What is blind spot?**
    Blind spot is a small portion of visual field of each eye that corresponds to the position of optic dick. Optic disk is insensitive to light because of absence of visual receptors. So, object is not seen if its image falls on optic disk. Therefore, a small blind spot is formed in visual field.
23. **What is macula lutea?**
    Macula lutea is a yellow spot situated little lateral to optic disk in the posterior wall of the eyeball. The yellow color is due to the presence of a yellow pigment. There is a small

depression in the center of macula densa called fovea centralis.

24. What is fovea centralis? What is its importance?
Fovea centralis is a minute depression in the center of macula lutea. It is the region of acute vision because it contains only the cones.

25. Name the intraocular fluids.
i. Vitreous body
ii. Aqueous humor.

26. What is vitreous body? How is it formed?
Vitreous body is a viscus fluid present in the space between the lens and retina. It is a highly viscous and gelatinous substance that is formed by a fine fibrillar network of proteoglycan molecules.

27. What is the function of vitreous body?
Vitreous body helps to maintain the shape of the eye.

28. What is aqueous humor? How is it formed?
Aqueous humor is a thin fluid present in the space between lens and cornea. It is formed from plasma within capillary by diffusion, ultrafiltration and active transport of substances through epithelial cells lining the ciliary processes.

After formation, aqueous humor reaches the posterior chamber by passing through suspensory ligaments. From here it reaches the anterior chamber via pupil.

29. How is aqueous humor drained?
Aqueous humor is drained from anterior chamber into extraocular veins by passing through limbus (the angle between cornea and iris), the meshwork of trabeculae and canal of Schlemm.

30. What are the functions of aqueous humor?
Aqueous humor:
i. Maintains the shape of eyeball
ii. Maintains the intraocular pressure
iii. Provides nutrition, oxygen and electrolytes to avascular structures such as lens and cornea
iv. Removes metabolic end products from lens and cornea.

31. What is the normal intraocular pressure? How is it measured?
Normal intraocular pressure is 12 to 20 mm Hg. It is measured by tonometer.

32. Name the ocular muscles.
i. Superior rectus
ii. Inferior rectus
iii. Medial rectus
iv. Lateral rectus
v. Superior oblique
vi. Inferior oblique.

33. What are the nerves supplying ocular muscles?
i. Oculomotor (III) nerve that supplies superior rectus, inferior rectus, medial rectus and inferior oblique muscle
ii. Trochlear (IV) nerve that supplies superior oblique muscle
iii. Abducent (VI) nerve that supplies lateral rectus muscle.

34. What is glaucoma? What is its effect?
Glaucoma is the eye disease characterized by increased intraocular pressure above 60 mm Hg. It causes damage of optic nerve resulting in blindness.

35. What are the causes for glaucoma?
Major cause for glaucoma is the blockage in drainage system of aqueous humor in trabeculae resulting in increased intraocular pressure.

It also develops secondary to other disorders such as diabetes, inflammation or injury to eye and excess use of drugs such as corticosteroids.

36. What are the changes taking place in lens during old age?
After 40 to 45 years of age, the elastic property of lens is decreased resulting in presbyopia. After 55 to 60 years, lens becomes opaque resulting in cataract.

37. What is cataract?
Cataract is the opacity or cloudiness in natural lens of the eye. It develops in old age after 55 to 60 years.

38. What are the causes of cataract other than old age?
i. Eye injuries
ii. Previous eye surgery
iii. Diseases such as diabetes and Wilson disease
iv. Hypocalcemia
v. Long-term use of drugs such as steroids, diuretics and tranquilizers
vi. Long-term unprotected exposure to sunlight
vii. Alcoholism
viii. Family history
ix. Diet containing large quantity of salt.

39. What is the refractory power of cornea and lens?
Refractory power of cornea is 42 D (Diopter)
Refractory power of lens is 23 D.

40. What are the visual receptors or photoreceptors? Explain their distribution briefly.
Visual receptors or photoreceptors are rods and cones present in the retina of eyeball. In fovea centralis, only the cones are present. While proceeding from fovea towards periphery of retina, rods increase and cones decrease in number. At the periphery of retina, only rods are present.

41. What is the function of rods?
Rods have low threshold for light stimulus and are responsible for dim light vision or night vision or scotopic vision.

42. What are the functions of cones?
Cones have high threshold for light stimulus and are responsible for bright vision or day light vision or photopic vision. Cones are also responsible for acuity of vision and color vision.

43. What are the structures of rod cells and cone cells?
i. Outer segment
ii. Inner segment
iii. Cell body
iv. Synaptic terminal.

44. What is the neurotransmitter present in synaptic terminals of rod cell and cone cell?
Glutamate.

45. What is rhodopsin?
Rhodopsin or visual purple is the photosensitive pigment present in the outer segment of rod cells.

46. What is the chemical nature of rhodopsin? What are its components?
Rhodopsin is a conjugated protein.

Components of rhodopsin:
i. Protein called opsin: Opsin in rhodopsin is scotopsin.
ii. Coloring substance called chromophore: Chromophore in rhodopsin is retinal.

