

UNIT

1

Introduction to Human Anatomy

Structure

- 1.1 Introduction
- 1.2 Some important definitions
- 1.3 Several terms used in anatomy to describe.
- 1.4 Terms to describe movements occurring at various joints.
- 1.5 Different anatomical system of human body.

Summary

Learning Objectives

- Student should be able to know the meaning and historical background of Anatomy.
- Student should be able to know the meanings of different terms and definitions of anatomy.
- Student should have an idea of different anatomical systems of human body.

1.1 Introduction

Anatomy is the study of structure of human body. Study of anatomy helps in understanding the functions of body. **Herophilus** (335-280 BC) born in Chalcedon in Asia Minor (now Kadiköy, Turkey), and later moved to Alexandria

is called the 'Father of anatomy'. **Andreas Vesalius**, a Flemish physician is referred to as the 'Father of modern human anatomy'. Different aspects included in anatomy are Histology, Osteology, Myology, Arthrology and Neurology etc. Histology is study of tissues. Osteology is study of bones. Myology is study of muscles. Arthrology is study of Joints. Neurology is study of nerves and nervous system.



Fig. 1.1 Andreas Vesalius, Latinized form of Andries van Wesel (1514 – 1564)
“Father of modern human anatomy”

1.2 Some Important Definitions

Cell: Cell is the tiniest particle of body. It is the basic functional and structural unit of body.

Tissue: Tissue is a group of cells of similarity in structure, function and origin.

Organ: Organ is a group of different kinds of tissues for performing specific functions.

System: System is collection of different organs of body to work collectively to conduct some kinds of functions.

Ex: Respiratory system, Digestive system, etc.

Organism : Organism consists of different systems.

1.3 Several Terms used in Anatomy to indicate Anatomical Positions

Some of the terms are-

1. Superior: Nearer to head.
2. Inferior: Lower or below

3. Anterior or ventral : Front
4. Posterior or dorsal: Back
5. Proximal: Nearer
6. Distal: Away
7. Superficial : Nearer to the skin surface.
8. Deep: Deeper from skin surface.
9. Medial: Nearer to midline.
10. Lateral: Away from midline.

Median line or sagittal line: It is imaginary plane dividing the body into two halves.

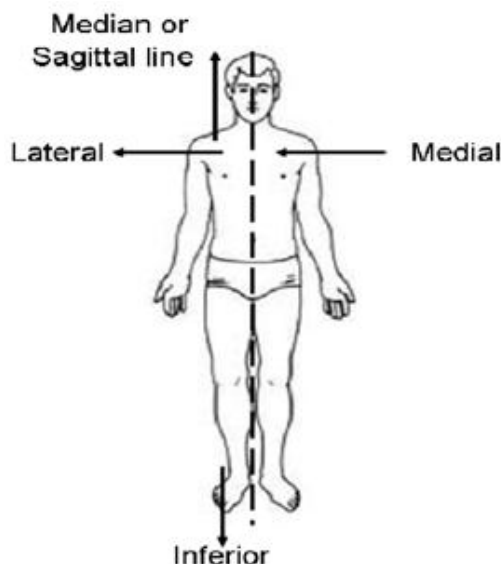


Fig. 1.2 Anatomical Positions

Horizontal section: It divides body into superior and inferior portions.

Sagittal section: It divides body into right and left portions. Coronal section: It divides the body into anterior and posterior portions.

1.4 Terms to describe movements occurring at Various Joints

1. Flexion : Flexion is the movement where similar surfaces come nearer to each other reducing the angle between them.ex: Bending of fore arm near elbow.

2. Extension: It is the movement causing similar surfaces to go apart. It

is opposite to flexion. ex : Straightening of bent fore arm.

3. Adduction: It is the movement bringing the limb towards mid line.

4. Abduction: It is the movement taking the limb away from the mid line.

5. Rotation: It is the movement around central axis involving 360° .

6. Medial rotation : It is rotation towards medial direction.

7. Lateral rotation: Rotation towards lateral direction is called lateral direction.

8. Circumduction: It is the movement involving flexion, abduction, extension and adduction occurring in sequence.

1.5 Different Anatomical Systems of Human Body

Different anatomical systems of human body and their parts in brief are-

1. Skeletal system

Total 206 bones forming the human skeleton can be divided into-

(1) Bones of Axial skeleton (2) Bones of appendicular skeleton

(1) Bones of Axial skeleton are divided into- (i) Bones of skull & (ii) Bones of trunk.

(i) Bones of skull : a. Bones of cranium b. Bones of face

(ii) Bones of trunk:: a. Sternum b. Ribs c. Vertebral column

(2) Bones of appendicular skeleton:

a. Bones of upper limbs b. Bones of lower limbs

2. Muscular system

The muscular system is the body's largest system, normally comprising about 40 percent of body weight.

Muscles are three types. 1. Skeletal muscles 2. Cardiac muscle 3. Smooth muscles

3. Respiratory system

1. Nose 2. Pharynx 3. Larynx 4. Trachea They lead to the lungs.
5. Bronchi 6. Bronchioles 7. Alveolar ducts 8. Alveoli

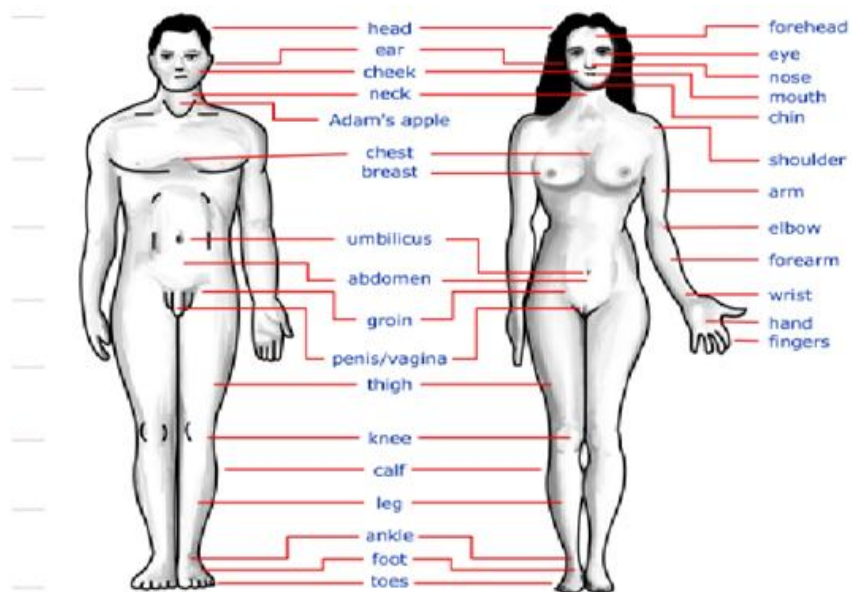


Fig 1.3 Outer parts of body male & female

4. Digestive System and Hepato Biliary System

Various parts of the Digestive tract-

1. Mouth 2. Pharynx 3. Oesophagus 4. Stomach 5. Small intestine 6. Large intestine 7. Rectum 8. Anus

Accessory organs of the digestive tract -

1. Teeth 2. Three pairs of salivary glands 3. Liver and biliary system 4. Pancreas

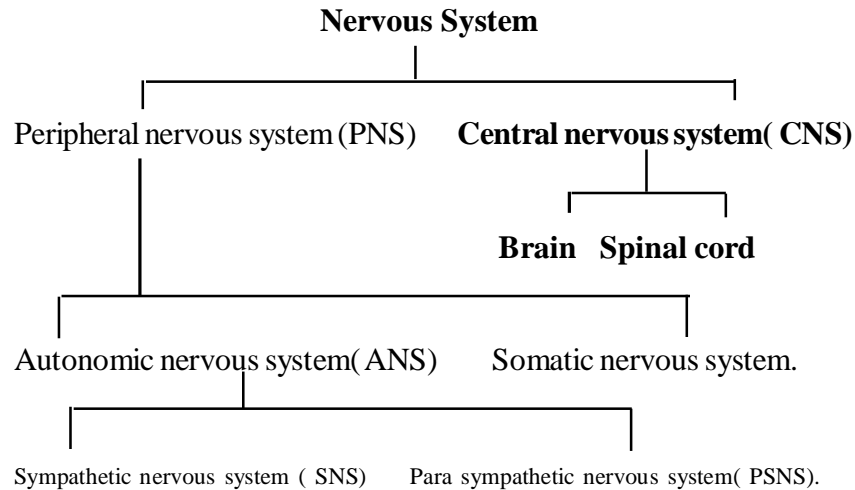
5. Cardio vascular System

Cardiovascular system consists of Heart and Vascular system. There are two types of blood vessels mainly. They are arteries and veins.

6. Lymphatic System

Lymphatic system is a closed system consisting of 1) Lymphatic capillaries
2) Lymphatic vessels 3) Lymph nodes and 4) Lymphducts.

7. Nervous System



8. Excretory system

Excretory system consists of channels of excretion. They are-

1. Urinary system consisting of - Kidneys (2), Ureters (2), Urinary bladder & Urethra
2. Skin 3. Liver 4. Lungs (2) 5. Digestive tract 6. Salivary glands (3 pairs)

9. Endocrine System

Endocrine glands of human body are-

(1) Hypothalamus	(3) Thyroid gland
(2) Pituitary gland (Master gland)	(5) Adrenal glands
(4) Parathyroid gland	(7) Testes
(6) Pancreas	(9) Placenta
(8) Ovaries	(11) Pineal body
(10) Thymus &	

10. Reproductive System

Male reproductive system:

Parts of male reproductive system are- Testes, Epididymis, Vas deferens, Seminal vesicles, Ejaculatory ducts, Prostate gland, Bulbo urethral glands & Penis.

Female reproductive system:

From outside inwards it contains the parts as follows :

- Vagina - Uterus - Fallopian tubes - Ovaries

11. Sense Organs

Sense organs of human body are eyes(2), Ears (2), Nose, Tongue& Skin.

Conclusion

Anatomy is the science of study of structure of human body. It helps in understanding the functions of various systems of human body.

Summary

Anatomy is the science dealing with structure of body. Subject matter of anatomy includes Histology, Osteology, Myology, Arthrology, Neurology etc. Various terms describing the human body are - Median line, medial, lateral superior, inferior, anterior, posterior, proximal, distal, superficial, deep etc. Terms describing the movements occurring at various joints of body are- Flexion, extension, adduction, abduction, rotation, medial rotation, lateral rotation, circumduction etc.

Different anatomical systems of human body are-

1. Skeletal system 2. Muscular system
3. Respiratory system 4. Digestive System and Hepato Biliary System
5. Cardio vascular System 6. Lymphatic System
7. Nervous System 8. Excretory system 9. Endocrine System
10. Reproductive System 11. Sense Organs

Model Questions

Short Answer Type Questions

1. Define anatomy and mention various subjects which enrich Anatomy.
2. Write the definitions of a) Histology b) Osteology.
3. What are a) Myology b) Arthrology c) Neurology ?
4. Explain the terms -Median line, medial and lateral.
5. Define the terms superior and inferior.

6. Write the definitions of a) Anterior b) Posterior.
7. Give the definitions of a) Proximal b) Distal.
8. Explain the terms - Superficial and deep.
9. Define the movements a) Flexion b) Extension.
10. Write the definitions of Adduction and Abduction.
11. Explain the terms a) Rotation b) Circumduction.
12. Define the terms a) Medial rotation b) Lateral rotation.

Long Answer Type Questions

1. Define Anatomy and write the introduction of Anatomy.
2. Explain in brief about different anatomical systems of human body.

UNIT

2

Cell Tissue**Structure**

2.1 Cell

2.2 Tissue - Classification in brief.

2.3 Summary

Learning Objectives

- Student should know the structure and properties of a cell.
- Student should know various types of tissues.

2.1 Cell**2.1.1 Definition**

Cell is the basic structural and functional unit of living matter. It is the smallest unit of life. It is capable of carrying life processes independently. Some organisms such as bacteria are unicellular.

2.1.2 Structure and Properties**2.1.2.1 Structure of Cell**

There are two types of cells in body. They are 1) Somatic cells 2) Gonadal cells.

Somatic cells are diverse cells which make up somatic structure of body.

Gonadal cells are gametes which can unite to form new individual.

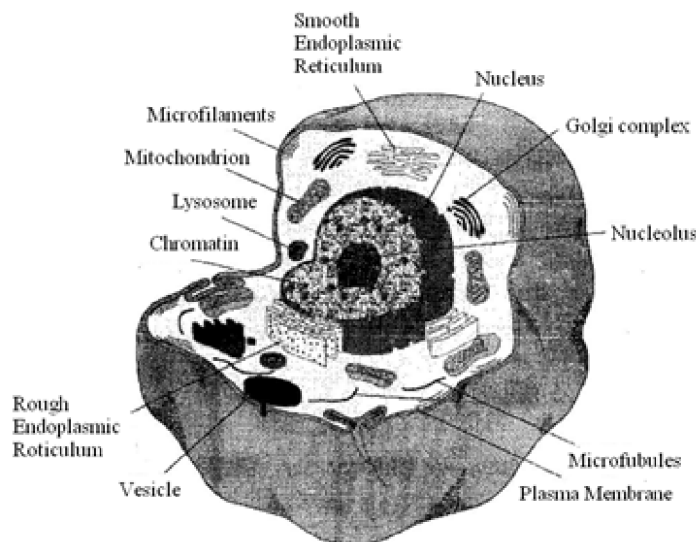


Fig 2.1 Structure of a Cell

Cells vary in size and shape. Most of the cells contain similar type of intracellular components. Average size of mammalian cell is 10^{-2} mm in diameter.

Every cell comprises following parts.

1. Cell wall (cell membrane)
2. Protoplasm, consisting of Cytoplasm and Nucleus

Cell Wall

It is also called as plasmalemma or plasma membrane or cell membrane. It is the outer protective layer of cell. It isolates cell from neighbouring environment. It cannot be seen by light microscope. It can be seen by electron microscope. It is about 80 \AA thick. It has trilaminar structure of phospholipid bilayer sandwiched between two densely stained protein layers. Phospholipid molecules have two parts. They are 1) Head (Phosphate) & 2) Tail (Fatty acid) outer surface of cell wall contains pinocytotic vesicles. Inner surface is continuous with endoplasmic reticulum (ER). Functions of cell wall are 1) Transport of materials (main function) 2) Protection 3) Reception of external stimuli. 4) Ingestion of nutrients 5) Excretion of waste products of cellular metabolism.

Cytoplasm

Cytoplasm is the mass of living matter between cell wall and nucleus. It contains stored foods, secretion granules, pigments and crystals. These are called

cytoplasmic inclusions. Stored foods are carbohydrates, fats, proteins, minerals and vitamins. Pigments are two types - endogenous and exogenous. Endogenous pigments are haemoglobin and melanin. Exogenous pigments are carotene from vegetables, dusts (carbon) and minerals (silver, lead etc.) Cytoplasmic organelles are- Endoplasmic reticulum, Golgi apparatus, Mitochondria, Lysosomes, Ribosomes, Centrosomes etc.

Endoplasmic reticulum

Endoplasmic reticulum is system that continues with infoldings of cell membrane and interlaces with the interior of cell. There are two types of endoplasmic reticulum- Smooth ER & Rough ER. Smooth ER is network of smooth tubules. Functions of smooth ER are metabolism and synthesis of steroids and glycogen. Rough ER consists of ribosomes. It is prominent in Adrenal cortex, liver and striated muscle. Functions of rough ER are 1) Protein synthesis & 2) Translation of language of nucleic acids.

Golgi apparatus

It is shaped like network of threads. Its functions are 1) Synthesis of various secretions & 2) Storage of enzymes, ascorbic acid and some other substances.

Mitochondria

They are granular, filamentous or rod shaped solid bodies. They vary in size from 0.5 to 5 microns. They are surrounded by trilaminar double membrane. Inner one remains folded to form partitions called cristae mitochondriales. Intramitochondrial space contains fluid called matrix. Number and size of mitochondria of a cell are determined by energy requirements of cell. Cells of liver, kidney and heart possess large amount of mitochondria.

Functions of mitochondria are 1) They are called power houses of cells. They supply 95% of cell's energy requirement. In presence of oxygen, Krebs's cycle runs in mitochondria with the help of respiratory enzymes - flavoprotein enzymes and cytochrome. These enzymes help in oxidative phosphorylation. They provide site for formation of ATP. & 2) Synthesis of RNA and DNA.

Lysosomes

They are digestive organs of cells. They are also called suicide bags of cells. They are digestive organelles of cells. They contain powerful hydrolytic enzymes. Lysosomes are absent in RBC. Functions of lysosomes are 1) Breaking down of particles taken in to cell and digestion. 2) Autolysis 3) Phagocytosis 4) Killing of cells (planned way) 5) Cell division etc.

Ribosomes

They are scattered through out cytoplasm singly or as groups. They are ribonucleoprotein in nature. Their function is protein synthesis.

Centrosome

Centrosome contains centrioles. Centrioles control polarisation of spindle fibres. Centriole is closely related to spindle formation during cell division (Mitosis).

Plasmosin

Plasmosin is constant constituent of cytoplasm. They form

- Tonofibrils in epithelial cells, myofibrils in muscles and neurofibrils in nerves.

They consist of long protein molecules rich in deoxy-ribonucleoprotein.

Vacuoles

They are also cytoplasmic organelles. They are found covered by fat on staining with dilute neutral red solution.

Nissl bodies

They are found in nerve cells.

Secretory granules

They store secretory products of cell and are found in- Golgi apparatus and E.R.

Nucleus

It is the key structure of living cell. Nucleus is covered by nuclear membrane. Nucleus consists of chromatin and nucleolus. Chromatin is dense chromosomal network. There is usually simple nucleolus or 2-5 nucleoli in a cell. Nucleolus contains nucleolemma. Nuclear material differs from cytoplasm in several ways. Chromosomes seen in interphase nucleus are densely stained portions of chromosomes. Chromatin contains different genes which determine heredity of cell.

Chromosomes

Chromosomes are present as individual bodies in interphase as well as in mitosis. Predominant component in chromosome is DNA. Genes are located in chromosome. They are discrete units of transmission of hereditary characters.

In female, 2X chromosomes and in males 1X and 1Y chromosomes are present.

2.1.2.2 Properties

Properties of cell in unicellular organisms like amoeba are -

- | | |
|-------------------|-----------------------------|
| (a) Irritability | (b) Conductivity |
| (c) Contractility | (d) Absorption |
| (e) Excretion | (f) Growth and reproduction |
| (g) Motility | (h) Secretion |

2.2 Tissue - Classification in Brief

2.2.1 Tissue

Tissue is defined as group of cells of similarity in structure, function and genesis.