47. What is Wald visual cycle? What are the stages of this cycle?
Wald visual cycle is the series of photochemical reactions when rhodopsin absorbs the light that falls on retina.

Stages of Wald visual cycle:

i. Rhodopsin is decomposed into bathorhodopsin
ii. Bathorhodopsin is converted into lumirhodopsin
iii. Lumirhodopsin decays into metarhodopsin I
iv. Metarhodopsin I is changed to metarhodopsin II
v. Metarhodopsin II is split into scotopsin and all-trans retinal All-trans retinal is converted into all-trans retinol (vitamin A)

Metarhodopsin is usually called activated rhodopsin since it is responsible for development of receptor potential in rod cells.

48. What is visual transduction or phototransduction?
Visual transduction or phototransduction the process by which light energy is converted into receptor potential in the visual receptors.

49. What is the difference between the resting membrane potential in visual receptors and sensory receptors in the body?
Resting membrane potential in visual receptors is very less and it is only about – 40 mV whereas in other sensory receptors in the body it is – 70 to – 90 mV.

50. Why the receptor potential in rod cells is less compared other sensory receptors?
It is because of influx of sodium ions.

51. What is the difference between the process of receptor potential in visual receptors and other cells of the body?
Receptor potential in other sensory receptors is due to depolarization. In visual receptors receptor potential is due to hyperpolarization.

52. What are the photosensitive pigments present in cone cells?
Porpyropsin, iodopsin and cyanopsin.

53. What is dark adaptation? What is its maximum duration?
Dark adaptation is a process by which the person is able to see the objects in dim light. When a person enters a dark room from a bright-lighted area, he cannot see any object. After sometime, his eyes get adapted and he starts seeing the objects slowly.

Maximum duration for dark adaption is 20 minutes.

54. What are the causes for dark adaptation?
i. Increase in the sensitivity of rods due to resynthesis of rhodopsin
ii. Dilatation of pupil.

55. What is light adaptation? What is its maximum duration?
Light adaptation is a process in which eyes get adapted to increased illumination. When a person enters a bright light area from a dim light area, he feels discomfort for some time due to dazzling effect of bright light. After about some time, he is able to see the objects without discomfort.

Maximum duration for light adaptation is 5 minutes.

56. What are the causes for light adaptation?
i. Reduction in the sensitivity of rods due to breakdown of rhodopsin
ii. Constriction of pupil.

57. What is night blindness or nyctalopia? What is its cause?
Night blindness or nyctalopia is the loss of vision when light in environment becomes dim. Night blindness is due to the deficiency of vitamin A.

58. Define electroretinogram (ERG).
Electroretinogram (ERG) is the record of electrical activity produced in retina when it is stimulated by the light rays.

59. Define acuity of vision.
Acuity of vison is the ability of eye to determine the precise shape and details of any object.

60. Name the receptors responsible for acuity of vision.
Cones are responsible for acuity of vision.

61. How is acuity of vision tested?
Distant vision: By using Snellen's chart
Near vision: By using Jaeger's chart.

62. Define field of vision.
Part of external world seen by one eye when it is fixed in one direction is known as field of vision.

63. What is binocular vision?
Binocular vision is the vision in which both the eyes are used together, so that a portion of external world is seen by the eyes together. in man and some animals in whom the eyeballs are situated in front of head, the visual fields of both eyes overlap. Because of this, a portion of external world is seen by both eyes.

64. What is monocular vision?
Monocular vision is the vision in which each eye is used separately. In some animals like horse, eyeballs are situated at the sides of head. So, the visual fields of both eyes overlap only to a very small extent. Because of this, different portion of the external world is seen by each eye.

65. What are the divisions of visual field?
i. Temporal field that extends to about 100° laterally
ii. Nasal field that extends to about 60° medially
iii. Upper field that extends to about 60° above
iv. Lower field that extends to about 75° below.

66. What are corresponding retinal points?
Corresponding retinal points are the area in retina of both eyes, on which the light rays from the object fall.

67. What is diplopia? How does it occur?
Diplopia means double vision. While looking at an object, if the eyeballs are directed in such a way that the light rays do not fall upon the corresponding point of retina of both eyes, a double vision or diplopia occurs i.e., one single object is seen as double.

68. What are the causes for permanent and temporary diplopia?
Permanent diplopia is caused by paralysis or weakness of ocular muscles. Temporary diplopia occurs due to imbalanced actions of ocular muscles in conditions like alcoholic intoxication.

69. What is blind spot?
Blind spot is a small area of retina where visual receptors are absent. Optic disk in retina does not have any visual receptors and if the image of any object falls upon optic disk, the object cannot be seen. So, this part of retina is called blind spot.

70. How is visual field determined?
By:
i. Using perimeter
ii. Using Bjerrum's screen
iii. Confrontation test.

71. Trace the pathway for visual sensation.
Visual pathway includes:
i. Receptors: Rods and cones
ii. First order neurons: Bipolar cells in retina

iii. Second order neurons: Ganglionic cells in retina
iv. Optic nerve: Formed by axons of ganglionic cells
v. Optic chiasma: Crossing of medial fibers of optic nerve
vi. Optic tract: Formed by crossed and uncrossed fibers of optic nerve
vii. Third order neurons: Lateral geniculate body
viii. Optic radiation
ix. Primary cortical center: Visual cortex.

72. Where is the subcortical center for visual sensation?
Lateral geniculate center forms the subcortical center for visual sensation.

73. Where is optic radiation or geniculocalcarine tract?
Optic radiation or geniculocalcarine tract is the group of nerve fibers from lateral geniculate body. The fibers of optic radiation pass through internal capsule and end in visual cortex.

74. Where is the center for vision?
Center for vision is in visual cortex that is situated in calcarine fissure in medial surface of occipital lobe.

75. What are the areas of visual cortex?
i. Primary visual area : Area 17
ii. Visual association area : Area 18
iii. Occipital eye field : Area 19.

76. What are the functions of areas of visual cortex?
Primary visual area (area 17): Concerned with perception of visual impulses
Visual association area (area 18): Responsible for interpretation of visual impulses
Occipital eye field (area 19): Concerned with movements of eyeballs.

77. Define anopia and hemianopia.
Anopia is the loss of vision in one visual field. Hemianopia is the loss of vision in one half of visual field.

78. Name the types of hemianopia.
i. Homonemous hemianopia
ii. Heteronemous hemianopia.

79. What is homonymous hemianopia?
Homonymous hemianopia means loss of vision in the same halves of both the visual fields.

80. What are the types of homonymous hemianopia?
i. Right homonymous hemianopia: Loss of vision in right half of visual field of both eyes
ii. Left homonymous hemianopia: Loss of vision in left half of visual field of both eyes.

81. What is heteronymous hemianopia?
Heteronymous hemianopia means loss of vision in the opposite halves of both the visual fields.

82. What are the types of heteronymous hemianopia?
i. Binasal hemianopia: Loss of vision in nasal half of visual field of both eyes
ii. Bitemporal hemianopia: Loss of vision in the temporal half of visual field of both eyes.

83. Name the effects of lesion at different levels of visual pathway.
i. Lesion in optic nerve: Total blindness
ii. Lesion in lateral fibers of optic chiasma on one side: Nasal hemianopia
iii. Lesion in lateral fibers of both the sides of optic chiasma: Binasal hemianopia
iv. Lesion in medial fibers of optic chiasma: Bitemporal hemianopia
v. Lesion in left optic tract, left lateral geniculate body, left optic radiation or left visual cortex: Right homonymous hemianopia
vi. Lesion in right optic tract, right lateral geniculate body, right optic radiation or right visual cortex: Left homonymous hemianopia.

84. What is macular sparing?
Macular sparing is the retention of macular vision in conditions like homonymous hemianopia. And total blindness does not occur in spite of lesion in visual cortex.

85. What are the causes for macula sparing?
i. Fibers from macula project into the visual cortex of both sides
ii. Fibers from macular region are projected into both anterior and posterior parts of each visual cortex.

86. Define pupillary reflexes. Classify them.
Pupillary reflexes are the reflexes, which cause the alteration in the diameter of pupil.
Pupillary reflexes are classified into three types:
i. Light reflex
ii. Ciliospinal reflex
iii. Accommodation reflex.

87. Define and classify light reflex.
Light reflex is the reflex in which, pupil constricts when light is flashed into the eye.
Light reflex is classified into two types:
i. Direct light reflex in which, the flash of light in one eye causes constriction of pupil in the same eye.
ii. Indirect or consensual light reflex in which the flash of light in one eye causes constriction of pupil in the same eye as well as in the opposite eye.

88. Trace the pathway for light reflex.
Afferent fibers: Fibers from optic pathway ending in pretectal nucleus of midbrain
Center: Pretectal nucleus
Efferent fibers: Fibers from pretectal nucleus reach Edinger–Westphal nucleus of III cranial nerve. Fibers from this go to ciliary ganglion. Short ciliary nerves arising from this supply constrictor pupillae muscles of iris.

89. What is ciliospinal reflex?
Ciliospinal reflex is the dilatation of pupil caused by painful stimulation of skin over the neck.

90. What is the nerve supply to the muscles of iris?
Constrictor pupillae muscle: Supplied by parasympathetic nerve fibers from Edinger–Westphal nucleus of III cranial nerve.
Dilator pupillae muscle: Supplied by sympathetic fibers.

91. Define accommodation of eyeball.
Accommodation is the adjustments of eye to see either near or distant objects clearly.

92. What are the adjustments made in eyeballs during accommodation?
i. Convergence of eyeballs: Due to contraction of medial recti
ii. Constriction of pupil: Due to contraction of constrictor pupillae
iii. Increase in the anterior curvature of lens: Due to contraction of ciliary muscle.

93. What is Young–Helmholtz theory of accommodation?
It describes how the curvature of the lens increases during accommodation.