2.2.2 Classification

Human body contains following types of tissues.

1) Epithelial tissue 2) Connective tissue 3) Muscular tissue & 4) Nervous tissue

2.2.2.1 Epithelial tissue

Epithelial tissue gives covering to other tissues by forming epithelial membrane. Epithelial membrane rests upon lamina propria. Lamina propria is loose vascular connective tissue, which supplies requirements to epithelial membrane. Cells of epithelial tissue lie close together cemented by a mucoprotein containing hyaluronic acid and calcium salts.

Functions of epithelial tissue are -

1. Protection to underlying surfaces
2. Providing surface for absorption
3. Secretory activity
4. Excretion

Types of Epithelial tissue: Epithelial tissue is majorly classified into

1. Simple epithelium - consisting of single layer of cells
2. Compound epithelium - consisting of multiple layers of cells.

Simple epithelium: Different types of simple epithelial tissues are

- (a) Squamous or pavement epithelium - consisting of single layer of flat

cells.

(b) Cuboidal epithelium - consisting of single layer of cuboidal cells of same dimensions.

(c) Columnar epithelium - consisting of single layer of cells which are lengthier in height than breadth.

(d) Ciliated columnar and cuboidal epithelium-columnar and cuboidal cells containing cilia.

(e) Glandular epithelium - lining the alveoli and ducts of glands.

Squamous or pavement epithelium :

It is found in alveoli of lungs, serous membranes like peritoneum, pleura, nephrons, inner lining of heart etc.

Functions : 1. Dialysis 2. Passage of liquids 3. Protection

Cuboidal epithelium : They are found in inner parts of thyroid gland, salivary glands, digestive glands etc.

Functions 1. Protection 2. Secretion 3. Storage etc.

Columnar epithelium: It is supported by basement membrane. It is found in stomach, small intestine, large intestine, alveoli, ducts of glands etc. In alimentary canal and nephron, it is brush bordered. Goblet cells are another type of columnar epithelium found in large intestine mainly and secrete mucus.

Functions : 1. Absorption 2. Secretion

Ciliated columnar and cuboidal epithelium:

They are ciliated. Border of cell containing cilia contains basal particles in a row. They are found in trachea, fallopian tubes, CNS etc.

Functions: 1. Ciliary movement to maintain flow of mucus in one direction

2. In CNS, its function is suggested to be circulation of CSF.

Glandular-epithelium : They line the alveoli and ducts of glands ex-salivary, sebaceous, mammary and intestinal glands.

Functions : 1. Formation of new substances & 2. Secretion

Compound epithelium : Compound epithelium is classified into -

1. Transitional epithelium-consisting of four layers of cells and lying between simple epithelium and many layered stratified epithelium.

2. Stratified squamous cornified epithelium - consisting of many layers and horny due to deposition of keratin.

3. Stratified squamous noncornified epithelium - consisting of stratified squamous epithelium, not keratinised.

4. Stratified columnar epithelium - consisting of several layers of columnar cells.

5. Stratified columnar ciliated epithelium - consisting of stratified columnar epithelium containing cilia.

Transitional epithelium : It is found in pelvis of kidney, ureter, urinary bladder and urethra etc.

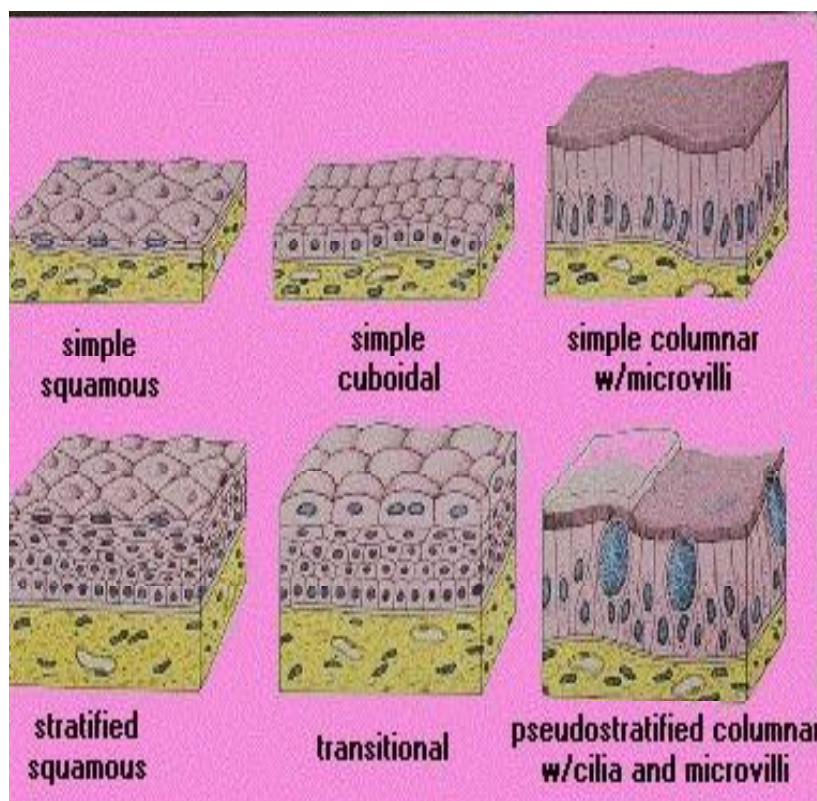


Fig 2.2 Simple and Compound Epithelial Tissue

Functions: 1. Protection 2. Prevention of reabsorption
3. Prevention of drawing water from blood and tissues.

Stratified squamous cornified epithelium : It is found in skin. Hairs, nails, horns, enamel of teeth are modified stratified squamous cornified epithelium.

- Functions:
1. Protection from atmosphere
 2. Protection from mechanical pressure
 3. Protection from injury and friction

Stratified squamous non-cornified epithelium : It is found in cornea, mouth, pharynx, oesophagus, anal canal, urethra, vagina and cervix etc.

Functions: Mechanical protection

Stratified columnar epithelium : It is found in conjunctiva, pharynx, epiglottis, cavernous portion of urethra etc.

Stratified columnar ciliated epithelium: It is found in larynx, soft palate etc.

2.2.2.2 Connective Tissue

Connective tissue is also called mesenchymal tissue. It is developed from mesoderm. It serves the function of binding two tissues. Cells will be less and intercellular matrix will be abundant.

Several types of connective tissue are -

- | | |
|--------------------------------|---------------------------|
| (a) Areolar tissue | (b) Adipose tissue |
| (c) White fibrous tissue | (d) Yellow elastic tissue |
| (e) Reticular tissue | (f) Blood |
| (g) Hemopoietic tissue | (h) Cartilaginous tissue |
| (i) Osseous tissue | (j) Jelly like tissue |
| (k) Reticuloendothelial tissue | |

Areolar tissue : It is supporting and packing tissue. It is distributed between muscular, vascular and nervous tissues. It is distributed in subcutaneous, subserous and submucous tissues. It is composed of fibres and cells. Spaces in the network of fibres is filled with ground substance. Fibres contained are white or collagenous fibres and yellow elastic fibres.

Types of cells found in areolar tissue are -

- | | |
|----------------------|------------------|
| (a) Fibroblasts | (b) Histiocytes. |
| (c) Basophilic cells | (d) Plasma cells |
| (e) Pigment cells | (f) Mast cells |
| (g) Lymphocytes | (h) Monocytes |

Adipose tissue : It is also known as loose connective tissue. It contains fat inside fat cells. It is found below skin in mesentery, omentum etc. It prevents injury to organs. It gives shape to limbs.

It stores energy in the form of fat. It helps in regulation of body temperature.

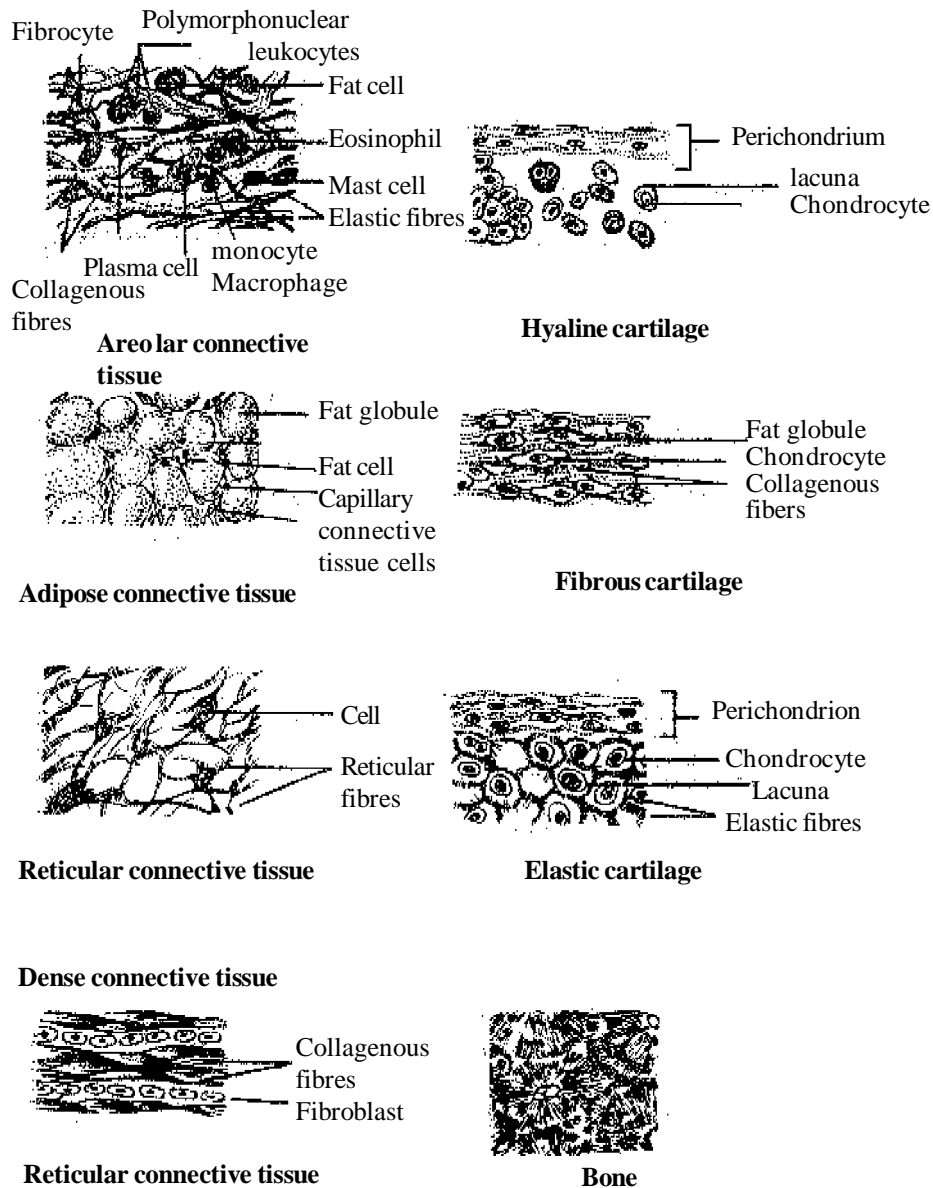


Fig 2.3 Different Connective Tissues

White fibrous tissue : It is made of white fibres formed by fibroblasts.

These fibres are non branching and present in bundles. They are present in tendons and ligaments of limbs. It is made of collagen.

Yellow elastic tissue : It is another variety of fibrous tissue. It is yellow in colour. Fibres are thicker, bundles are wavy, but follow a straight course. Fibres appear angular. Fibres are made of elastin. It is most resistant to many chemicals. It is digested by pancreatin.

It is found in areolar tissue throughout body. It is in concentrated form in ligamentum nuchae of quadrupeds and ligamentum flava of vertebra. It is also present in bronchi, larynx, arterial walls etc. It functions as strong elastic rope. It serves to maintain circulation and blood pressure by its elastic recoil.

Reticular tissue : Reticular tissue is similar to white fibrous tissue with certain differences. Reticular tissue is widely distributed and forms basement membrane of many epithelia. It is found in spleen, liver, lymph and bone marrow etc.

Blood : Blood is fluid connective tissue of body. It is dealt in detail in Blood chapter.

Haemopoietic tissue : There are two types of haemopoietic tissues. They are -

- (a) Myeloid tissue
- (b) Lymphatic tissue

Myeloid tissue : Myeloid tissue is blood forming tissue as well as phagocytic. Myeloid tissue is synonymously used for bone marrow. 'Myelos' means marrow. There are two types of bone marrow

- (a) Red bone marrow ... Active form
- (b) Yellow bone marrow - Inactive form.

Red cells are produced in red bone marrow. In foetal life, most of the bones contain red bone marrow. In postnatal life and with advancement of age, red bone marrow is located only in upper ends of humerus and femur, bones of skull, thorax, vertebrae and pelvic innominate bones. Yellow bone marrow occupies the space where red bone marrow will not be present. Although half of the bone marrow (red bone marrow) is active and half is inactive in adult, active half is enormously functional.

Lymphatic tissue: Lymphatic tissue is two types -

- (a) Non capsulated lymph nodes present in loose connective tissue.
- (b) Capsulated lymph tissue present in lymph organs - lymph node, spleen, thymus, tonsils.

Cartilaginous tissue : It is connective tissue, which is intermediate between fibrous tissue and osseous tissue in firmness and elasticity. Components of cartilaginous tissue are cartilage cells, chondroblasts, inter cellular ground substance called matrix, fibres and two types of proteins called chondromucoid and chondroalbumoid. Chondromucoid on hydrolysis gives chondroitin sulphate.

Cartilaginous tissue is divided into three classes.

(a) Hyaline cartilage (b) Fibrocartilage (c) Elastic cartilage.

Hyaline cartilage : It is made of cartilaginous cells and clear homogenous ground substance. Cartilage cells are also called chondrocytes and occupy small empty spaces in matrix. These small empty spaces in the matrix are called lacunae. Matrix is solid intercellular substance of cartilage or bone. It is distributed in the articular end of bones.

Fibrocartilage: This type of cartilage has great tensile strength with flexibility and rigidity. It can stand with shearing forces. It is found in intervertebral discs, menisci of knee joints, mandibular joints, pubis symphysis, linings of tendon, grooves in bones etc.

Elastic cartilage : It is in between fibrous tissue and osseous tissue. It is yellow in colour and contains elastic fibres. It differs from hyaline cartilage as it contains large number of elastic fibres in the matrix. It is distributed in external ear, epiglottis, eustachian tube and some laryngeal cartilages.

Elastic cartilage strengthens attached organs.

Jelly like connective tissue : It is an embryonic form of areolar tissue

Cells are large fibroblasts. A few macro phages and lymphocytes are also present. Ground substance is mucin in nature. It is found in umbilical cord. It is called as Wharton's jelly here. Vitreous humour of eye ball is composed of this tissue in adult life.

Reticuloendothelial tissue : It possesses various types of connective tissue cells, widely distributed in body. Main functions are phagocytosis, antibody formation, erythropoiesis, haemolysis etc.

Osseous tissue : Osseous tissue constitutes skeleton. It is the hardest connective tissue of body. It is made of bone cells and intercellular ground substance. There are three types of bone cells. They are - Osteoblasts, osteocytes and osteoclasts. Organic part of intercellular ground substance is made of osteocollagenous fibres, bound by ossein.

There are two types of bone tissues according to density and hardness.

They are (1) Compact bone tissue.

(2) Spongy bone tissue

Outer layer of all bones and shaft is compact bone tissue. Inner parts of flat bones, rounded ends of long bones, body of vertebrae possess spongy bone tissue.

Bone is covered with periosteum. Periosteum has two layers- Outer layer and inner layer called cambium. Cambium is osteogenic in its functions to produce osteoblasts and osteoclasts. Endosteum is the lining membrane of marrow cavity. It possesses osteogenic and haemopoietic functions. Bursae consist of small sacs of connective tissue with synovial fluid. Bursae act like cushions and relieve pressure in moving parts. Bone cavity is the hollow space inside the bone and filled with bone marrow. Bone marrow is two types - Red bone marrow and yellow bone marrow. Further reference of bone marrow can be had at myeloid tissue.

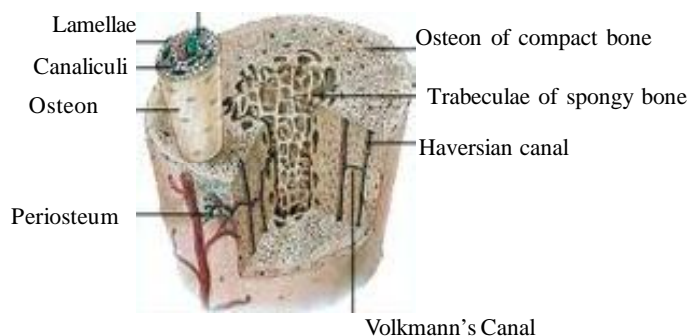


Fig 2.4 Bone Tissue

Transverse section of bone: T.S. of bone under microscope shows Haversian system consisting of -

1. Central Haversian canal
2. Lamellae
3. Lacunae
4. Canaliculi

Central Haversian canal contains blood vessels, nerves and lymphatic vessels. Lamellae are layers of bone deposited in concentric circles around Haversian. Lacunae are interlamellar spaces. Canaliculi are minute canals joining lamellae and communicating with central Haversian canal.

Composition of bone

Ossification

Refer to Bones and Joints.

Types of bones

2.2.2.3 Muscular Tissue

It is type of tissue having ontractile ability on excitation. It has also property of conductivity. There are different types of muscular tissues. Their classifications are based on physiological and anatomical aspects.

Types of muscular tissues based on striation : On this basis, they are two types

1. Striated muscles
2. Non striated muscles.

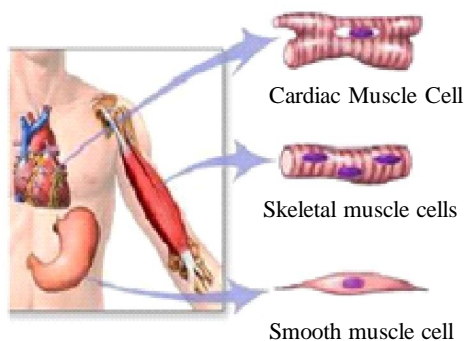


Fig 2.5 Types of Muscular Tissue

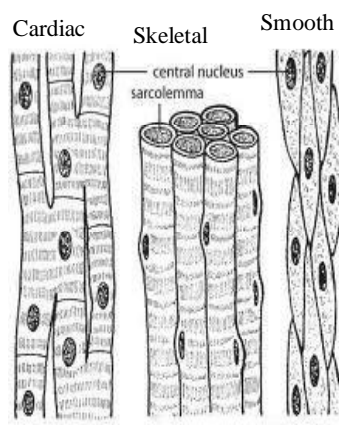


Fig 2.6 Types of Muscular Tissue

Striated muscles have cross striations. Non striated muscles do not have

cross striations and are plain.