94. Explain briefly the mechanism of increase in the anterior curvature of lens during accommodation.
During distant vision, lens is flat due to the traction by suspensory ligaments. During near vision, ciliary muscle contracts and draws the choroid forward. So, the ciliary processes are brought closer to lens and the suspensory ligaments are slackened. Now, the tension on the lens is released. Due to the elastic property, the lens bulges forward so that anterior curvature of lens increases.

95. What are Purkinje-Sanson images?
Purkinje-Sanson images are the images of flame of a lighted candle held in front of eye. These images are used to demonstrate the increase in the anterior curvature of lens during accommodation.

96. Trace the pathway for accommodation.
Afferent fibers: Visual fibers from retina to visual cortex in occipital lobe and the association fibers from here to frontal eye field in frontal lobe.
Center: Frontal eye field (area 8).
Efferent fibers: Fibers from frontal eye field to Edinger–Westphal nucleus of III cranial nerve. Fibers from this nucleus reach ciliary ganglion. Nerve fibers from this pass through short ciliary nerves and supply constrictor pupillae. Some fibers from frontal eye field reach somatic motor nucleus of III cranial nerve and fibers from this supply the medial recti.

97. What is range of accommodation?
Range of accommodation is the distance between far point (punctum remotum) and near point (punctum proximum). It is expressed in cm.

98. What is amplitude of accommodation?
Amplitude of accommodation is the difference between refractive power of eye during far vision (static refraction) and during near vision (dynamic refraction). It is expressed in diopter.

99. What is Argyll Robertson pupil?
Argyll Roberson pupil is a condition in which the light reflex is lost but accommodation reflex is present.

100. What is Horner syndrome or oculosympathetic palsy? What are its symptoms?
Horner syndrome is an eye disorder caused by damage to cervical sympathetic nerve.
Symptoms:
i. Ptosis: Drooping of upper eyelid
ii. Swelling of lower eyelid
iii. Miosis or myosis: Abnormal constriction of pupil
iv. Enophthalmos: Sinking of eyeball into its cavity
v. Absence of sweating on affected side of the face.

101. What is presbyopia? What is the cause for it?
Presbyopia is a condition characterized by progressive diminished ability of eyes to focus on near objects with age. It is due to gradual reduction in amplitude of accommodation because of failure to increase the anterior curvature of lens.

102. What are the spectral colors? Name them.
Colors forming the spectrum are called spectral colors. Spectral colors are violet, indigo, blue, green, yellow, orange and red (VIBGYOR).

103. What are the primary colors? Name them.
Primary colors are those, which can produce white when combined together. Primary colors are red, green and blue.

104. What are the complementary colors? Give examples.
Complementary colors are the pair two colors, which produce white when mixed or combined in proper proportion.
Examples:
i. Red and greenish blue
ii. Orange and cyan blue
iii. Purple and green.

105. What are the theories of color vision? Name them.
Theories of color vision are the theories, which explain the mechanism of perception of color by eyes.
i. Thomas Young's trichromatic theory
ii. Helmholtz trichromatic theory
iii. Granit's modulator and dominator theory
iv. Hartridge's polychromatic theory
v. Hering's theory of opposite colors.

106. Define color blindness.
Color blindness is the failure to appreciate one or more colors.

107. What are the causes of color blindness?
i. Trauma: Injury to eye
ii. Chronic diseases such as glaucoma, diabetes, Parkinson disease and Alzheimer disease
iii. Long-term use of some drugs such as antibiotics, antihypertension drugs, barbiturates and antituberculosis drugs.

108. Classify color blindness.
Color blindness is the failure to appreciate one or more colors.
Types of color blindness:
i. Monochromatism
ii. Dichromatism
iii. Trichromatism.

109. What is monochromatism? What are its types?
Monochromatism is the condition in which the subject cannot appreciate any color and the whole spectrum is seen in different shades of gray.
It is divided into two types:
i. Rod monochromatism
ii. Cone monochromatism.

110. What is dichromatism? What are its types?
Dichromatism is the condition when only two of the three primary colors are appreciated.
It is of three types:
i. Protonopia in which the first primary color, red cannot be appreciated
ii. Deuteranopia in which green cannot be appreciated
iii. Tritanopia in which blue cannot be appreciated.

111. What is trichromatism? What are its types?
Trichromatism is the condition in which all the three primary colors are appreciated but the perception of one of the colors is very weak.
It is divided into three types:
i. Protonamaly in which perception of red color is weak
ii. Deuteranomaly in which perception of green is less
iii. Tritanomaly in which perception of blue is less.

112. How is color blindness determined?
By using:
i. Ishihara's color charts
ii. Colored wool
iii. Edridge–Green lantern.

113. What is refractive error?
Error of refraction or refractive error is the inability of eye to focus the image of objects accurately on retina.

114. Classify errors of refraction.
i. Ametropia
   a. Myopia
   b. Hypermetropia
ii. Anisometropia
iii. Astigmatism
iv. Presbyopia.

115. Define emmetropia.
Emmetropia is the condition with normal refractory power of eye.

116. Define ametropia.
Ametropia is the condition with deviation of refractory power of eye from normal condition resulting in inadequate focusing on retina.

117. What is myopia or short sightedness? What is its cause?
Myopia or short sightedness is the eye defect characterized by the inability to see the distant object. But the near vision is normal. It is caused by increase in anteroposterior diameter of the eyeball. So, the image from distant object is brought to a focus in front of retina.

118. How is myopia corrected?
By using concave lens.

119. What is hypermetropia or long sightedness? What is its cause?
Hypermetropia or long sightedness is the eye defect characterized by the inability to see the near objects. But the distant vision is normal. It is caused by the decrease in the anteroposterior diameter of eyeball. So, the light rays are brought to a focus behind retina.

120. How is hypermetropia corrected?
By using convex lens.

121. What is anisometropia? How is it corrected?
Anisometropia is the condition in which the two eyes have unequal refractory power. It is corrected by using different appropriate lens for each eye.

122. Define astigmatism. What is its cause?
Astigmatism is the condition in which the light rays are not brought to a sharp point upon retina. It is caused by irregularity in the curvature of lens and unequal refractory power of lens in different meridians.

123. What are the types of astigmatism?
i. Regular astigmatism: In this, the refractory power is unequal in different meridians but, in one single meridian, it is uniform throughout.
ii. Irregular astigmatism: In this, the refractory power is unequal not only in different meridians but also in different points of same meridian.

124. How is astigmatism corrected?
By using cylindrical lens.

125. How is presbyopia corrected?
By using convex lens.

126. Name the parts of ear.
i. External ear: Consists of auricle and external auditory meatus.
ii. Middle ear: Consists of auditory ossicles, auditory muscles and Eustachian tube.
iii. Internal ear: Consists of cochlea and vestibular apparatus.

127. What is tympanic membrane?
Tympanic membrane is a thin, semitransparent membrane, which separates the middle ear from external auditory meatus.

128. What is the role of middle ear in hearing?
Middle ear transmits the airborne sound waves from tympanic membrane to inner ear by permitting the adjustment of the difference in impedance (obstruction) between air and fluid in inner ear.

129. What are auditory ossicles. Name them.
Auditory ossicles are the three miniature bones, which are arranged in the form of a chain, extending across middle ear from tympanic membrane to oval window.
Auditory ossicles are:
i. Malleus
ii. Incus
iii. Stapes.

130. What are the skeletal muscles attached to auditory ossicles?
i. Tensor tympani
ii. Stapedius.

131. What is tympanic reflex? What is its significance?
Tympanic reflex is an attenuation reflex characterized by involuntary contractions of tensor tympani and stapedius muscles, in response to load noise.
Significance:
i. Tympanic reflex prevents rupture of tympanic membrane by loud noise
ii. It also prevents fixation of footplate of stapes against oval window during exposure to loud noise
iii. It also protects cochlea from loud noise.

132. What is Eustachian tube or auditory tube? What is its function?
Eustachian tube or auditory tube is the flattened canal extending from anterior wall of middle ear to nasopharynx. It is responsible for equalization of pressure on either side of tympanic membrane.

133. Name the sense organs present in internal ear or labyrinth.
i. Cochlea for hearing
ii. Vestibular apparatus for equilibrium.

134. What are the compartments of cochlea?
i. Scala vestibuli
ii. Scala media or cochlear duct
iii. Scala tympani.

135. What are the membranes, which divide cochlea into three compartments?
i. Vestibular membrane or Reissner's membrane: Separates scala vestibuli and scala media
ii. Basilar membrane: Separates scala media and scala tympani.

136. Name the fluids present in cochlea.
i. Perilymph in scala vestibuli and scala tympani
ii. Endolymph in scala media.

137. What is helicotrema?
Helicotrema is small canal that connects scala vestibuli and scala tympani at the apex of cochlea.

138. What is ductus reunions?
Ductus reunions is a slender canal that connects scala media with saccule of vestibular apparatus.

139. What is organ of Corti?
Organ of Corti is the receptor organ for hearing. It is the neuroepithelial structure in cochlea.

140. What are the receptor cells of auditory sensation? And mention their innervation.

Inner and outer hair cells present in Organ of Corti form receptors of auditory sensation.

Auditory receptors are supplied by bipolar cells of spiral ganglion, situated in modiolus of cochlea. Peripheral short processes (dendrites) of the bipolar cells are distributed around hair cells as afferent nerve fibers. Their long processes (axons) leave the ear as cochlear nerve fibers and enter medulla oblongata. In medulla oblongata, these fibers divide into two groups, which end on ventral cochlear nucleus and dorsal cochlear nucleus of the same side in medulla oblongata.

141. What is tectorial membrane? What is its function?

Tectorial membrane is the membrane present at the roof of organ of Corti and it is in contact with processes of hair cells of organ of Corti. When sound waves reach the inner ear, the endolymph in scala media vibrates. This causes movements of tectorial membrane. The movements of tectorial membrane stimulate the hair cells.