Types of muscular tissues on the basis of control:

On this basis, they are two types

1. Voluntary muscles
2. Involuntary muscles

Voluntary muscles are under volitional control. Involuntary muscles are not under volitional control.

Types of muscular tissues on the basis of distribution:

On this basis, they are

1. Skeletal muscles
2. Cardiac muscle
3. Visceral muscles.

Skeletal muscles are attached to bones. They are under the control of will power. Hence they are voluntary muscles. Fibres of skeletal muscles show striations. Hence they are also striated muscles.

Epimysium is the outer covering of skeletal muscle. Perimysium is the outer covering for smaller bundles of skeletal muscle. Smaller bundles into which skeletal muscle is divided are called fasciculi. Each fasciculus contains muscle fibres. Each fibre is covered by endomysium.

Histology of skeletal muscle fibres: Skeletal muscle fibres are cylindrical. They are elongated with several nuclei.

Dimensions of skeletal muscle fibres are - $1-40 \times 0.01 - 0.1 \text{ mm}^2$

Sarcolemma is the transparent cell wall of muscle fibre. Myofibrils are bundles of myofilaments embedded in sarcoplasm inside the plasmalemma. Sarcoplasm contains sarcosomes (mitochondria), small Golgi apparatus, myoglobin, lipid glycogen, sarcoplasmic reticulum.

From electron microscopic studies, it is relevant that myofilaments are formed by thread like protein filaments of which, thicker one is myosin filament (100\AA diameter) and thinner one is actin filament (50\AA). They contain multiple flat nuclei in periphery under sarcolemma.

Cardiac muscle: It is involuntary, striated muscle of heart. It contracts rhythmically and automatically.

Main differences between skeletal and cardiac muscle are

1. Spontaneous nature of rhythmicity and contractility of cardiac muscle.

2. 3-D network of Fibres of cardiac muscle appearing like syncytium under light microscope.

3. Single oval shaped nucleus at the centre of each cell.

Visceral muscles: They are smooth, involuntary and plain muscles of viscera. Visceral muscle fibres are smooth and elongated. They are fusiform with tapering towards periphery. Fine longitudinal striations may be found in special preparation. They contain one oval or rod shaped nucleus at the centre of each cell.

2.2.2.4 Nervous Tissue

Nervous tissue constitutes nervous system. Nervous tissue is excitable type tissue receiving and transmitting messages. It is composed of neurons & neuroglia. Nervous system is ectodermal in origin. There are three types of cells in nervous tissue. They are -

1. Gray matter - forming nerve cells
2. White matter - forming nerve fibres
3. Neuroglia - holding nerve cells and fibres together and supporting them.

Histogenesis of nervous tissue: Nervous system develops from ectoderm and neural plate (also called medullary plate). Medulloblasts give rise to neuroblasts and spongioblasts. Neural cells (Neuroblasts) pass through different stages to give neurone. Spongioblasts are also called glial cells. Spongioblasts give rise to neuroglia.

Neuron : Neuron is the basic functional and structural unit of nervous system.

Parts of neurone are -

1. Nerve cell body (also called perikaryon or neurocyton or soma)
2. Nerve fibres (also called processes of nerve cells)

Nerve cell body : It is the part of neurone containing cell membrane, neuroplasm and nucleus. Neuroplasm contains neurofibrils, Nissl bodies, mitochondria, Golgi apparatus. Superficial reticulum of Golgi, ribosome, endoplasmic reticulum, centrosome and inclusions. Neurofibrils are fine filaments passing through neuroplasm from dendrites to axon. Nissl bodies are angular granules stained with basic dyes.

Nerve fibres : Two types of nerve fibres (also called processes of nerve cell) arise from nerve cell. They are -

- (a) Receptive processes called dendrons (also called dendrites)

(b) Discharging processes called axon.

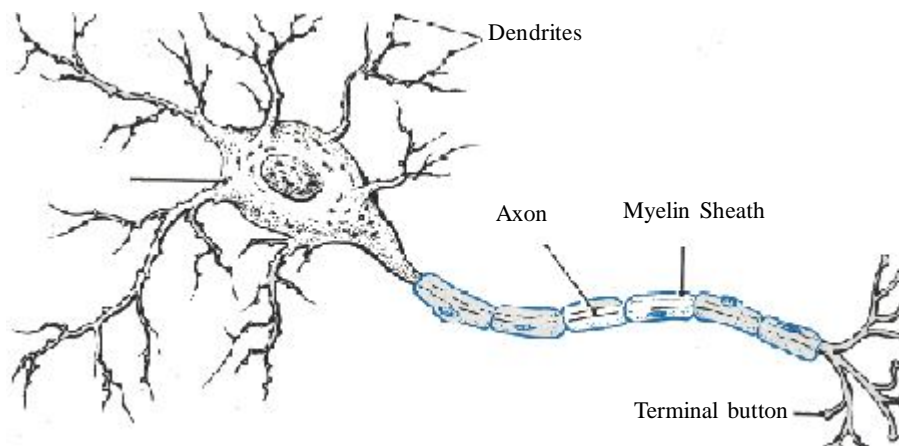


Fig 2.7 Structure of Neuron

Dendrites carry impulses from other neurons and carry them towards nerve cell body. Axon carries impulses away from nerve cell. Axon consists of three parts - axis cylinder, myelin sheath and neurolemma. Axis cylinder contains axoplasm, neurofibrils and mitochondria. Myelin sheath is absent over nerve fibres within grey matter. It is present over nerve fibres after entering white matter. Myelin sheath is also called medullary sheath. Fibres covered with myelin sheath are called myelinated fibres and fibres not covered by myelin are called non myelinated fibres. Function of myelin sheath is insulation of nerve fibre. Nodes of Ranvier are points of absence of myelin in the myelinated fibres (medullated fibres). Neurolemma is the homogeneous nucleated covering over somatic and autonomic nerve fibres outside C.N.S. Myelinated fibres in brain and spinal cord do not have neurolemma. Neuroglia is special type of interstitial tissue giving support and insulation. They are divided into- astrocytes, - oligodendrocytes (or oligodendroglia) and microglia.

Fibres of peripheral nerve trunks are divided into bundles. Individual fibres are held together by loose connective tissue called endoneurium. Each bundle is covered by a sheath called perineurium. Epineurium is the tough enclosure of whole nerve trunk.

Conclusion

Cell is the basic structural and functional unit of living matter.. Tissue is group of cells of similarity in structure, function and genesis.

Summary

Cell is the basic structural and functional unit of body. Types of cells of body are somatic cells and gonadal cells. Structure of cell contains cell wall, cytoplasm and nucleus. Cytoplasm contains cytoplasmic organelles and cytoplasmic inclusions. Cytoplasmic organelles are- Endoplasmic reticulum, Golgi apparatus, Mitochondria, Lysosomes, Ribosomes, Centrosomes etc. Nucleus is the key structure of living cell. Nucleus is covered by nuclear membrane. Nucleus consists of chromatin and nucleolus. Tissue is defined as group of cells of similarity in structure, function and genesis. Human body contains following types of tissues.

1) Epithelial tissue 2) Connective tissue 3) Muscular tissue & 4) Nervous tissue

Epithelial tissue gives covering to other tissues by forming epithelial membrane.

Types of Epithelial tissues are- 1) Simple epithelium - consisting of single layer of cells 2) Compound epithelium - consisting of multiple layers of cells. Several types of connective tissue are - a) Areolar tissue b) Adipose tissue c) White fibrous tissue d) Yellow elastic tissue e) Reticular tissue f) Blood g) Hemopoietic tissue h) Cartilaginous tissue i) Osseous tissue j) Jelly like tissue k) Reticuloendothelial tissue. Muscular tissue is mainly 3 types. a) Skeletal muscles b) Smooth muscles & c) Cardiac muscle. Nervous tissue consists of neurons and neuroglia.

Model questions

Short Answer Type Questions

1. What is cell?
2. Mention the properties of cell.
3. Explain trilaminar structure of cell wall.
4. List out cytoplasmic organelles.
5. Explain endoplasmic reticulum.
6. Write the functions of a) Smooth E.R. b) Rough E.R.
7. What are the functions of Golgi apparatus?
8. Write about mitochondria.
9. What are a) Lysosomes and b) Ribosomes ?

10. Write about plasmosin.
11. Write about first evidence of differentiation of cellular mass.
12. Mention major classes of tissues of human body.
13. Define a) Simple epithelium b) Compound epithelium
14. Describe pavement epithelium.
15. Give the distribution of pavement epithelium.
16. Write the description and distribution of cuboidal epithelium.
17. Write about columnar epithelium.
18. Mention the classes of compound epithelium
19. Write the distribution of
 - (a) Transitional epithelium
 - (b) Stratified squamous cornified epithelium.
20. Write the functions of
 - (a) Stratified squamous non cornified epithelium.
 - (b) Stratified columnar epithelium.
21. What are the types of cells found in areolar tissue?
22. Write about white fibrous tissue.
23. Explain Myeloid tissue.
24. What are different types of cartilaginous tissue?
25. Write about Reticuloendothelial tissue.
26. What are types of bone tissue?
27. Give the T.S. of bone.
28. Mention different types of muscular tissues.
29. Explain
 - (a) Epimysium
 - (b) Perimysium.
 - (c) Endomysium
30. Define
 - (a) Sarcolemma

(b) Sarcoplasm.

31. Differentiate between skeletal and cardiac muscular tissues.
32. Write about visceral muscles.
33. What is nervous tissue?
34. Write different types of maters of nervous tissue.
35. Explain histogenesis of nervous tissue.
36. What are parts of neurone?
37. Mention types of nerve processes.
38. Define
 - (a) Receptive processes of nerve cell.
 - (b) Discharging processes of nerve cell.
39. Write about Soma.
40. Define
 - (a) Myelinated nerve fibres.
 - (b) Non myelinated nerve fibres.
41. Explain
 - (a) Endoneurium.
 - (b) Perineurium.

Long Answer Type Questions

1. Write the structure of cell.
2. Classify tissues.

Respiratory System

Structure

- 3.1 Definition
- 3.2 Parts of Respiratory System
- 3.3 Summary

Learning Objectives

- Student should know the structure of respiratory system.
- Student should understand about respiratory muscles.

3.1 Definition

It is the system consisting of parts concerned with inhalation and exhalation.

3.2 Parts of the Respiratory System

1. Nose
2. Pharynx
3. Larynx
4. Trachea

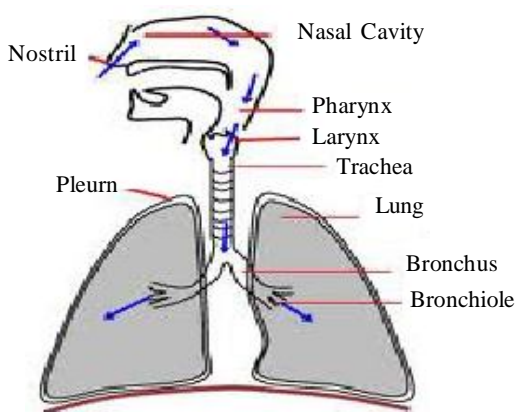


Fig 3.1 Respiratory System

They lead to the lungs.

5. Bronchi

6. Bronchioles

7. Alveolar ducts

8. Alveoli

They are within the lungs.

Upper respiratory tract extends from upper nares to the vocal cord. Lower respiratory tract extends from vocal cord to the alveoli

1. Nose

It is the part of respiratory system through which Air is inhaled in and exhaled out.

External nose: It is the visible part of nose. It is formed by the two nasal bones and cartilage. It is covered by skin. There are hairs inside.

Nasal Cavity : It is a large cavity divided by a septum. It is lined with ciliated mucous membrane. It is extremely vascular.

Anterior nares: They are the openings which lead in.

Poserior nares: They are similar openings at the back and lead into pharynx.

Roof : Roof of the nose is formed by ethmoid bone at the base of the skull.

Floor: Floor of the nose is formed by the hard and soft palates at the roof of the mouth.

Paranasal sinuses: They are the hollows in the bones surrounding the nasal cavity, which are lined with mucous membrane and open into nasal cavity. Maxillary sinus lies below the orbit and opens through the lateral wall of the nose.

Frontal sinus lies above the orbit towards the midline of the frontal bone. Ethmoidal sinuses are contained within the part of the ethmoid bone separating the orbit from the nose. They are numerous.

Sphenoidal sinus lies in the body of the sphenoid bone.

2. Pharynx

It lies between Nasal cavity and larynx.

Pharynx is divided into three parts. They are.

1. Naso pharynx
2. Oro pharynx
- & 3. Laryngo pharynx

Naso pharynx lies between nasal cavity and oro pharynx. It is lined with ciliated mucous membrane which is continuous with lining of the nose. Oro pharynx lies in between Naso pharynx and laryngopharynx. Its lateral wall contains collections of lymphoid tissue called tonsils. Laryngopharynx is the lowest part of pharynx. It lies behind larynx.

3. Larynx

It lies below pharynx and above trachea. It is continuous with oropharynx. Muscles of the neck lie in front of larynx. Laryngopharynx and cervical vertebrae lie behind larynx. Lobes of thyroid gland lie on the either side of larynx.

Larynx is composed of several cartilages. They are joined together by ligaments and membranes.

Cartilages of Larynx are-

1. Thyroid cartilage.
2. Cricoid cartilage.
3. Arytenoid cartilages.
4. Epiglottis

Thyroid cartilage : Thyroid cartilage is formed with two flat pieces of cartilage. It is the largest upper part. Thyroid cartilage is lined with stratified epithelium. Lower part is lined with ciliated epithelium.

Cricoid cartilage: It lies below the thyroid cartilage. Its shape is like signet ring. It is broad at the back. It is lined with ciliated epithelium.

Arytenoid cartilages : They are a pair of small pyramids. They are made of hyaline cartilage. They are located on the broad portion of cricoid cartilage.

Vocal ligaments are attached to them. Chink is the gap between vocal ligaments.

Epiglottis: Epiglottis is a leaf shaped cartilage. It is attached to the inside of the front wall of thyroid cartilage. During swallowing, larynx moves upwards and forward and its opening is occluded by epiglottis.

4. Trachea

It is also called as wind pipe. It is a cylindrical tube. It is about 11 cm. in length. It begins at the lower end of pharynx. It divides into two bronchi at the level of fifth thoracic vertebra. It is made of sixteen to twenty C-shaped incomplete cartilages. They are connected by fibrous tissue at the back. It is lined by ciliated epithelium. Ciliated epithelium contains goblet cells which secrete mucus.

5. Bronchi

Trachea divide into right and left bronchi. Trachea and bronchi, combinedly are inverted Y shaped. Right bronchus leads into right lung and left bronchus leads into left lung. Right bronchus is shorter than left bronchus. It is also wider. Bronchi are made up of complete rings of cartilage.

6. Bronchioles

Bronchioles are the finest branches of bronchi. They do not have cartilage. They are lined by cuboidal epithelium. Bronchioles become further smaller to form terminal bronchioles. Terminal bronchioles are a single layer of flattened epithelial cells.

7. Alveolar ducts

Terminal bronchioles divide repeatedly to form minute passages. These minute passages are called alveolar ducts. Alveolar sacs and alveoli open from alveolar ducts.

8. Alveoli

Alveoli are the final terminations of each bronchi. They contain a thin layer of epithelial cells. They are surrounded by numerous capillaries. Capillary network is the site of exchange of gases between blood and air in the alveoli.

Lungs

Lungs are the principal organs concerned with respiratory process. They are two in number. They are spongy organs. They lie in the thoracic cavity on either side of heart and great vessels. They extend from roof of the neck to the diaphragm. Ribs, costal cartilages and intercostal muscles lie in front of lungs. Behind them-ribs, intercostal muscles and transverse processes of thoracic

vertebrae lie. Mediastinum is a block of tissue in between the two lungs. With in mediastinum lie-Heart, great vessels, trachea, oesophagus, thoracic duct and thymus gland.

Lungs are conical in shape with apex above and base below. A pex slightly rises over the clavicle. Base is near the diaphragm. Each lung is divided into lobes by means of fissures. Right lung is bigger than left lung. Right lung is divided into three lobes. Left lung is divided into two lobes. Each lobe is divided into number of lobules. Each lobe contains a small bronchial tube. This tube divides and sub divides to end in air sacs.

Pleura is a serous membrane covering the lungs. It contains two layers. Inner layer close to the lungs is called as visceral layer. Outer layer is called as parietal layer. Pleural fluid lies in the space between visceral and parietal layers.

Hilum is a triangular shaped depression on the concave medial surface of the lung. It is a vertical slit on each lung through which structures like blood vessels, nerves and lymphatics pass. Root of the lungs (Hilum) is formed by pulmonary arteries, pulmonary veins, bronchial arteries, bronchial veins, bronchi, lymphatic vessels. Pulmonary arteries carry deoxygenated blood to lungs from heart. Pulmonary veins carry oxygenated blood from lungs to the heart. Bronchial arteries are the branches of thoracic aorta carrying arterial blood to lungs. Bronchial veins are the vessels carrying venous blood of lungs to superior venacava.

Respiratory muscles

Intercostal muscles and diaphragm are respiratory muscles. However, during forced respiration sternocleidomastoid, scalenie, mylohyoid, platysma and abdominal muscles also participa

Intercostal muscles: They are two series of muscles. Thus they are 11 pairs. They are external intercostal muscles and internal intercostal muscles. They are innervated by intercostal nerves.

Diaphragm : It is a large dome shaped sheath of muscle. It separates thoracic cavity from abdominal cavity. It is innervated by phrenic nerve on each side.

Summary

Respiratory system is system consisting of parts related with respiration. Parts of respiratory system are -Nose, pharynx, larynx, trachea, bronchi, bronchioles, alveolar ducts and alveoli. Alveoli are the ultimate sites of gaseous exchange. Lungs are two in number. Right lung is divided into three lobes. Left

lung is divided into two lobes. Each lobe is divided into lobules. Pleura is serous membrane covering lungs. Hilum on each lung is a depression through which blood vessels, nerves, lymphatics etc. pass into the lung.

Respiratory muscles are intercostal muscles and diaphragm.

Conclusion

Respiratory system is the system consisting of parts related to respiration. Respiratory muscles help in respiration.

Model questions

Short Answer Type Questions

1. What are the parts of respiratory system, which lead into lungs?
2. Name the parts of respiratory system which lie within lungs.
3. Mention the parts of nose.
4. What are the parts of pharynx?
5. Name the cartilages of larynx.
6. Explain trachea.
7. What are a) Bronchi b) Bronchioles?
8. Write about alveoli.
9. What are respiratory muscles?
10. Name the series of intercostal muscles.
11. How many pairs of intercostal muscles are there?
12. What are the nerves innervating intercostal muscles?
13. Describe diaphragm?