142. What are the divisions of vestibulocochlear nerve (VIII cranial nerve)?

i. Vestibular division: Supplies the vestibular apparatus.
ii. Cochlear division: Supplies the cochlea.

143. Trace the auditory pathway.

i. Receptors: Hair cells in organ of Corti
ii. First order neurons: Neurons in spiral ganglia Axons of these neurons form cochlear nerve
iii. Second order neurons: Neurons in ventral and dorsal cochlear nucleus
iv. Third order neurons: Neurons in superior olivary nucleus and nucleus of lateral lemniscus
v. Subcortical center: Medial geniculate body of thalamus
vi. Cortical centers: In auditory cortex in temporal lobe of cerebral cortex.

144. What is auditory radiation? What is its significance?

Auditory radiation is the group of nerve fibers from medial geniculate body go to the temporal cortex, via internal capsule. The fibers of auditory radiation are involved in reflex movement of head, in response to auditory stimuli.

145. What are the cortical areas for auditory sensation?

i. Primary auditory areas: Areas 41 and 42
ii. Wernicke's area
iii. Auditopsychic area: Area 22.

146. What are the functions of cortical areas for auditory sensation?

Primary auditory areas (areas 41 and 42): Concerned with perception of auditory impulses.

Wernicke's area and auditopsychic area (area 22): Concerned with analysis and interpretation of auditory impulses.

147. What are effects of lesion of auditory pathway?

i. Lesion of cochlear nerve causes deafness of the ear.
ii. Unilateral lesion of auditory pathway, above the level of cochlear nuclei causes diminished hearing.
iii. Degeneration of hair cells in the organ of Corti leads to presbycusis. Presbycusis is the gradual loss of hearing. It is common in old age.
iv. Lesion in superior olivary nucleus results in poor localization of sound.

148. What is the role of external ear in hearing?

External ear directs the sound waves towards the tympanic membrane.

149. What is role of middle ear in hearing?

Role of middle ear in hearing is to conduct the sound waves. When sound waves reach the tympanic membrane, it vibrates. Vibrations from tympanic membrane are transmitted by auditory ossicles in the middle ear to perilymph of internal ear through oval window.

150. What is sound impedance? How is impedance offered in the ear?

Impedance means obstruction or opposition to the passage of sound waves. In the ear, impedance is offered by the perilymph present in cochlea.

151. What is impedance matching?

Impedance matching is the process by which tympanic membrane and auditory ossicles convert the sound energy into mechanical vibrations in cochlear fluid with minimum loss of energy by matching the impedance offered by fluid.

152. What is the significance of impedance matching?

Impedance matching is the most important function of middle ear. Because of impedance matching the sound waves are transmitted to cochlea with minimum los of intensity. Without impedance matching, conductive deafness occurs.

153. Name the types of conduction of sound waves in the ear.

i. Ossicular conduction
ii. Bone conduction
iii. Air conduction.

154. What is the role eustachian tube?

Eustachian tube is not concerned with hearing directly. However, it is responsible for equalizing the pressure on either side of tympanic membrane.

155. What is traveling wave?

Travelling wave is a mechanical wave initiated by auditory stimulus in basilar fibers at base of basilar membrane. It travels along basilar membrane towards the apex of basilar membrane near helicotrema like that of arterial pulse wave.

Vibrations from tympanic membrane reach the oval window and cause movement of fluid in scala vestibuli, scala media and scala tympani. Movement of fluid in scala tympani initiates the wave in basilar membrane near round window. This wave travels through basilar membrane towards helicotrema, at the apex of cochlea.

156. What is the significance of traveling wave?

Traveling wave produces vibration in basilar membrane, which in turn, causes stimulation of hair cells in organ of Corti.

157. What is sound transduction?

Sound transduction is a sensory transduction in hair cells which are the receptor cells in organ of Corti by which sound energy is converted into action potential in the auditory nerve fiber.

158. Name the electrical potentials involved during the process of hearing.

i. Receptor potential or cochlear microphonic potential
ii. Endocochlear potential or endolymphatic potential
iii. Action potential in auditory nerve fibers.

159. What is cochlear receptor potential or cochlear microphonic potential?

Cochlear receptor potential or cochlear microphonic potential is the mild depolarization that is developed in the hair cells of organ of Corti when sound waves are transmitted to internal ear.

Resting membrane potential in hair cells is – 60 mV. Stimulation of hair cells causes development of mild depolarization up to – 50 mV.

160. What are the properties of cochlear receptor potential?
Cochlear receptor potential is:
i. Monophasic
ii. Non-propagative.

161. What is the significance of cochlear receptor potential?
Cochlear microphonic potential causes generation of action potential in auditory nerve fiber.

162. What are the roles of inner and outer hair cells in sound transduction?
Inner hair cells: Responsible for sound transduction and cause generation of action potential in auditory nerve fibers.
Outer hair cells: Responsible for mechanoelectrical transduction by shortening during depolarization and elongating during hyperpolarization. These actions of outer hair cells facilitate movement of basilar membrane and increase the amplitude and sharpness of sound.