Long Answer Type Questions

1. Write the anatomy of respiratory system.

UNIT

4

Digestive System and Hepato Biliary System

Structure

- 4.1 Introduction
- 4.2. Parts of Digestive Tract
- 4.3 Peritoneum
- 4.4 Accessory Organ of Digestive System

Learning Objectives

- Student should know the anatomy of Digestive and hepato biliary system.
- Student should also know the structures of abdomen supporting digestive organs.

4.1 Introduction

Digestive system consists of gastrointestinal tract and various glands attached. Length of the tract is about 8-10 metres. It starts with mouth and ends with anus.

4.2 Various parts of the Digestive Tract

1. Mouth
2. Pharynx
3. Oesophagus
4. Stomach

- 5) Small intestine 6) Large intestine
7) Rectum 8) Anus

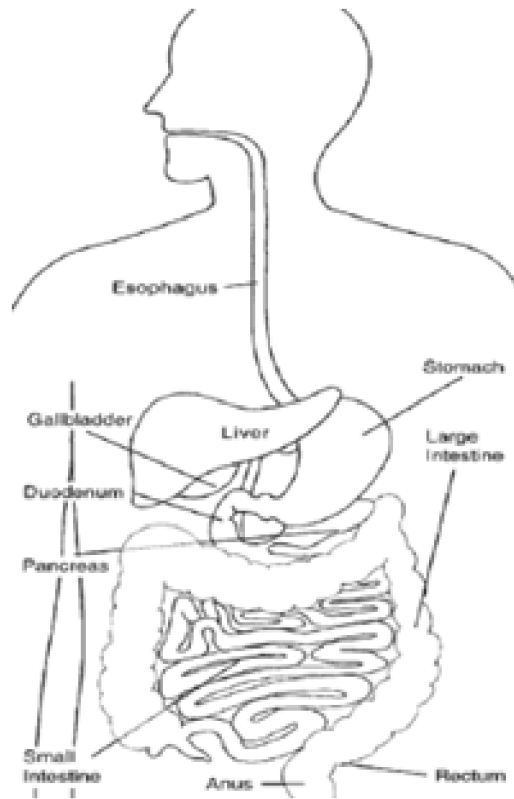


Fig 4.1 Digestive System and Hepato Biliary System

Accessory organs of the digestive tract -

1. Teeth 2. Three pairs of salivary glands
3. Hepato biliary system 4. Pancreas

Mouth

It is the first part of the digestive tract. It opens through upper and lower lips. Roof of the mouth is called as palate. It is dome shaped. Front part of the roof is hard palate and back part of the roof is soft palate. Walls of the mouth are formed by muscles of cheeks. Mouth is lined by mucous membrane. It is continuous with skin of lips and mucous lining of pharynx. Lips enclose orbicularis oris muscle. This muscle keeps the mouth closed. Pharyngeal tonsils are on either side at the back of oral cavity. Uvula hangs down from lower border of soft palate.

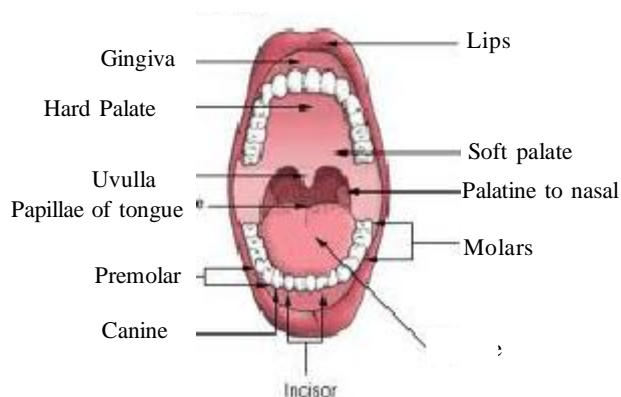


Fig 4.2 Mouth

Tongue

Tongue is at the base of the mouth. It is a musculo-membranous structure. It consists of 1. Stratified and cornified epithelium 2. Voluntary, cross striated muscle fibres and 3. Glands. Epithelium of tongue is modified into papillae and taste buds. Under surface of the anterior part of tongue is connected to the floor of the mouth by frenulum. Frenulum is a fold of mucous membrane.

Teeth

Man is provided with two sets of teeth in his life. First set is called as Deciduous teeth or primary teeth. They are 10+10 in number. They erupt through the gums during first and second years of life. Second set starts replacing the first set at about sixth year and process is complete by twenty fifth year. Second set remains upto old age and is called as permanent teeth.

Permanent teeth are 16+16 in number. Four types of teeth are there. They are -

1. Incisor teeth (I)
2. Canine teeth (C)
3. Premolar teeth (P)
4. Molar teeth (M)

Upper teeth are attached to upper Jaw and Lower teeth are attached to lower Jaw.

Arrangement of permanent teeth

	M	P	C	I		I	C	P	M
Right upper jaw	3	2	1	2	Left upper jaw	2	1	2	3
Right lower jaw	3	2	1	2	Left lower jaw	2	1	2	3

Structure of tooth:

Each tooth consists of three parts. They are - 1) Root 2) Neck 3) Crown

Root is embedded in the alveolus of maxilla or mandible. Neck is the constricted part between root and crown. Crown is the part projecting beyond the gum.

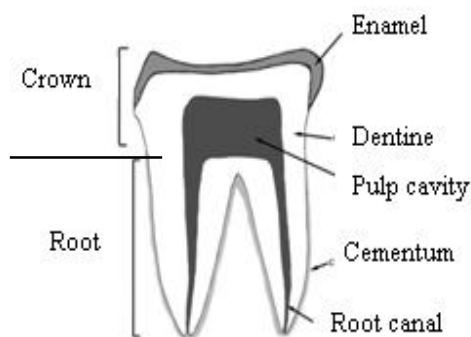


Fig 4.3 Structure of Tooth

Tooth is composed of three substances. They are -

1. Dentine
2. Enamel
3. Cementum

Dentine forms major part of tooth. Enamel is the outer covering of crown.

It is the hardest substance. Cementum is in the neck. It is as hard as bone.

Crowns of Incisor teeth are chisel shaped. Crowns of canine teeth are large and conical. Crowns of premolar teeth are bicuspid and almost circular. Crowns of Molar teeth are broad and tetra or penta cuspid.

Salivary glands

There are three pairs of salivary glands in the mouth. They are-

1. Parotid
2. Submandibular and
3. Sublingual glands.

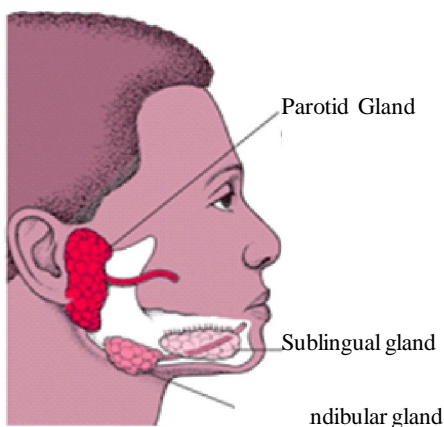


Fig 4.4 Salivary Glands

1. Parotid glands : They are the biggest salivary glands .One gland is present below each ear. Each gland opens on inner side of cheek opposite to the second upper molar teeth through its duct. Ducts of the parotid glands are called as Stenson's ducts.

2. Submandibular glands : They are also called as Submaxillary glands. They are smaller than parotid glands. One on each side lies under the angle of Jaw. Each submandibular gland has a duct called wharton's gland. They open near the mid line under the tongue.

3. Sublingual glands: They are the smallest salivary glands. They lie under the tongue. They pour their secretions in to the mouth through several openings.

Pharynx

Pharynx lies between mouth and Oesophagus. It is divided into 1. Nasopharynx 2. Oropharynx and 3. Laryngopharynx. It serves commonly for both digestive and respiratory systems. Base of the skull forms its roof. There lies a

lymph node called adenoid at the back of nasopharynx.

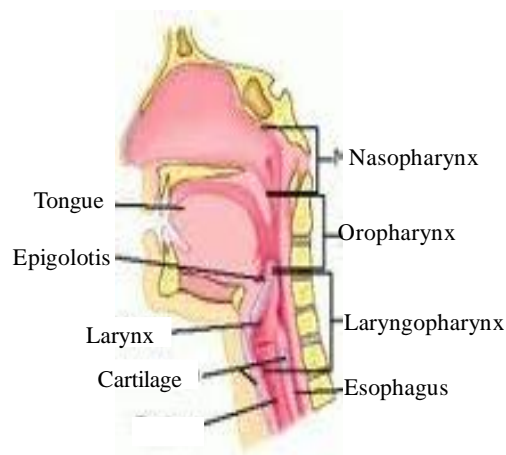


Fig 4.5 Pharynx

Oesophagus

It is muscular tube extending between pharynx and stomach.

Trachea and vertebral column lie in the front and back of oesophagus respectively. It lies in both thoracic and abdominal cavities. It passes from thoracic cavity into abdominal cavity through oesophageal opening of the diaphragm. On the each side of upper part of oesophagus, are present-corresponding common carotid artery and part of thyroid gland. Oesophagus begins at the level of 6th vertebra, enters the abdomen at the level of tenth thoracic vertebra and ends at the level of 11th thoracic vertebra.

Cross section of oesophagus shows similar structure as remainder of alimentary canal. It shows the following layers.

(1) Muscular coat (2) Submucous coat (3) Mucous coat

It is devoid of Serosa. Upper one third of oesophagus consists of striated muscles. Lower one third contains smooth muscles and middle one third contains both types of muscles.

Stomach

Stomach is the most dilated part of digestive tract. It is **J** shaped. It is situated between the end of the oesophagus and beginning of the small intestine. It lies below the diaphragm in the abdominal cavity. Its major part is to the left of the mid line. It distends when it is filled with food. Average capacity of stomach

is 1.5 L in an adult. Stomach has two surfaces, two curvatures, two ends, three parts and two sphincters. They are as follows.

The two surfaces of stomach are- 1. Anterior surface 2. Posterior surface.

Two curvatures are- 1. Lesser curvature 2. Greater curvature.

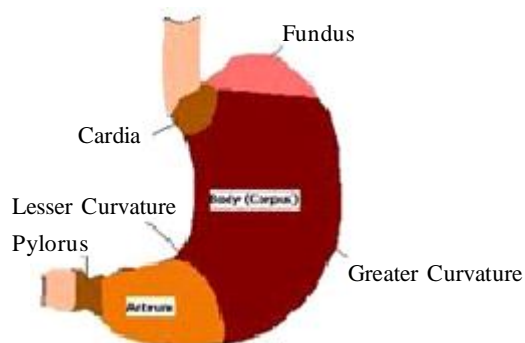


Fig 4.6 Parts of Stomach

Three parts of stomach are -1. Fundus (upper portion) - above the cardiac sphincter 2. Body (middle portion) - between fundus and pylorus. 3. Pylorus (lower portion) - below incisura angularis. Pylorus is subdivided into pyloric antrum and pyloric canal. Two ends of stomach are

1. Cardiac end guarded by cardiac sphincter.
2. Pyloric end guarded by pyloric sphincter.

Two sphincters of stomach are-

1. Cardiac sphincter (at the beginning).
2. Pyloric sphincter (at the ending)



Fig 4.7 Internal Structure of Stomach

Histologically, it shows

1. Outer serous coat, which is the visceral layer of peritoneum.
2. Muscular coat made of three layers consisting of longitudinal, circular and oblique unstripped muscle fibres.
3. Submucous layer made of loose areolar tissue
4. Mucous membrane containing numerous folds called as rugae.

Small intestine

It is a coiled tubular structure about 6 metres long. It extends from pyloric sphincter to its junction with large intestine at the ileo-caecal valve. It lies within the curves of large intestine in the central and lower parts of abdominal cavity.

It is divided into three parts. They are

1. Duodenum 2. Jejunum 3. Ileum

Duodenum: It is the first part of small intestine. It is C shaped. Duct from gall bladder, bile duct and pancreatic duct open into duodenum through the hepatopancreatic ampulla. Hepatopancreatic ampulla is guarded by a sphincter like muscle. Head of the pancreas lies in the curve of duodenum.

Jejunum: Jejunum is the upper two fifth part of remainder of the small intestine. It lies in between duodenum and ileum. It is bound behind by a fold of peritoneum called mesentery which carries blood vessels, autonomic nerves and lymphatics to jejunum. It has several glands.

Ileum : It is the distal three fifth of long and coiled up small intestine. It extends between Jejunum and caecum (beginning of large intestine). There are number of Peyer's patches in ileum. They are minute lymphoid structures. Ileum has similar structure as Jejunum but more villi. Ileum also contains digestive glands. But they are less than in the jejunum.

Structure of small intestine : It contains four layers similarly as the remainder of alimentary tract. They are -

1. Serous coat, formed of peritoneum (Serosa)
2. Muscular coat with a thin external layer of longitudinal fibres and a thick internal layer of circular fibres. (Muscularis externa).
- 3) Submucous coat containing blood vessels, lymph vessels and nerves (submucosa). It contains Brunner glands.

4. Mucous membrane (Muscularis interna/Muscularis mucosa)

Structure of small intestine contains goblet cells in addition to villi. They produce mucus.

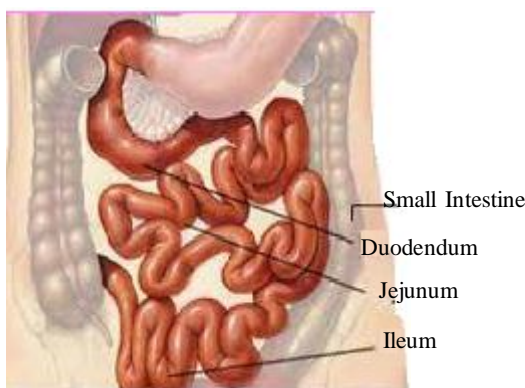


Fig 4.8 Parts of Small Intestine

Lining of the mucous membrane has the following three features. They are

1. Mucous membrane contains circular folds. Unlike the rugae of the stomach, they are permanent. They enhance the surface area available for absorption.
2. It contains fine hair-like projections called villi, each contains a lymph vessel called lacteal and blood vessels.
3. It is supplied with glands of simple, tubular type. They secrete intestinal juice.

Small intestine contains lymphoid tissue considerably. Mucous membrane contains solitary lymphatic follicles. They are most numerous in the lower part of ileum.

Large intestine

Ileum of the small intestine merges into large intestine. There is ileocaecal valve at the junction of ileum and large intestine. Colon measures about 1.5 metres in length.

Large intestine consists of following parts.

They are- 1. Caecum.

2. Vermiform appendix.

3. Ascending colon.
4. Transverse colon.
5. Descending colon.
6. Sigmoid colon.

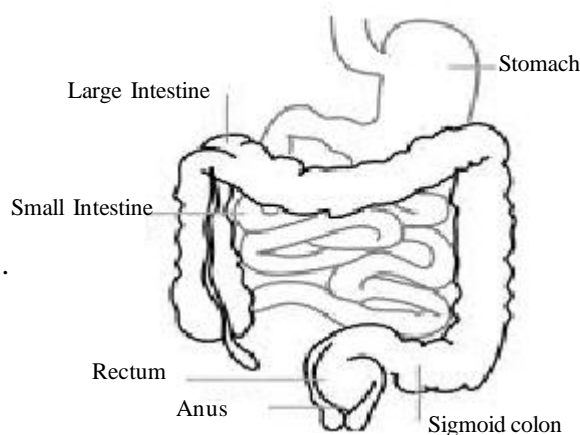


Fig 4.9 Parts of Large Intestine

1. **Caecum:** It is a short rounded sac. It lies in the right iliac fossa. It begins at the ileocecal valve where ileum and caecum join. It is continuous with ascending colon.
2. **Vermiform appendix:** It springs out from caecum at about an inch from ileocaecal valve. Lumen of the appendix communicates with that of caecum. It contains same four layers as intestine but the submucous layer contains lymphoid tissue. It is a vestigial organ in human body.
3. **Ascending colon:** It ascends upwards from caecum and in front of right kidney. It turns to left below the liver. It forms into transverse colon.
4. **Transverse colon:** It lies transversely below the stomach. It is suspended from its own mesentery from the posterior abdominal wall. It extends to the left and merges with descending colon at the lower surface of spleen. It extends between the lower surfaces of liver and spleen.
5. **Descending colon:** It is situated vertically on the left side of abdomen. It extends from transverse colon and merges with sigmoid colon.
6. **Sigmoid colon:** It lies in the pelvis. Hence it is also called as pelvic colon. It is situated at the left. It forms loops. It has a mesentery of its own. It continues below with rectum.

Structure of large intestine: Large intestine has the same structure as small intestine. Difference is - longitudinal muscles are arranged in three bands. Mucous membrane does not contain villi.

Rectum: It is a straight tube lying in lower posterior part of pelvic region. It is 12 cm long extends from sigmoid colon to anal canal. It is situated behind urinary bladder, prostate and seminal vesicles in male and behind uterus and vagina in females. It lies as a straight tube on the inside of sacrum and coccyx. Mucous coat of rectum has longitudinal and transverse folds. Lower portion of rectum is called as rectal ampulla. Rectal ampulla is a dilated part.

Anus: Rectum ends in anus. It is about 1 inch long. It is a small canal guarded by two sphincters. Internal sphincter is involuntary and external sphincter is voluntary.

4.3 Peritoneum

Peritoneum is a serous membrane. In males it is a closed sac lining the abdomen. In females, free ends of uterine tubes open into peritoneal cavity.

Peritoneum consists of two layers. They are

1. Parietal layer lining the walls of abdominal cavity.
2. Visceral layer covering the abdominal organs.

Peritoneal cavity: It is the space between parietal and visceral layers of peritoneum.

Omenta: Folds of the peritoneum connected to stomach are called as omenta

Omenta are divided into -

1. Greater omentum
2. Lesser omentum

Greater omentum hangs from lower border of stomach to the front surface of small intestine. Lesser omentum extends from lower border of liver to the lesser curvature of stomach.

Mesentery: Mesentery is the fold of peritoneum which attaches different parts of small intestine to the posterior abdominal wall. Blood vessels, nerves and lymphatics enter the intestines through mesentery.

Pelvic peritoneum: Part of the peritoneum lying in the pelvic region is called as pelvic peritoneum.

Peritoneal ligments: Folds of the peritoneum connecting organs like liver, uterus etc to the posterior part of abdominal wall are called as peritoneal ligaments.