163. What is endocochlear or endolymphatic potential? What is its significance?
Endocochlear or endolymphatic potential is the electrical potential that exists between endolymph and perilymph with endolymph having a potential of + 80 mV.
It increases the excitability and response of hair cells.

164. What are the theories of hearing?
i. Theories of first group: According to these theories, analysis of pitch of the sound is the function of cerebral cortex:
   a. Telephone theory of Rutherford
   b. Volley theory.
ii. Theories of second group: According to these theories, analysis of pitch of the sound is the function of cochlea:
   a. Resonance theory of Helmholtz
   b. Place theory
   c. Traveling theory.

165. Name the auditory defects or deafness.
i. Conduction deafness
ii. Nervous deafness.

166. What is conduction deafness? What are its causes?
Conduction deafness is the type of deafness that occurs due to impairment in transmission of sound waves in the external ear or middle ear.
Causes:
i. Obstruction of external auditory meatus by wax
ii. Thickening of tympanic membrane due to repeated middle ear infection
iii. Perforation of eardrum by unequal pressure on either side
iv. Otis media: Inflammation of middle ear
v. Otosclerosis: Fixation of footplate of stapes against oval window.

167. What is nervous deafness? What are its causes?
Nervous deafness is the deafness caused by damage of any structure in cochlea such as hair cell, organ of Corti, basilar membrane or cochlear duct or lesion in auditory pathway.
Causes:
i. Degeneration of basilar membrane or cochlear duct or the lesion in the auditory pathway
ii. Damage of cochlea by prolonged exposure to load noise
iii. Tumor affecting VIII cranial nerve.

168. Name the tests for hearing.
i. Rinne's test
ii. Weber's test
iii. Audiometry.

169. What is the frequency of tuning fork that is used for hearing tests?
512 cycles/second.

170. Which type of conduction is better in persons with normal hearing?
In persons with normal hearing, air conduction is better than bone conduction.

171. Which type of conduction is better in conduction deafness?
In conduction deafness, bone conduction is better than air conduction.

172. What does happen to conduction of sound in nerve deafness?
In nerve deafness, both air conduction and bone conduction are reduced or lost.

173. What is audiometry?
Audiometry is a technique used to determine the nature and extent of auditory defects.

174. Name the sense organs for taste or gustatory sensation.
Taste buds are the sense organs for taste sensation.

175. Where are the taste buds situated?
Taste buds are situated on the papillae of tongue and in the mucosa of epiglottis, palate, larynx and proximal part of esophagus.

176. What are the types of papillae on the tongue?
i. Filiform papillae situated over the dorsum of tongue
ii. Fungiform papillae situated over the anterior surface of tongue near the tip
iii. Circumvallate papillae arranged in the shape of 'V' over the posterior part of tongue.

177. Name the types of cells present in the taste buds. Which are the receptor cells?
i. Type I cells or sustentacular cells
ii. Type II cells
iii. Type III cells
iv. Type IV cells or border cells
Type III cells are the receptor cells in taste bud.

178. Trace the pathway for taste sensation.
Pathway for taste sensation includes:
Receptors: Receptor cells in taste buds.
First order neurons: Neurons in the nuclei of the cranial nerves namely, facial nerve, glossopharyngeal nerve and vagus nerve.
Second order neurons: Neurons in the nucleus tractus solitarius.
Third order neurons: Neurons in the posteroventral nucleus of thalamus.
Taste center: Opercular area of cerebral cortex.

179. Name the nerves carrying taste sensation.
i. Chorda tympani branch of facial nerve: Carries taste sensation from anterior two thirds of tongue.
ii. Glossopharyngeal nerve: Carries taste sensation from posterior two thirds of tongue.
iii. Vagus nerve: Carries taste sensation from other areas.

180. Name the primary taste sensations.

i. Sweet
ii. Salt
iii. Sour
iv. Bitter
v. Umami.

181. Name the chemical substances producing taste sensation.

Sweat taste: Organic substances like monosaccharides, poly saccharides, glycerol, alcohols, aldehydes, ketones and chloroform and inorganic substances like lead and beryllium.

Salt taste: Chlorides of sodium, potassium and ammonium, nitrates of sodium and potassium and some sulfates, bromides and iodides.

Sour taste: Hydrogen ions in acids and acid salts.

Bitter taste: Organic substances: Quinine, strychnine, morphine, glucosides, picric acid and bile salts Inorganic substances: Salts of calcium, magnesium and ammonium. Bitter taste is mainly due to cations.

Umami taste: Glutamate.

182. Name the taste sensations having very low threshold value and very high threshold.

Bitter taste has a very low threshold (quinine in 1 in 2,000,000 dilution) value.

Sweet taste has a very high threshold (sugar in 1 in 200 dilution) value.

183. What is taste transduction?

Taste transduction is the process by which taste receptor converts chemical energy into action potentials in taste nerve fiber.