Pouch of Douglas: Sac of peritoneum between rectum and uterus is called as pouch of Douglas.

Regions of abdomen: Abdomen is divided into nine regions.

- | | |
|------------------------|------------------------|
| 1. Right hypochondrium | 2. Epigastrium |
| 3. Left hypochondrium | 4. Right lumbar region |
| 5. Umbilical region | 6. Left lumbar region |
| 7. Right iliac fossa. | 8. Hypo gastrium |
| 9. Left iliac fossa. | |

4.4 Accessory organs of Digestive System

Teeth and salivary glands are covered under mouth.

4.4.1 Hepatobiliary System

4.4.1.1 Liver

Liver is the largest organ in abdomen. It is the largest gland in the body. It is situated in the upper right part of abdominal equity. It occupies almost entire hypochondrium. It lies below the diaphragm under the cover of lower ribs.

Lobes of liver : Falciform ligament divides it into two lobes. They are-

1. Right lobe
2. Left lobe

Right lobe of the lies over the right colic flexure and right kidney. Left lobe lies over stomach. Right lobe is bigger than left lobe. On the inferior surface two bands are present. They subdivide liver into four compartments.

1. Right lobe
2. Left lobe
3. Quadrate lobe
4. Caudate lobe.

Lobules of liver : Liver consists of large number of hepatic lobules. They are hexagonal in shape. Diameter of each lobule is about 1 mm. Each lobule has a small central intra lobular vein, which is a tributary of a hepatic vein.

Portal canals are present around the edges of lobules. Each portal canal contains 1. Inter lobular vein. 2. a branch of hepatic artery and

3. a small bile duct.

These three structures together are called as portal triad. Lobules consist of liver cells. These cells are large cells. Liver cells are arranged in sheets of one cell thickness. They are called as hepatic laminae. Spaces between laminae contain small veins with many anastomoses and small bile ducts called canaliculi.

Surfaces of Liver:

1. Superior surface.
2. Inferior surface.
3. Anterior surface.
4. Posterior surface.

- Superior surface of liver is in contact with inferior surface of diaphragm.
- Inferior surface faces abdominal viscera.
- Anterior surface is separated from ribs and costal cartilages by diaphragm
- Posterior surface lies in front of vertebral column, aorta, inferior vena cava and lower end of oesophagus.

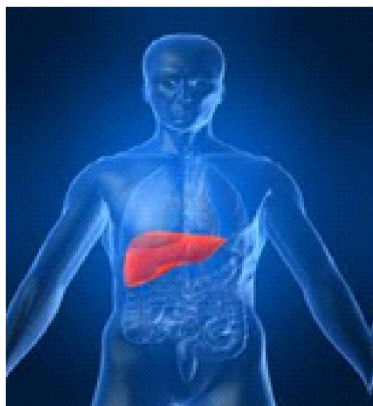


Fig 4.10 Liver

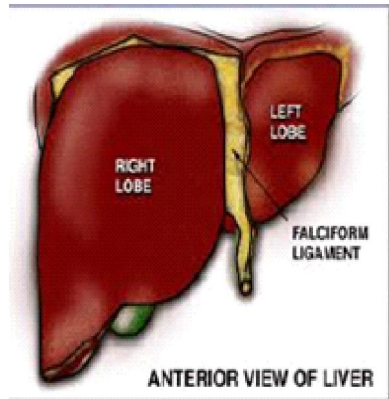


Fig 4.11 Lobes of Liver

Blood supply

Hepatic artery and portal vein carry blood to liver. Hepatic artery supplies oxygenated blood to liver. It is a branch of coeliac plexus. It arises from abdominal aorta. Portal vein brings blood to liver from stomach, spleen and intestines. It divides into interlobular veins. They subdivide and finally form central veins. One central vein lies in centre of each lobule. These central veins unite to form sublobular veins. Sublobular veins unite to form hepatic veins.

These hepatic veins join with inferior venacava and drain impure blood of liver into inferior venacava.

4.4.1.2 Biliary system

Biliary system consists of

1. Common hepatic duct formed by the union of right and left hepatic ducts from liver.
2. Gall bladder
3. Cystic duct from gall bladder
4. Common bile duct formed by union of common hepatic duct and cystic duct.

Gall bladder

Gall bladder is a pear shaped organ situated at the under surface of right lobe of liver.

It consists of three parts.

1. Fundus. 2. Body 3. Neck

Layers of gall bladder: It consists of three layers. They are-

1. Outer serous coat.
2. Middle muscular coat
3. Inner mucous coat.

4.4.1.3 Pancreas

Pancreas is a soft greyish pink coloured gland. It is about 12 to 15 cm long. It lies transversely across the posterior abdominal wall behind the stomach. Pancreas has three parts.

1. Head 2. Body and 3. Tail.

Head of the pancreas lies within the curve of duodenum. Tail extends as far as the spleen. Body lies between Head and tail. Pancreatic duct lies within the organ. Pancreatic duct joins bile duct at the head of the pancreas and open together into duodenum at hepatopancreatic ampulla.

Pancreas is composed of lobules. Each consists of tiny vessel. All these tiny vessels lead to the main duct and end in number of alveoli. Alveoli lined with cells secrete the enzymes trypsinogen, amylase and lipase. Collections of cells

called as Islets of langerhans are present in between the alveoli. Alpha cells constitute 25 percent of total number of Islets and beta cells constitute 75 percent of the total number of Islets.

Conclusion

Digestive system contains the parts related to the functions of ingestion, secretion, digestion, absorption and excretion.

Summary

Digestive system consists of Gastrointestinal tract and various glands attached. Major organs are mouth, pharynx, oesophagus, stomach, small intestine, large intestine, rectum and anus. These are concerned with functions like Ingestion, deglutition, absorption and excretion. Accessory organs are teeth, salivary glands, liver and biliary system, pancreas etc.

Model Questions

Short Answer Type questions

1. List the main parts of Digestive system.
2. Mention different accessory organs of digestive system.
3. What are the two sets of teeth?
4. Mention the types of permanent teeth.
5. Write the arrangement of permanent teeth.
6. What are the parts of a tooth?
7. Mention the components of tooth.
8. How many pairs of salivary glands are there? What are they?
9. Write the locations of salivary glands.
10. Name the ducts of
 - (a) Parotid glands
 - (b) Submandibular glands.
11. Mention different parts of pharynx.
12. What are the layers in the cross section of oesophagus?
13. Mention various parts of stomach.

14. What are the surfaces of stomach?
15. Name the curvatures of stomach.
16. Write the names of sphincters of stomach.
17. List the layers of stomach.
18. Mention the parts of small intestine.
19. What are the layers in the structure of small intestine?
20. Define (a) Rugae (b) Villi
21. Write about vermiform appendix.
22. What are the lobes of liver when viewed from the inferior surface of liver?
23. What is a portal triad?
24. Define (a) Laminae (b) Canaliculi
25. Name the surfaces of liver.
26. Write the parts of Biliary system?
27. Where is Gall bladder situated? What are its parts?
28. Name the layers of gall bladder.
29. Mention the locations of parts of pancreas.
30. What are islets of langerhans?

Long Answer Type Questions

1. Define Digestive system. What are the various parts? Describe anatomy of mouth.
2. Describe the anatomy of pharynx and oesophagus. Draw the diagrams.
3. Write the anatomy of stomach. Draw the diagram and label.
4. What are different parts of small intestine? Explain their anatomy with figures wherever required.
5. Write the anatomy of large intestine. Draw the figure and label.
6. Explain the anatomy of liver. Draw figure.
7. Explain gall bladder and pancreas.

Cardio Vascular System

Structure

- 5.1 Introduction
- 5.2 Anatomy of Heart
- 5.3 Conducting system of Heart
- 5.4 Anatomy of Vascular System
- 5.5 Types of Circulation

Learning Activities

- Student will know the anatomy of heart
- Student will know the anatomy of vascular system.
- Student will know the types of circulation.

5.1 Introduction

Cardiovascular system consists of Heart and Vascular system. It is well organised blood transport system of body. Heart is the central pumping organ. Blood vessels constituting vascular system are arteries, arterioles, capillaries, venules and veins.

5.2 Anatomy of Heart

Heart lies on the left upper part of thoracic cavity. It lies between the two lungs under sternum. It is broad above and conical below.

5.2.1 Histology of Heart : Heart consists of three layers. They are-

1. Pericardium - outermost layer consisting of
 - (a) Visceral pericardium
 - (b) Parietal pericardium
- (2) Myocardium - Middle layer made of cardiac muscle cells and interstitial cells.
- (3) Endocardium - Innermost layer.

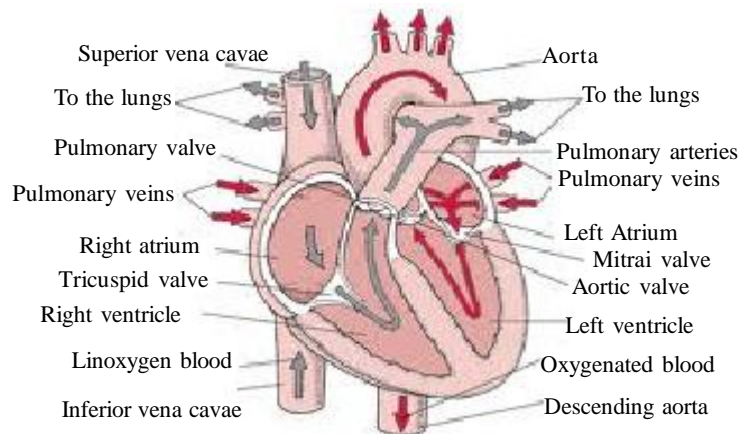


Fig 5.1 Structure of Heart

Pericardium forms bag like structure between visceral and parietal layers containing pericardial fluid.

5.2.2 Chambers of Heart

Heart has four chambers. Two of them are upper chambers called atria or auricles. Lower two chambers are called ventricles. The two atria are separated by interatrial septum. The two ventricles are separated by interventricular septum.

Atria are filling chambers and ventricles are pumping chambers. Compared to atria, ventricles are thicker since they are pumping chambers. Of the two ventricles, wall of left ventricle is three times thicker than that of right ventricle since left ventricle pumps oxygenated blood to all parts of body and right ventricle pumps deoxygenated blood to lungs only.

5.2.3 Valves of Heart

Opening between right atrium and right ventricle is guarded by tricuspid valve. It prevents back entry of blood into right atrium from right ventricle at the beginning of ventricular systole. Opening between left atrium and left ventricle is guarded by bicuspid or mitral valve. It prevents back entry of blood into left atrium at the beginning of ventricular systole - Pulmonary trunk is guarded by tricuspid semilunar valve which prevents back flow into right ventricle at the beginning of ventricular diastole. Aorta has tricuspid semilunar valve which prevents back flow of blood into left ventricle at the beginning of ventricular diastole.

Chordae tendinae and papillary muscles: Papillary muscles arise from ventricular walls. Chordae tendinae attach apical end of valves and papillary muscles. They prevent over distension of valves during diastole.

5.2.4 Blood Vessels attached to Heart

Blood vessels attached to heart are -

1. Superior and inferior venacavae - carrying deoxygenated blood from parts of body to right atrium.
2. Pulmonary artery carrying venous blood to lungs from right ventricle.
3. Pulmonary veins carrying oxygenated blood from lungs to the left atrium of heart.
4. Aorta carrying oxygenated blood to all parts of body from left ventricle of heart.

Blood vessels supplying oxygenated blood to heart : Right and left coronary arteries arising from Aorta supply oxygenated blood to heart.

Blood vessels draining heart : Coronary veins bring deoxygenated blood of heart into coronary sinus, which opens directly into right atrium.

Ductus arteriosus : Ductus arteriosus is the vestigial remnant of cord like structure which existed in foetal life between arch of aorta and pulmonary trunk. In foetal life, it bypasses pulmonary circulation. After birth, it closes, becomes obsolete and atrophies.

Septum ovale : It is crescentic mark on interatrial septum. It is closed foramen ovale that existed in foetus.

Foramen ovale : It is the opening in interatrial septum in foetal life. It avoids blood entry into lungs in foetal life. After birth, it closes and forms septum ovale.

5.2.5 Cardiac centres

1. Cardio inhibitory centre is dorsal motor nucleus of vagus in medulla.
2. Cardio accelerator centre is situated in lateral horn cells of upper thoracic segments of spinal cord.

5.2.6 Nerve supply to Heart

Sympathetic and vagus nerves supply heart.

5.3 Conducting System of Heart

System of conducting impulses of cardiac contraction consist of-

- (1) Sinoatrial node (SA node)
- (2) Atrioventricular node (AV node)
- (3) Bundle of His.
- (4) Right and left branches of bundle of His.
- (5) Purkinje fibres.

SA node : It is present at the opening of superior venacava into right atrium. It is called pacemaker of heart. It is made of modified cardiac muscle fibres. It measures about 5x20 mm.

AV node: It is present in the right atrium at the posterior part of inter atrial septum. It is close to the opening of coronary sinus. Cells of AV node are cardiac muscle fibres having a few myofibrils. It measures about 2x5 mm.

Bundle of His : Main trunk of bundle of His is continuous with AV node. It passes through interventricular septum. It is about 20 mm long.

Right and left branches of bundle of His : Bundle of His divides into right and left branches. Right branch is longer than left branch. Left branch bifurcates into superior and inferior divisions.

Purkinje fibres : They arise from brnaches of bundles of His. They spread from interventricular septum directly to papillary muscle and ultimately end in sub endocardial network. Purkinje fibres have larger diameter than ordinary cardiac muscle fibres. Purkinje fibres have diameter of 50-70 μ where as cardiac muscle fibres have diameter of about 15 μ .

5.4 Anatomy of Vascular System

Blood vessels constitute vascular system. There are two types of blood vessels mainly. They are arteries and veins. Arteries subdivide into arterioles. Arterioles end in capillaries. Capillaries are single layered thin vessels. Capillaries unite to form venules. Venules unite to form veins. Arteries are the vessels carrying oxygenated blood to tissues (except pulmonary arteries). Veins are the vessels carrying dexxygenated blood (except pulmonary veins).

Histology of Arteries and Veins :Arteries and veins consist of three layers

1. Tunica externa - outer layer made of fibrous tissue and elastic tissue and also called tunica adventitia.
2. Tunica media - middle layer of plain muscles and network of elastic fibres.
3. Tunica interna - innermost layer made of endothelial cells and also called tunica intima.

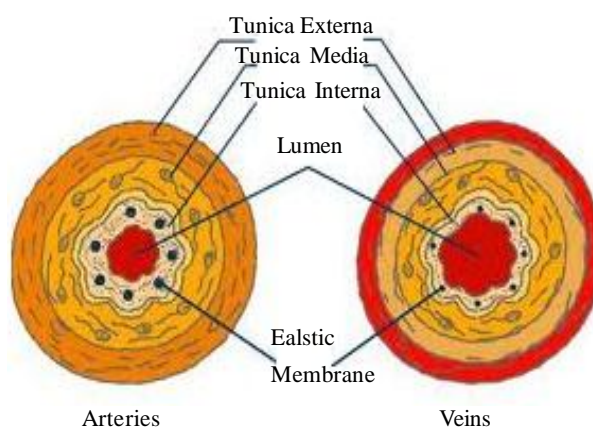


Fig 5.2 T.S. of Artery and Vein

Tunica media in arteries is thicker than in veins.

Valves of Veins : Valves are present in veins (of lower limbs particularly). They prevent back flow of blood from heart. These valves are semilunar pocket like flaps. They are formed by local folding of intima.

Vasavatorum : They are blood vessels supplying blood to large arteries and veins of above 0.1mm diameter.

Sinusoids : Sinusoids and sinusoidal capillaries are not true capillaries. They have larger size than capillaries. Continuous endothelial lining is absent.

5.4.1 Arteries of the Body

Aorta, arising from left ventricle of heart is the main artery of body. It consists of three parts. They are-

1. Ascending aorta, giving off two branches
 - i. Right coronary artery

ii) Left coronary artery. Coronary arteries supply blood to heart.

2. Arch of aorta : Giving off three branches and supplying blood to head, neck and upper limb-

branches of arch of aorta are -

i) Innominate artery - dividing into

a) Common carotid artery

b) Right subclavian artery

ii) left common carotid artery

iii) left subclavian artery.

3. Descending aorta - divided into

i) Thoracic aorta - supplying blood to wall of chest cavity and viscera

ii) Abdominal aorta supplying wall of abdominal cavity and its viscera.

Right and left common carotid arteries divide into -

a) Internal carotid artery b) External carotid artery on right and left sides.

Branches of external Carotid artery

i) Facial artery, supplying face

ii) Maxillary artery, supplying jaws

iii) Temporal artery supplying temporal parts in skull.

iv) Occipital artery supplying occipital parts in skull.

Branches of Internal Carotid Artery

i) Anterior cerebral artery supplying brain

ii) Middle cerebral artery supplying brain &

iii) Ophthalmic artery, supplying eyes.

Circle of willis : Circle of willis is formed by cerebral arteries and branch of vertebral artery. Branch of vertebral artery is also called basilar artery.

Right and left sub clavian arteries, their course and branches :

- Subclavian artery after entering axilla continues as axillary artery.

- It becomes brachial artery at lower boundary of axilla.

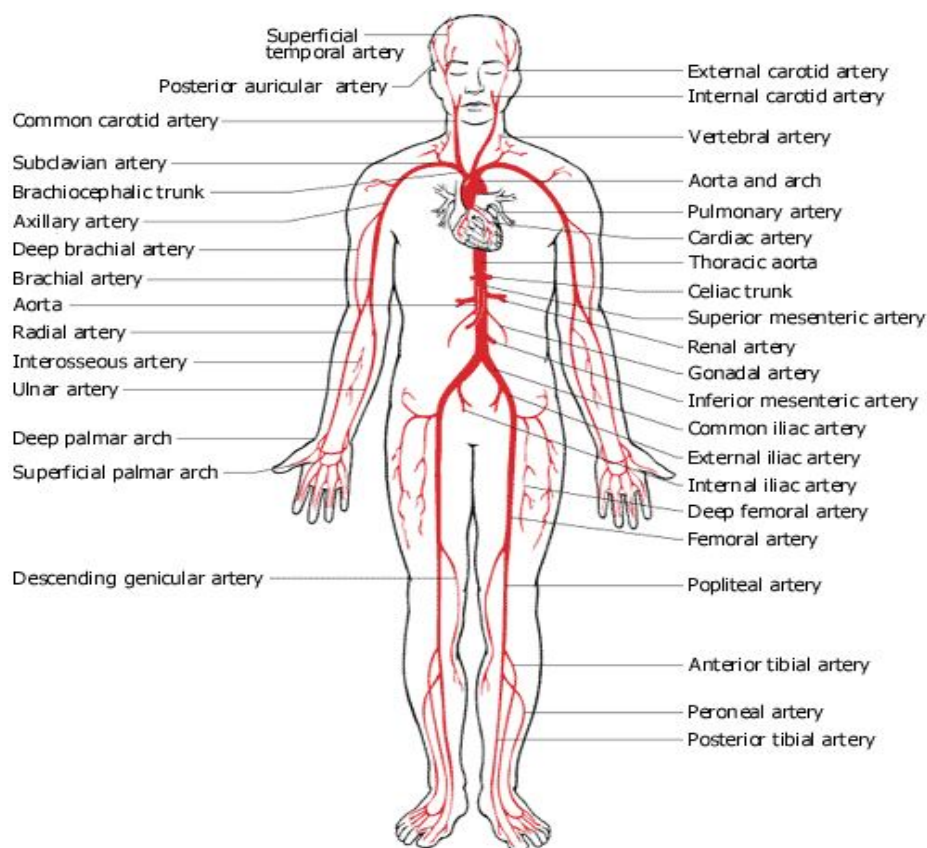


Fig 5.3 Arteries of Human Body

- It runs down the arm and divides into
 - (a) Radial artery
 - (b) Ulnar artery
- Palmar arch is formed by union of these two arteries in the palm
- Palmar arch divides into digital arteries, which supply fingers.

Course of thoracic aorta: Desencending aorta continues as thoracic aorta above diaphragm.

- It, then continues as abdominal aorta below diaphragm.

Branches of abdominal aorta.

They are

- (i) Coeliac plexus
- (ii) Mesenteric arteries

iii) Renal arteries

iv) Final branches

Coeliac plexus divides into-

i) Hepatic artery - supplying liver

ii) Gastric artery - supplying stomach

iii) Splenic artery - supplying spleen.

Mesenteric arteries are -

i) Superior mesenteric artery

ii) Inferior mesenteric artery

Renal arteries supply kidney.

Final branches are -

i) Right common iliac artery ii) Left common iliac artery

These common iliac arteries divide into -

i) Internal iliac artery - supplying pelvic organs. In females, its branch uterine artery supplies uterus.

ii) External iliac artery -

Continuing in thigh as femoral artery.

Continuing in popliteal fossa as popliteal artery.

It divides in leg into -

a) Anterior tibial artery - giving rise to dorsalis pedis artery.

b) Posterior tibial artery - giving rise to plantar artery

Plantar arch is formed by union of dorsalis pedis and plantar artery. Plantar arch divides into digital branches supplying the toes.

5.4.2 Veins of the body

All the veins of the body join superior and inferior venacavae and drain the collected blood into right atrium of heart.

Superior venacava : Superior venacava is formed by union of right and left brachiocephalic veins collecting blood from head, neck, upper extremities and some part of thorax.

Inferior venacava : Inferior venacava is formed by union of two common iliac veins collecting blood from lower extremities and abdomen. It extends upwards through abdomen and thorax and opens into right atrium.

Veins of the head, neck and upper limbs :

Internal and external jugular veins drain head and neck. They join with subclavian veins forming brachiocephalic veins. Subclavian veins collect blood from upper limbs. Subclavian vein is axillary vein in axilla. It is formed by union of brachial, cephalic and basilic veins of upper arm. Radial and ulnar veins of fore arms join with those of upper arms. Radial veins collect blood from metacarpals. Ulnar vein collects from fingers through palmar arch.

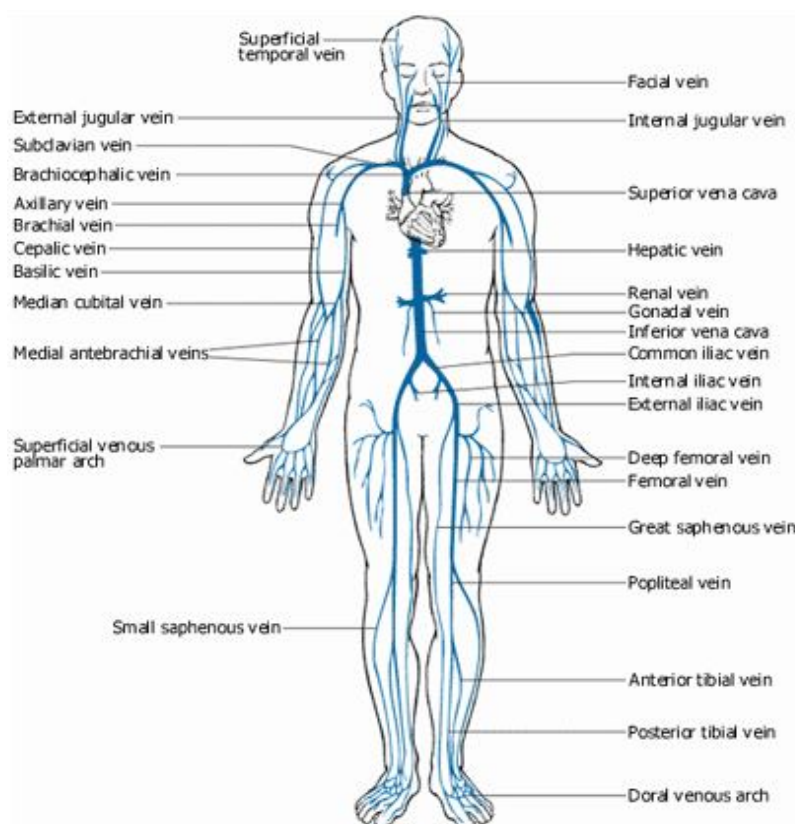


Fig 5.4 Veins of Human Body

Veins of abdomen and lower limbs : Popliteal vein is formed by union of anterior and posterior tibial veins of leg. It continues as femoral vein. Femoral vein continues as external iliac vein. External iliac vein joins with internal iliac vein and forms common iliac vein. Common iliac veins of both sides unite and form inferior venacava. Common iliac vein collects blood from lower extremities

and abdomen. In abdominal region, renal veins from kidneys, gonadal veins from testes or ovaries, suprarenal veins from suprarenal glands, hepatic vein from liver, lumbar veins from abdominal wall and internal iliac veins join inferior venacava. Internal iliac or hypogastric veins drain blood from gluteal muscles, medial side of thigh, urinary bladder, prostate gland, vas-deferens, uterus and vagina.

5.5 Types of Circulation

There are mainly two circulatory networks in the body. They are

- 1) Systemic circulation or greater circulation
- 2) Pulmonary circulation or lesser circulation

Systemic circulation : Oxygenated blood is circulated to all the parts of body from the left ventricle of heart through AORTA. Deoxygenated blood of all parts of body reaches right atrium of heart through SUPERIOR and INFERIOR VENACAVAE. This is the major circulatory network of body and called systemic circulation or greater circulation.

Pulmonary circulation : Deoxygenated blood reaching right atrium goes into right ventricle and from here, it reaches lungs through pulmonary artery. After losing CO_2 in lungs, it gets oxygenated and reaches left atrium of heart through PULMONARY VEINS. It is called pulmonary circulation or lesser circulation.

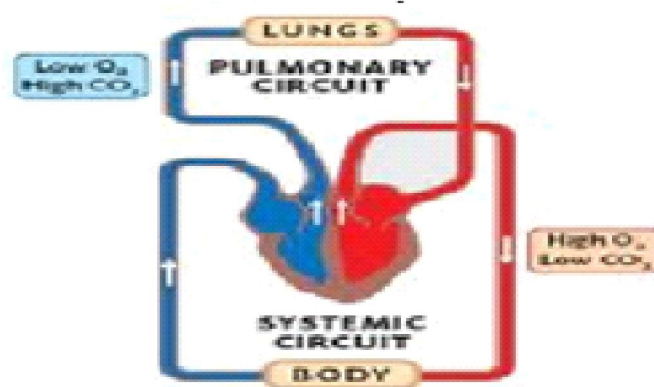


Fig 5.5 Types of Circulation

Coronary circulation : Coronary circulation is the circulation of blood in the blood vessels of the heart muscle (myocardium). The vessels that deliver oxygen-rich blood to the myocardium are known as coronary arteries. The

vessels that remove the deoxygenated blood from the heart muscle are known as cardiac veins.

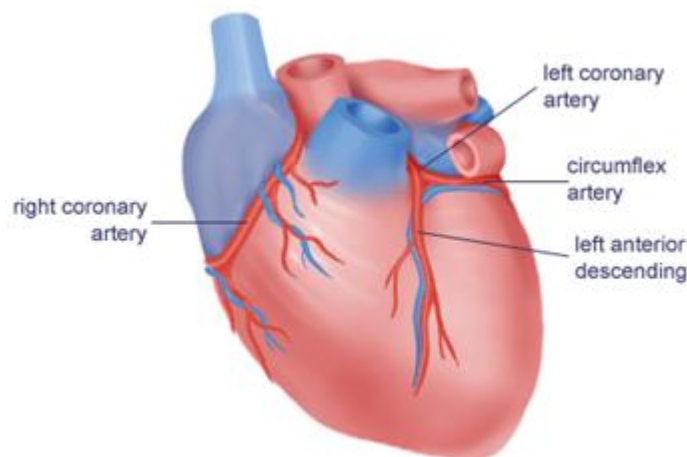


Fig 5.6 Coronary Circulation

The coronary arteries that run on the surface of the heart are called epicardial coronary arteries. The coronary arteries that run deep within the myocardium are referred to as subendocardial. The coronary arteries are classified as "end circulation", since they represent the only source of blood supply to the myocardium: there is very little redundant blood supply, which is why blockage of these vessels can be so critical. Right and left coronary arteries arising from ascending aorta supply oxygenated blood to heart. Coronary veins collecting deoxygenated blood from heart join coronary sinus, which opens into inferior venacava.

Portal circulation : It is the circulatory network through liver. Portal vein and hepatic artery bring blood to liver. Portal vein carries blood into liver through superior mesenteric and splenic veins. Superior mesenteric vein carries blood from mesenteric bed (stomach, small intestine, part of large intestine and pancreas). Splenic vein carries from spleen. Hepatic artery carries oxygenated blood to liver. Capillaries of portal vein join with capillaries of hepatic artery. Hepatic vein carries blood circulated in liver to right atrium of heart through inferior venacava. This circulatory network of liver is called portal circulation.

Conclusion

Cardio vascular system consists of heart and blood vessels of body.

Greater circulation & Lesser circulation are important circulation systems of body

Summary

Cardio vascular system consists of heart and vascular system. Heart contains four chambers. Upper two chambers are called atria or auricles and lower two chambers are called ventricles. Histology of heart shows pericardium, myocardium and endocardium. Conducting system of heart consists of S.A. node, A.V. node, bundle of His, branches of bundle of His and purkinje fibres. Vascular system consists of arteries, arterioles, capillaries, venules and veins. Arteries and veins contain three layers- tunica externa, tunica media and tunica interna. Aorta is the main artery of the body. Superior and inferior venacavae are the main veins of body. Veins of superior parts of body, upper parts of limbs and some parts of thorax join superior venacava. Veins of abdomen and lower limbs join inferior venacava. Different circulatory networks of body are - systemic circulation, pulmonary circulation, coronary circulation, portal circulation etc.

Model Questions

Short Answer Type Questions

1. Name the chambers of Heart.
2. What are the layers of heart?
3. Mention the valves of heart.
4. What are the blood vessels attached to heart?
5. Write about ductus arteriosus.
6. Explain nerve supply to heart.
7. List the conducting tissues of heart.
8. Where is S.A. node located?
9. Describe A.V. node.
10. What is bundle of His?
11. Name the layers of Arteries and Veins.
12. What are the parts of Aorta?
13. Write the branches of arch of aorta.
14. What are the branches of ascending aorta?
15. Name the divisions of descending aorta.

16. Write the branches of external carotid artery.
17. List the branches of internal carotid artery.
18. What is palmar arch?
19. Name the arteries of upper limbs.
20. What is the course of thoracic aorta?
21. Mention the branches of abdominal aorta.
22. Write the divisions of coeliac plexus.
23. What are mesenteric arteries?
24. What is plantar arch?
25. What are main veins of body?
26. Name the veins of head and neck.
27. Mention the names and course of veins of upper limbs.
28. Write the veins of lower limbs.
29. Mention abdominal veins.
30. What is systemic circulation?
31. Write about pulmonary circulation.
32. Explain portal circulatory network.
33. Describe coronary circulation.

Long Answer Type Questions

1. Explain the anatomy of heart with figure.
 2. Write about the histology of arteries and veins. Discuss arteries of body.
 3. Discuss Veins of body.
 4. Discuss the types of circulation of body.
- .

UNIT

6

Lymphatic System**Structure**

- 6.1 Introduction
- 6.2 Spleen
- 6.3 Tonsils
- 6.4 Thymus

Learning Objectives

- Student should know the anatomy of lymphatic system.
- Student should know different lymphoid tissues in the body.

6.1 Introduction

Lymphatic system is a closed system consisting of 1. Lymphatic capillaries 2. Lymphatic vessels 3. Lymph nodes and 4. Lymphducts.

6.1.1 Lymphatic capillaries

They are fine hair like vessels with porous walls. They arise in the tissue spaces. They unite to form lymphatic vessels. Walls of the capillaries have permeability to substances of greater molecular size than the substances permeable through walls of blood capillaries. Their walls are formed by endothelial cells and supported by fibrous connective tissues.

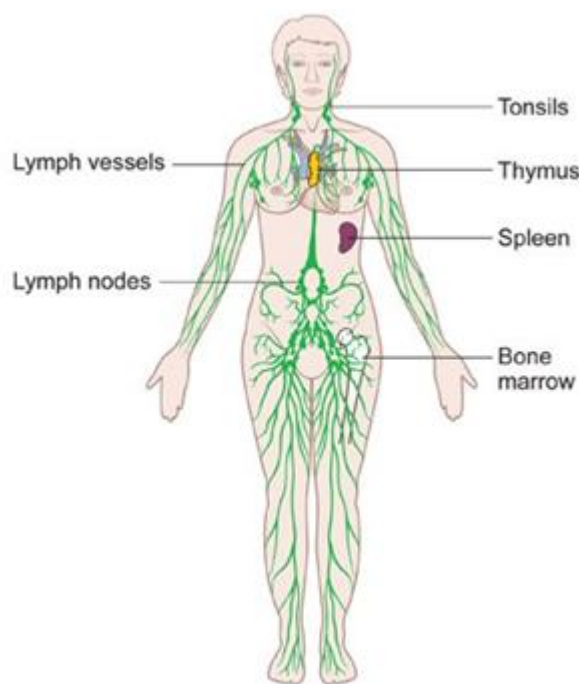


Fig 6.1 Lymphatic System

6.1.2 Lymphatic Vessels

Lymphatic capillaries unite to form lymph vessels. They have one sided valves. They are superficially and deeply located. They are found in skin, muscles and several visceral organs. Various lymphatic vessels are linked together by free anastomoses. Lymph vessels pass through lymph nodes. They gradually increase in size. Finally lymph collected from the body pours into right lymphatic duct and left lymphatic duct. Left lymphatic duct is also called as thoracic duct.

6.1.3 Lymph Nodes

Lymph nodes are small bodies made of lymphatic tissue. They vary in size from pin head to almond. They are important glandular structures spread at all strategic points in the body. They are located both superficially and deeply. Lymphatic vessels bring lymph to lymph nodes. They divide within the node and discharge lymph. Again lymph is gathered into fresh lymphatic vessels which empty lymph into lymphatic ducts after carrying the lymph through more lymph nodes. Lymphatic vessels entering into the lymph node are called afferent lymph vessels. Lymph vessels leaving the lymph nodes are called as efferent lymph vessels.

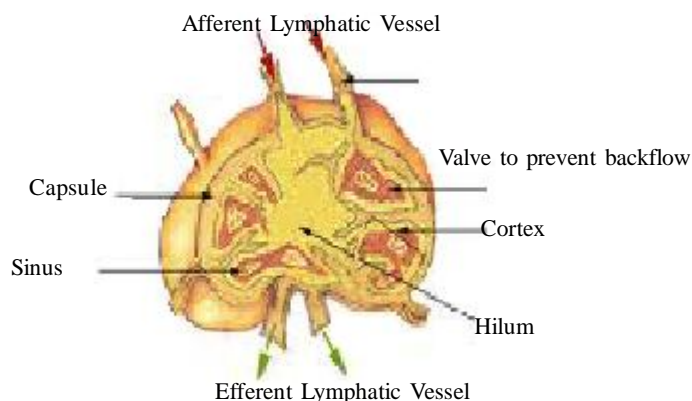


Fig 6.2 L.S. of Lymph node

Histology of Lymph node: Histology of lymph node shows three parts. They are -Cortex, medulla & hilum.

1. Cortex: Cortex is the outer part of lymph node. It contains lymphatic nodules peripherally and germinal centres in the inner zone. Germinal centres present in the lymph nodes produce lymphocytes. Lymph sinuses separate lymph nodules from capsule.

2. Medulla : It is the inner part of lymph node. It is devoid of lymph nodules. It contains reticulo endothelial cells. It also contains a few giant cells.

3. Hilum : It is the depression at one side of lymph node or lymph gland. Through Hilum, an artery enters and there is exit to a vein and an efferent lymphatic vessel. Afferent lymph vessels enter from all sides but efferent lymph vessel leaves through hilum. Chief efferent vessel leaving lymph node carries filtered and lymphocyte enriched lymph fluid.

Naming of lymph nodes: Lymph nodes are named accordingly as they are located. They are-

- (a) Cubital and axillary lymph nodes: They are situated in arms.
- (b) Popliteal and inguinal: Lymph nodes situated in legs are named so.
- (c) Submaxillary and cervical lymph nodes: Lymph nodes present in the neck are called as submaxillary and cervical lymph nodes.
- (d) Mediastinal lymph nodes: These are present in Thorax.
- (e) Abdominal lymph nodes: They are present in abdomen. ex: Mesenteries
- (f) Pelvic lymph nodes: Pelvic lymph nodes are present in pelvic organs.

6.1.4 Lymph Ducts

Efferent lymph vessels leaving lymph nodes pour lymph into right lymphatic duct and left lymphatic duct (thoracic duct). Thoracic duct is comparatively larger than right lymphatic duct. It begins at cisternachyli. Cisternachyli is a small pouch at the back of the abdomen. Lymphatic vessels from lower limbs, abdominal and pelvic organs empty into this pouch. From cystemachyli, thoracic duct runs up through mediastinum behind the heart to the root of the neck. Here, it turns to the left where lymphatic vessels from the left side of head, thorax and left upper limb join. Thoracic duct finally empties into left sub clavian vein at its junction with left internal jugular vein. It is provided with uni directional valves to prevent lymph from flowing in wrong direction. Right lymphatic duct is comparatively smaller. It is formed by joining of lymphatic vessels from right side of head, thorax and right upper limb at the root of neck. It enters into right subclavian vein, where it joins right internal jugular vein. Lymphatic ducts thus gather lymph from al the body and return it to blood stream.