184. What is ageusia? What are its causes?

Loss of taste sensation is known as ageusia. Aqeusia in anterior two thirds of the tongue is caused by lesion in facial nerve, chorda tympani or mandibular division of trigeminal nerve. Aqeusia in anterior one thirds of tongue is caused by lesion in glossopharyngeal nerve.

185. What is hypogeusia?

Decrease in taste sensation is called hypogeusia.

186. What is taste blindness?

Taste blindness is a rare genetic disorder in which the ability to recognize substances by taste is lost.

187. What is Dysgeusia?

Dysgeusia is the disfunction of taste sense associated with unpleasant taste perception.

188. What is flavor of food?

Flavor of food is the combination of two chemical sensations namely taste and smell sensations.

189. What are the receptors for sensation of smell or olfactory sensation?

Receptors for sensation of smell or olfactory sensation are the expanded end of dendrite of bipolar neurons situated in olfactory mucous membrane.

190. What is vomeronasal organ?

Vomeronasal organ is an accessary olfactory organ found in animals including mammals.

191. What about vomeronasal organ in human beings?

Recently, it is claimed that vomeronasal organ is present in human beings in the form of vomeronasal pits on anterior part of nasal septum. It is not known whether it is having olfactory function or not. Receptors in the pit detect odorless human pheromones or vomeropherins.

192. Trace the pathway for olfactory sensation.

i. Receptors: Ending of dendrite of bipolar cells in olfactory mucous membrane.
ii. Axons of these cells synapse with dendrites of mitral cells, which form the olfactory glomeruli in olfactory bulb.
iii. Axons from olfactory bulb form olfactory tract that terminates in the center situated in olfactory cortex.
iv. Olfactory cortex includes the structures of limbic system namely, olfactory nucleus, prepyriform cortex, olfactory tubercle and amygdala.

193. What is olfactory transduction?

Olfactory transduction is the process by which olfactory receptor converts chemical energy into action potentials in olfactory nerve fiber.

194. What are the different types of odor? Give examples.

i. Aromatic or resinous odor: Camphor, lavender, clove and bitter almond
ii. Ambrosia odor: Musk.
iii. Burning odor: Burning feathers, tobacco, roasted coffee and meat
iv. Ethereal odor: Fruits, ethers and bees wax
v. Fragrant or balsamic odor: Flowers and perfumes
vi. Garlic odor: Garlic, onion and sulfur
vii. Goat odor: Caproic acid and sweet cheese
viii. Nauseating odor: Decayed vegetables and feces.
ix. Repulsive odor: Bed bug.

195. What are the two types of olfaction?

i. Orthonasal olfaction is the perception of smell by means of sniffing into the nose. In this type of olfaction, the odor molecules pass through nostrils, reach the olfactory mucous membrane and stimulate the olfactory receptors.
ii. Retronasal olfaction is the perception of odor originating from mouth during eating or drinking. While chewing the food or while drinking, some of the odor molecules gently pass through the passage behind uvula, reach the nasal cavity and stimulate the olfactory receptors.

Retronasal olfaction is commonly linked with flavor of the food. Flavor is a combined sense which involves sensation of taste and sensation of smell.

196. What is anosmia?

Anosmia refers loss of sensation of smell.

197. What is hyposmia? What is its common cause?

Hyposmia is the reduced ability to recognize and to detect any odor. Its common cause is the constant exposure to a particular odor like that of perfume that is often used in excess.

198. What is hyperosmia?

Hyperosmia is the increased or exaggerated olfactory sensation.

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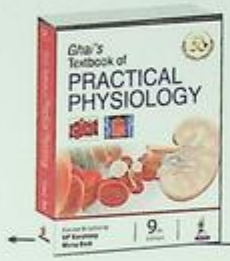

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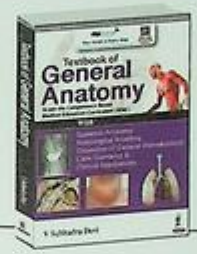

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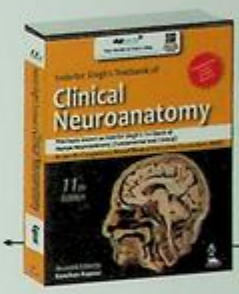

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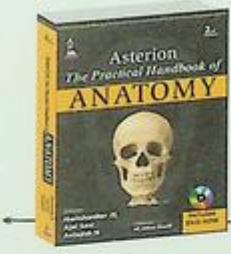

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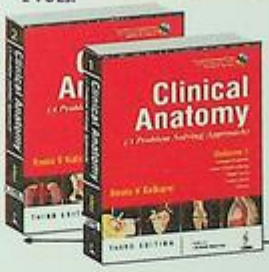

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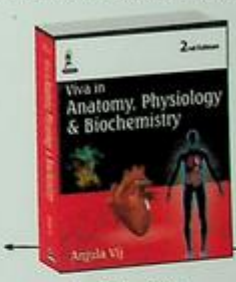

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