6.2 Spleen

Spleen is the largest lymphoid tissue in the body. It is a bean shaped, fist sized organ. It is a highly vascular organ. It is located in the left hypochondrium beneath the diaphragm. It is above the left kidney and descending colon and behind the stomach. It weighs about 150 g. in adult human being and does not contain afferent lymphatic vessels. It is haemopoietic.

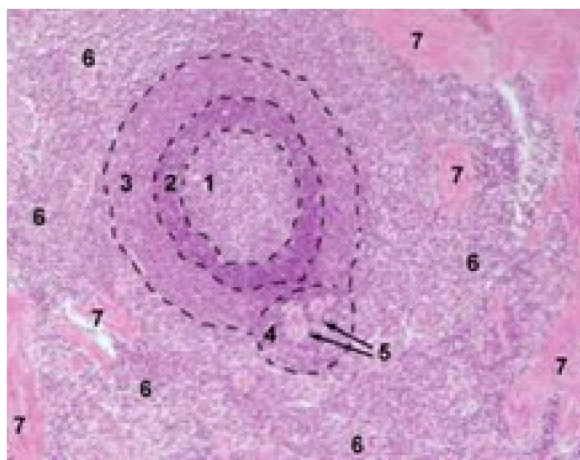


Fig 6.3 T.S. of Spleen

SPLEEN (follicle), stained with haematoxylin and eosin - lymphoid follicle, circled with dotted line shows-

- 1 - Germinal center of the follicle
- 2 - Mantle zone of the follicle

3 - Marginal zone of the follicle 4 - Periarterial area of the follicle

5 - Central arteriole 6- Red pulp 7 - Trabeculae

Splenic pulp : Splenic pulp is the parenchymal tissue within the capsule. It is two types 1) White pulp 2) Red pulp.

Splenic sinuses: Splenic sinuses are long vascular channels. They are 35 to 40 μ diameter.

Splenic cords: They are continuous partitions in between splenic sinuses.

Marginal zone: It is the junctional zone between white pulp and red pulp.

6.3 Tonsils

Tonsils are well-defined organs of accumulated lymphoid tissue in the mucous membrane at the root of tongue. Tonsils are present at the surrounding of pharynx, where nasal and oral passages unite. Tonsils do not possess afferent lymphatic vessels.

Tonsils can be divided into three groups.

1) Palatine tonsils - covered by stratified squamous epithelium

2) Lingual tonsil- situated at the root of tongue.

3) Pharyngeal tonsils - one on each side in the median posterior wall of nasopharynx.

6.4 Thymus

Thymus is partly endocrine gland and partly lymphoid structure. It is present in anterior and superior mediastinum of thorax. It extends from pericardium up into neck. It consists of two lobes.

Histology of thymus shows -

1) Capsule 2) Cortex & 3) Medulla

Conclusion

Lymphatic system is a closed system consisting of 1) Lymphatic capillaries 2) Lymphatic vessels 3) Lymph nodes and 4) Lymph ducts.

Summary

Lymphatic system is a closed system consisting of lymphatic capillaries, lymphatic vessels, lymph nodes and lymph ducts. Histology of lymph node shows three parts. They are - Cortex, medulla & hilum. Spleen, tonsils and thymus are

also lymphatic tissues. Spleen is haemopoietic organ. Splenic pulp is parenchymal tissue within the capsule of spleen.

Model Questions

Short Answer Type Questions

1. Define lymphatic system.
2. Explain lymphatic capillaries.
3. Describe lymphatic vessels.
4. What are (a) Cubital and axillary lymph nodes.
(b) Mediastinal lymph nodes.
5. Mention the histological parts of lymph node.
6. Name the lymph ducts.
7. Write the histology of spleen.
8. What is splenic pulp?
9. Define splenic sinuses.
10. Write the definition of tonsils.
11. Mention the parts in the histology of Thymus.

Long Answer Type Questions

1. Write the anatomy of lymphatic system.

UNIT

7

Bones and Joints**Structures**

- 7.1 Introduction
- 7.2 Composition of Bone
- 7.3 Ossification
- 7.4 Types of Bones
- 7.5 Bones of the Human Body
- 7.6 Joints
- Summary

Learning Activities

- Student should know all the bones of human body.
- Student should know about the joints.

7.1 Introduction

Bones and Joints form the skeletal system of body. There are about 206 bones in human body. Main functions of skeletal system are -

1. Giving support and protection to soft tissues and vital organs.
2. Giving attachment to muscles and assisting in body movements.

3. Formation of blood cells in the red bone marrow.
4. Storage of mineral salts like calcium and phosphorous.

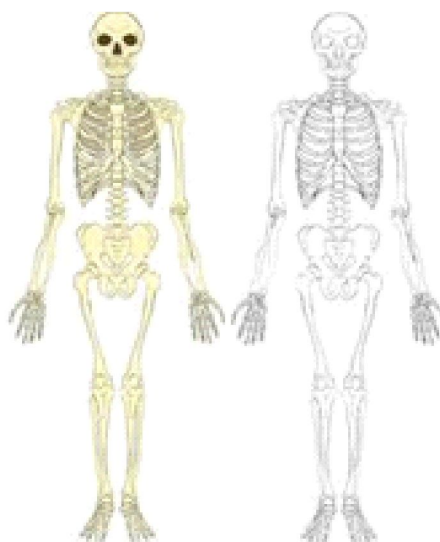


Fig 7.1 Skeletal System

7.2 Composition of Bone

Bone is structurally a complex organ and has the following composition.

water	-	25%
Ossein, Osseomucoid and Osseo Albumin (organic solids)	-	35%
inorganic salts of calcium	-	45%

Calcium salts impart hardness to bones.

Structure of bone tissue: Refer to Cell and Tissues.

Functions of bone marrow :

Bone marrow performs functions of -

- 1) Formation of blood cells(Haemopoiesis)
- 2) Destruction of old RBC with the help of reticulo endothelial cells(haemolysis)
- 3) Protection of body against infections by microbes with the help of reticulo endothelial cells against foreign particles(Defence mechanism)
- 4) Against foreign particles(Defence mechanism)

7.3 Ossification

Ossification is the process of bone formation. Development of bones takes place from spindle shaped cells called osteoblasts. There are two types of ossification. They are-

- 1) Intra membranous ossification.
- 2) Intra cartilaginous ossification.

1. Intra membranous ossification : Type of ossification in which, dense connective tissue is replaced by deposits of calcium, forming bone is called as intramembranous ossification.

Ex: Bones of skull are formed by this process.

2. Intra cartilaginous ossification : Type of ossification in which, cartilages are replaced by bone is called as intracartilaginous ossification. Most of the bones of the body are formed by this process.

7.4 Types of Bones

Bones are mainly three types. They are - 1) Long bones. 2) Short bones 3) Flat bones 4) Irregular bones 5) Sesamoid bones.

1. Long bones: Long bones are found in limbs. A long bone has two ends. Ends of a long bone are called as epiphyses. These two ends are connected by shaft, which is called as diaphysis. Periosteum is the outer membrane covering the bone. Periosteum is followed by layer of compact bone. Central medullary canal is inside this.

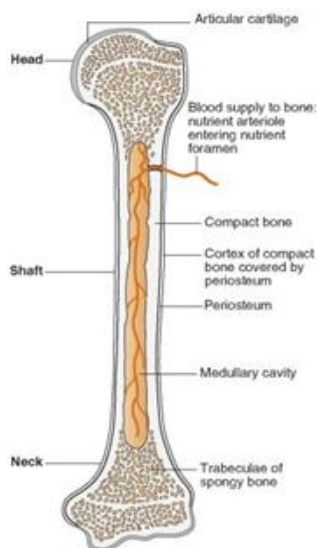


Fig 7.2 Long bones

Through nutrient foramen, arteries enter. Medullary canal contains yellow bone marrow. Extremities consist of mass of spongy bone, which contains red bone marrow. Yellow bone marrow contains fat and blood cells but is not rich in blood supply or red blood cells. Long bones develop from three centres called centres of ossification. Centre of ossification present in shaft is called diaphysis and centres of ossification present at the ends of the bones are called epiphyses. Line of cartilage between epiphysis and diaphysis is called epiphyseal cartilage or epiphyseal plate. Epiphyseal plate separates epiphysis and diaphysis approximately upto 25 years of age. After this age, fusion of diaphysis and epiphysis takes place. After fusion, growth in length of bone becomes impossible. Acromegaly is growth of bone occurring after fusion of diaphysis and epiphysis by the overactivity of growth hormone. It will be confined mostly to the bones of face and limbs. This growth will be abnormal. Gigantism is growth occurring in immature bones before fusion of diaphysis with epiphysis due to excessive secretion of growth hormone.

2. Short bones : Short bones do not have shaft. They contain spongy substance covered by shell of compact bone. ex: small bones of wrist and ankle.

3. Flat bones : They contain two layers of compact bone with spongy substance between the two layers. They are found in pelvis and scapula.

4. Irregular bones : Bones which do not fall into any category are irregular bones. ex: vertebrae and bones of face.

5. Sesamoid bones : They are small bones and develop in tendons of muscles. ex: Patella of knee joint.

7.5 Bones of the Human Body

Total 206 bones forming the human skeleton can be divided into **(1) Bones of Axial skeleton:**

(i) Bones of skull: Bones of cranium

Bones of face

(ii) Bones of trunk: Sternum

Ribs

Vertebral column

(2) Bones of appendicular skeleton:

Bones of upper limbs

Bones of lower limbs

7.5.1 Bones of Axial Skeleton

7.5.1.1 Bones of skull

Skull is a large bony structure containing cranium and bones of face attached to cranium.

Bones of Cranium : Cranium is called as brain box. It is a large, hollow bony case. It is formed by fusion of various bones with zigzag edges. Cranium is formed by 8 bones. They are -

1. Frontal bone-1

2. Parietal bones-2

3. Temporal bones-2

4. Occipital bone-1

5. Sphenoid bone-1

6. Ethmoid bone-1

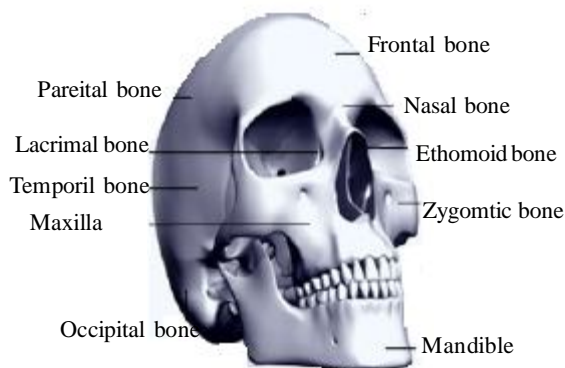


Fig 7.3 Bones of Skull

Sutures of the Cranium

Immovable joints of bones of skull are called sutures. Important sutures of cranium are- (1) Coronal Suture (2) Sagittal suture & (3) Lambdoid suture

Coronal suture : Coronal suture is the immovable joint between frontal bone and parietal bones.

Sagittal suture : Sagittal suture is the immovable joint between the two parietal bones.

Lambdoid suture : Lambdoid suture is the immovable joint between occipital bone and parietal bones.

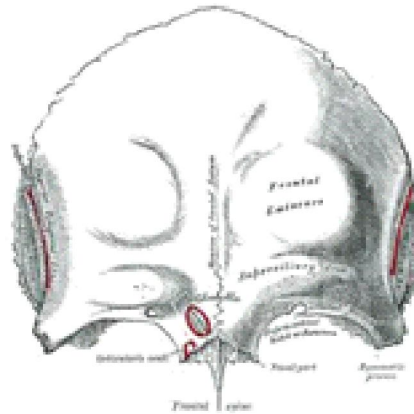
Frontal bone : It is in the front central portion of cranium. It is joined with two parietal bones. It extends upto forehead and forms roof of orbital and nasal cavities.

Features of frontal bone : It has the following features. They are-

(1) Supra orbital margins- forming the arches of orbit.

(2) Nasal notch - It is the bone projecting between supraorbital margins.

- 3) Super ciliary arch - It lies above these two structures.
- 4) Frontal tuberosities are the two prominences of forehead.



Parietal bones

A parietal bone has joint with:

- frontal bone anteriorly.
- occipital bone posteriorly.
- other parietal bone medially and
- temporal bone inferiorly

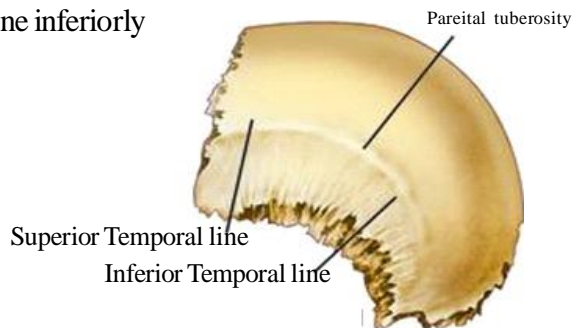


Fig 7.5 Parietal Bone

Temporal Bones

Temporal bones are two in number. They form lower part of sides of skull.

Temporal bones have joint with:

- sphenoid bone in the front
- parietal bones above.
- occipital bone behind.

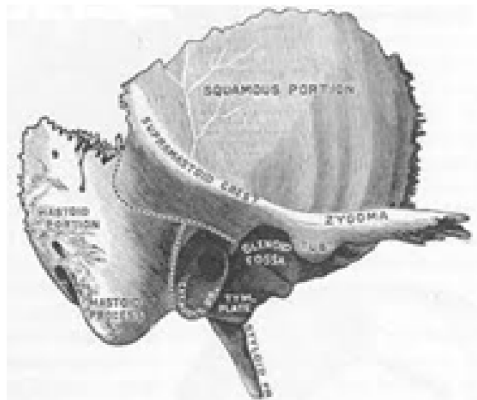


Fig 7.6 Temporal Bone

A temporal bone has the following parts.

- a) Squamous part : It is flat part having zygomatic process.
- b) Petrous part : It forms the bone of internal ear.
- c) Mastoid part : It contains mastoid process.
- d) Tympanic part : It contains external auditory meatus.

Occipital Bone

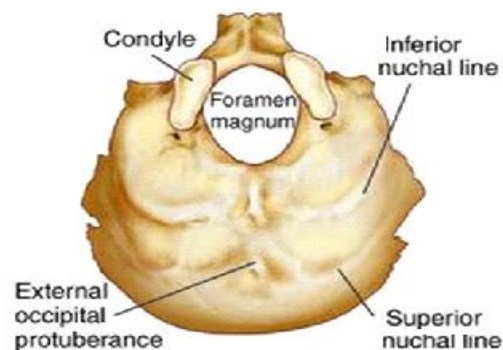


Fig 7.7 Occipital Bone

Features of occipital bone : An occipital bone has the following features.

(a) External occipital protuberance: It is a prominence of occipital bone. It gives attachment to muscles.

(b) Foramen magnum : It is a large oval opening below the external occipital protuberance. Cranial cavity communicates with vertebral canal through this opening.

(c) Occipital condyles: They are two in number. They lie one on each side of foramen magnum. They articulate with atlas. This joint allows nodding movement of head.

Sphenoid Bone

It is one in number. It is situated at the base of the skull in front of temporal bones. It forms large part of middle cranial fossa. It is shaped like a butterfly with outstretching.

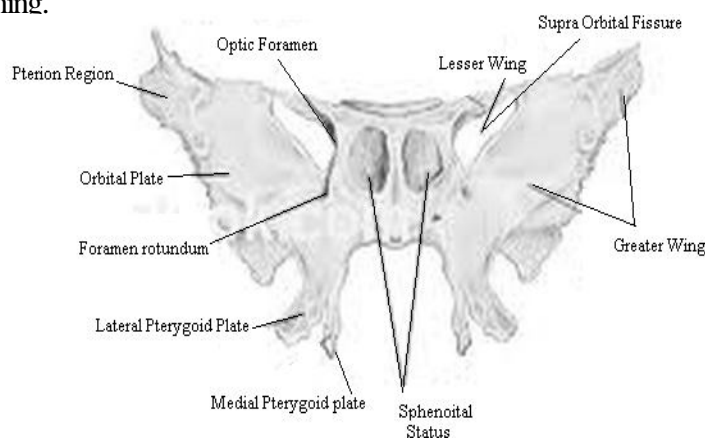


Fig 7.8 Sphenoid Bone

a. Body : Body contains two large air sinuses. They communicate with nasal cavity. Body also has a deep depression called hypophyseal fossa, which contains pituitary gland. Hypophyseal fossa is also called as sella turica.

b. Wings : These wing like structures are called greater and lesser wings. They have many openings for passage of nerves and blood vessels.

Ethmoid bone: It is one in number. It is cubical in shape. It fills the space between orbits. Ethmoid bone consists of three parts. They are -

- (a) Cribriform plate
- (b) Perpendicular plate
- (c) Labyrinths (2)

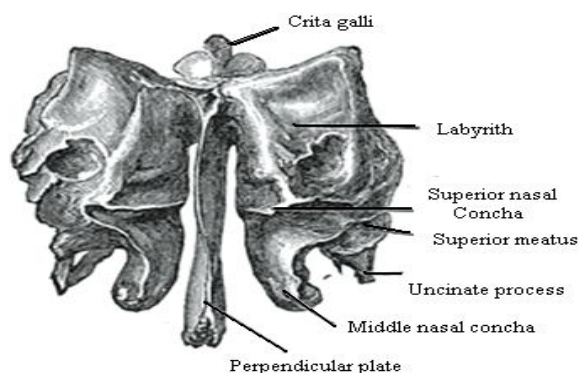


Fig 7.9 Ethmoid Bone

Cribriform plate is a small horizontal plate perforated with number of fine openings through which branches of olfactory nerve pass from nose to the brain. Perpendicular plate descends from cribriform plate. It forms upper part of nasal septum. Two labyrinths each consisting of a number of ethmoidal sinuses are thin walled and communicate with nasal cavity.

Superior and middle nasal conchae are thin plates of ethmoid bone. Inferior nasal conchae are curved plates of bone which lie in the walls of the nasal cavity below superior and middle nasal conchae of ethmoid bone.

Cranial Fossae

Base of the skull is divided into three fossae.

They are-

1. Anterior cranial fossa
2. Middle cranial fossa.
3. Posterior cranial fossa

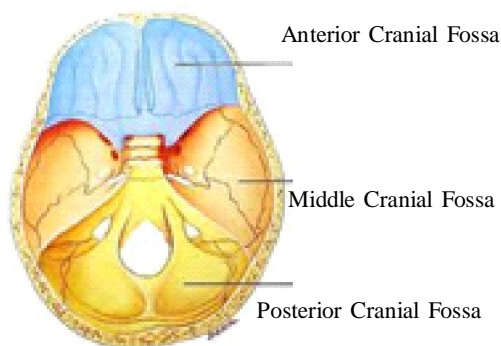


Fig 7.10 Cranial Fossae

Anterior cranial fossa is formed by horizontal plates of frontal bone. Middle cranial fossa is formed by sphenoid bone and petrous portion of temporal bones. Posterior cranial fossa is formed by occipital bone.

Fontanelles

Due to incomplete ossification of skull bones of child at birth, membranes fill the space between bones. These membranes at the angles of bones are called fontanelles. They are -

1. Anterior fontanelle.
2. Posterior fontanelle.

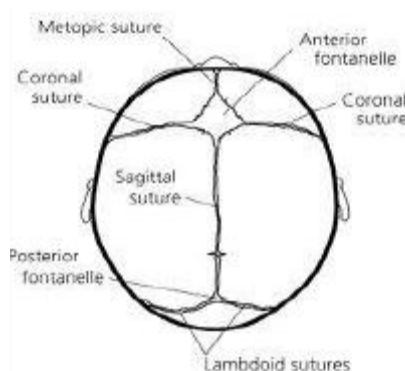


Fig 7.11 Fontanelles

Anterior fontanelle : It is the largest fontanelle present at the junction of frontal and two parietal bones where coronal and sagittal sutures meet. It closes at the age of 1½ years.

Posterior fontanelle : It is the fontanelle present at the junction of parietal bones and occipital bone. It closes as soon as birth takes place.

Sinuses : Sinuses are the cavities in the bones of skull and communicating with nose. They are 1) Frontal sinuses 2) Maxillary sinuses 3) Ethmoidal and sphenoidal sinuses.

Frontal sinuses are a pair of sinuses present in frontal bones. They are present one on each side of the root of the nose. Maxillary sinuses are a pair of sinuses in maxillary bones- each lying on each side of nose. Ethmoidal and sphenoidal sinuses are also present in skull.

Functions of sinuses

Functions of sinuses are-

1. Lightening of bones of face and cranium.
2. Giving resonance to voice.

Bones of the face

Bones making the face are 14 in number. They are-

- Maxillae -2 (upper jaw)
- Mandible -1 (lower jaw)
- Zygomatic bones -2 (cheek bones)
- Palate bones -2 (roof of mouth cavity and hard palate)
- Lacrimal bones -2
- Nasal bones -2 (Nasal bridge)
- Turbinate bones -2 (Nasal conchae)
- Vomer -1 (Lower part of nasal septum)

Maxillae

They are two in number.

They form upper jaw.

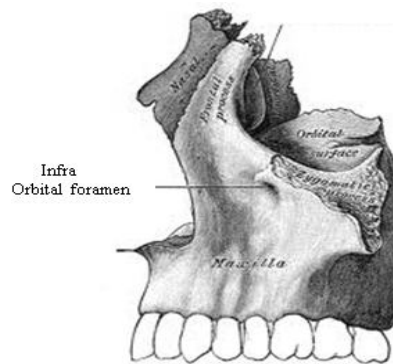


Fig 7.12 Maxilla

Features of Maxillae

1. Body is pyramidal in shape.
2. Zygomatic process, palatine process, alveolar process & frontal process are present. Alveolar process contains upper teeth.
3. Maxillary sinus is present in internal aspect.

Mandible : It forms the lower jaw. It is the only movable bone of skull.

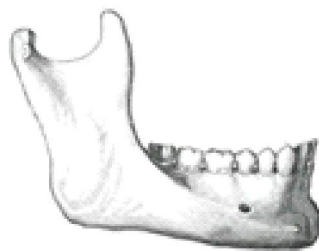


Fig 7.13 Mandible(left half)

Features of mandible:

- 1) Body is horizontal part in the centre. It contains lower teeth. It forms chin.
- 2) Two rami are present one on each side. Each ramus contains coronoid process in the front. Condyle of jaw lies behind.

Zygomatic bones : They are two in number. They are irregular bones forming the prominence of cheek and part of walls of orbit. Each of them contains temporal process which articulates with zygomatic process of temporal bone to form zygomatic arch.

Palate bones : They are two in number. They are irregular bones forming part of the hard palate, lateral wall of nasal cavity and floor of orbit.

Nasal bones : They are two in number. They are small bones situated in between sockets of orbits. They form nasal ridge.

Turbinate bones : They are two in number. They are called as nasal conchae.

Lachrymal bones: They are the smallest bones. They are fragile. They form part of walls of orbits. Grooved part of lacrimal bones contains lacrimal sac and nasolacrimal duct.

Vomer : It is one in number. It is a flat bone. It forms lower part of nasal septum. It is a vertical bone.

Hyoid bone: It is a 'U' shaped bone. It has a body and two horns (lesser horn and greater horn). It lies at the base of the tongue. It is attached to the styloid processes of temporal bone by means of ligaments.

7.5.1.2 Bones of Trunk

Bones of trunk are - Sternum, ribs, vertebral column.

Sternum : It is a long flat bone. It runs down the front of thorax. It is divided into three parts.

- a) Manubrium sterni
- b) Body - also called mesosternum c) Xiphoid process

Manubriumsterni : Manubrium sterni is triangular and articulates on either side with clavicle, first and second costal cartilages.

Features of Manubrium sterni :

- a) Clavicular notches - on both sides for articulation with clavicle.
- b) Suprasternal notch - between clavicular notches.
- c) Articular surfaces - on both sides for first rib.

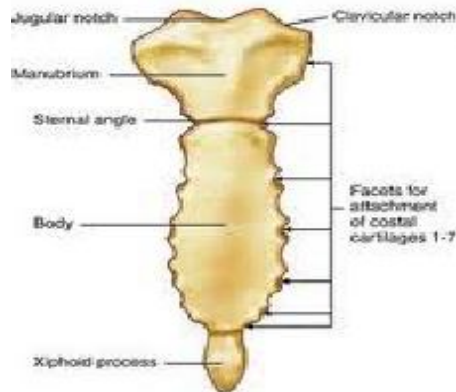


Fig 7.14 Sternum

Body : Body is longer and narrower than manubrium sterni. There is a small notch where it joins the manubrium.

Xiphoid process: Xiphoid process is small. It is the lowest part of sternum. Diaphragm, linea alba and rectus abdominus muscles are attached to this part of sternum.

Ribs

They are 12 pairs of arched bones attached on back side to thoracic vertebrae.



Fig 7.15 Ribs

Features of a rib: A rib has a) Anterior end b) Posterior end and c) Shaft.

- (a) Anterior or sternal end has depressions for attachment of costal cartilage
- (b) Posterior or vertebral end - It has three parts 1. Head 2. Neck 3. Tubercle.

Shaft : It has two surfaces

- 1) Inner surface 2) Outer surface.

It has two borders-

- 1) Upper border 2) Lower border.

Sub costal groove contains intercostal vessels and nerve. Classification of ribs: On the basis of attachment to sternum, they are classified as- 1) True ribs - attached to the sternum directly. First seven pairs are true ribs. 2) False ribs - attached to the sternum through costal cartilages. Remaining five pairs are false ribs. Of these, last two pairs are known as floating ribs.

Costal cartilages: They are bars of hyaline cartilage connecting ribs and sternum.

Vertebral Column

Vertebral column is a powerful and flexible pillar made of a number of irregular bones called vertebrae. There are 33 vertebrae connected to one another. They have limited movement. Vertebral column provides central axis. It provides protection to spinal cord.

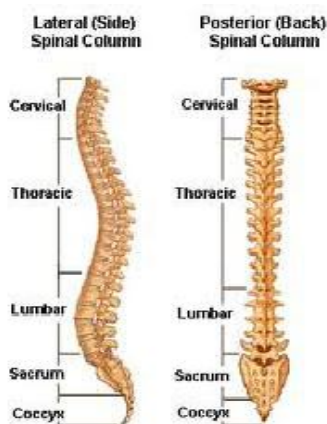


Fig 7.16 Vertebral Column

Structure of a typical vertebra: Except atlas and axis, remaining vertebrae have common features. Each vertebra consists of -

- (a) Body - cylindrical in shape and lying to the front.
- (b) Vertebral arch (also called neural arch) - posterior part. It encloses vertebral foramen.
- (c) Vertebral foramen - Spinal cord passes through this foramen.

- (d) Spinous process - directed backwards and downwards.
- (e) Two transverse processes - projecting laterally for attachment of muscles and ligaments.
- (f) 4 Articular processes - Two above, Two below. They meet corresponding processes of adjoining vertebrae.
- (g) Laminae - wide parts of arch carrying spinous process.
- (h) Intervertebral discs - They are discs of fibrocartilage for connecting one vertebra to another. Each disc has - outer ring of fibrous cartilage and inner core called nucleus pulposus.

Vertebrae are divided into five groups. They are

1. Cervical vertebrae- 7 in number forming the neck region.
2. Thoracic vertebrae - 12 in number forming back of thorax.



Fig 7.17 Thoracic Cerebrum

3. Lumbar vertebrae - 5 in number forming lumbar region.
4. Sacral vertebrae - 5 in number forming sacrum.
5. Coccygeal vertebrae - 5 in number forming coccyx.

Cervical vertebrae: They are smallest. First cervical vertebra is called atlas. 2nd vertebra is called axis.

Atlas: It is the first cervical vertebra. Features - 1. It does not have body. 2. It does not contain spinous process. 3) It has two facets on upper surface for articulation with condyles of occipital bone.

Axis : It is the second cervical vertebra. Features -

1. Odontoid process - upward projection from body.
2. Two facets - on anterior surface for articulation with atlas.

3. Spine - small and bifid part.

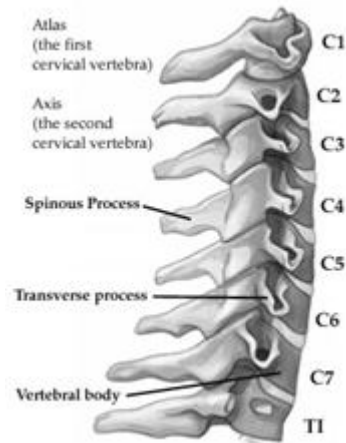


Fig 7.18 Cervical Vertebrae

Thoracic vertebrae : They are 12 in number. They carry ribs.

Features : 1. Body - heart shaped 2. Facets -one on each side for attachment of ribs 3. Transverse process 4. Vertebral foramen is not present.

Lumbar vertebrae : They are five in number. They are largest vertebrae.

Features : 1. They have no facets for articulation with ribs. 2) Spinous processes are large and strong. They give attachment to muscles. 3) Body is big and kidney shaped.

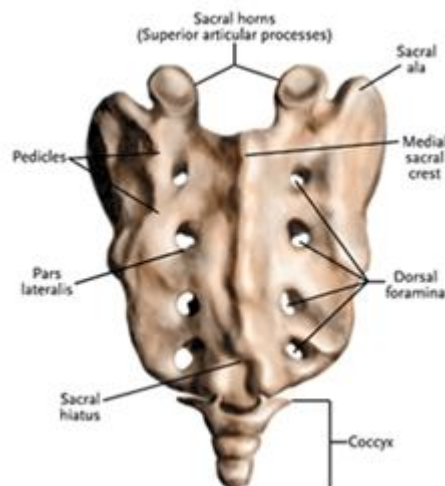


Fig 7.19 Sacro Coccygeal Vertebrae

Sacral vertebrae: They are five in number. They are fused forming sacrum. Sacrum is triangular and forms wedge between two hip bones with which it articulates. They have following features: 1. Four sacral foraminae - opening of anterior surface through which nerves pass 2. Lateral masses on either side - formed by union of transverse processes. 3. Sacral promontary - projection of

upper part of sacrum.

Coccygeal vertebrae : They are four in number. They are fused to form coccyx. Coccyx is a triangular bone. It articulates with sacrum.

Main functions of vertebral column are-

1. Supporting spinal cord.
2. Protecting spinal cord.
3. Cushioning when jumping and landing on feet.

Ligaments : Ligaments holding the vertebrae together are - 1. Anterior and posterior ligaments 2. Ligamenta flava 3. Supraspinous ligaments 4. Intervertebral discs.

Anterior and posterior ligaments connect anterior and posterior aspects of bodies respectively. Ligamenta flava connect vertebral arches. Supraspinous ligaments lie between spines and connect them. Intervertebral discs are made of fibrocartilage and are helpful for connecting vertebrae with one another.

Curves of vertebral column

Vertebral column has four curves when viewed from side.

1. Primary curves (a) Thoracic curves (b) pelvic curve
2. Secondary curves (a) Cervical curve (b) Lumbar curve

Primary curves are present during foetal life - cervical curve appears when child begins to hold up head and sit. Lumbar curve appears when child stands and walks.

7.5.2 Bones of Appendicular Skeleton

Bones of limbs: Appendicular skeleton consists of - a) Bones of upper limb (Bones of arms) b) Bones of lower limb (Bones of legs).

7.5.2.1. Bones of Upper Limb

Upper limb consists of shoulder, upper arm, fore arm, wrist and fingers.

Bones of upper limb are -

- (a) Bones of shoulder girdle - Scapula, clavicle (1+1) on each side
- (b) Bones of upper arm-Humerus (1) on each side.
- (c) Bones of fore arm -Radius,ulna(1+1) on each side.

(d) Bones of wrist and palm :

Bones of wrist - carpals (8)

Bones of palm - metacarpals(5)

(8+5=13) on each side.

(e) Bones of fingers :

Phalanges - 3 each for fingers other than thumb(3x4=12)

- 2 for thumb

Total - (12+2=14) on each side.

Functions of upper limbs are:

- handling the objects.
- performing various types of work.
- movement.

Functions of lower limbs are: - Locomotion, posture, giving stability to trunk.

Bones of shoulder girdle : Bones forming shoulder girdle are Scapula and Clavicle.

Scapula

Scapula is a large triangular flat bone. It contributes to the wide range of movement of upper limb. It lies over ribs behind thorax. It does not articulate with them. It has two surfaces:

1. Anterior or costal surface - nearest the ribs.
2. Posterior or dorsal surface - divided into two fossae by spine of scapula with ends with acromion process.

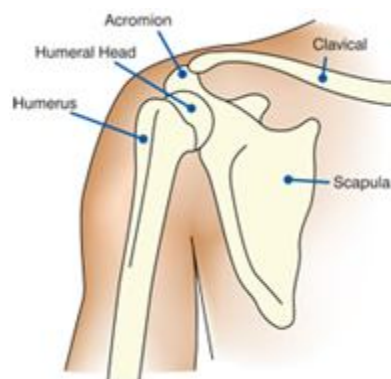


Fig 7.20 Scapula

The two fossae are

1. Supraspinous fossa - upper one giving attachment to supraspinatous muscle.
2. Infra spinous fossa - Lower one giving attachment to infraspinaous muscle.

It has three borders.They are -

1. Superior border - lying in the upper part.
2. Medial border (vertebral border) - nearest the vertebral column
3. Lateral border (axillary border) - nearest the axilla.

It has three angles.They are-

1. Superior angle - between superior and medial borders.
2. Inferior angle - between medial and lateral borders (lowest point of scapula)
3. Lateral angle (external angle) - It contains glenoid cavity for receiving the head of humerus to form shoulder joint. Coracoid process arises internal to glenoid cavity. It is large and irregular

Clavicle

It is also called as collar bone.It does not contain marrow cavity. It is a long bone at the root of the neck just below the skin.It is weight bearing bone.

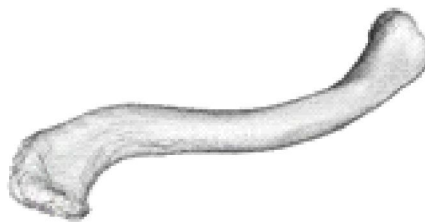


Fig 7.21 Clavicle

It is roughly shaped. It has two ends.They are- 1.Sternal extremity
2. Acromial extremity.Sternal extremity is inner extremity articulating with sternum.It is roughly pyramidal in shape.Acromial extremity is outer extremity articulating with scapula.It is flatter.

Humerus

It is the bone forming upper arm. It is the long bone of upper limb. It has two extremities and a shaft.

Upper extremity contains-

- (a) Head - hemispherical in shape.
 - articulating with glenoid cavity of scapula at shoulder joint.
- (b) Anatomical neck - below the head.
- (c) Greater tuberosity - below the anatomical neck
 - located in the outer side of upper extremity
- (d) Lesser tuberosity - below the anatomical neck
 - located at the front
- (e) Bicipital groove - lying between the two tuberosities
- f) Surgical neck - narrow point between the two tuberosities

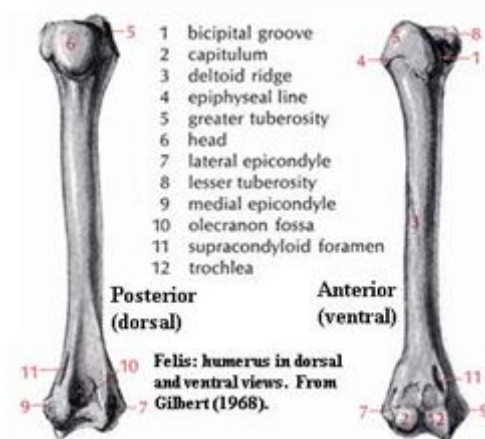


Fig 7.22 Humerus

Lower extremity contains -

- (a) Trochlea - pulley shaped surface on inner side articulating with ulna
- (b) Capitulum - on outer side
 - It articulates with radius
- (c) Coronoid fossa - It is a depression located above articulating

surface for ulna

- d) Olecranon fossa - It lies at back and receives olecranon process of ulna.
- e) Medial and lateral epicondyle - lying on each side of articulating surfaces.

Shaft contains -

- a) Deltoid tuberosity - rough tubercle on lateral aspect
- b) Spiral groove - also known as radial groove. Radial nerve passes through it.

Radius

It is the outer bone of fore arm. It is a long bone. It contains two extremities and a shaft.

Upper extremity : It contains -

- a) Head - It is disc shaped with hollow upper surface to articulate with capitulum of humerus. It also articulates with ulna.
- b) Neck - It lies below the head. It is a constricted portion.
- c) Radial tuberosity - on the ulna side, there is a projection, which is called radial tuberosity. Radial tuberosity gives insertion to biceps muscle.

Lower extremity: It is wider part. It forms wrist joint. It has a projection called styloid process.

Shaft : Shaft of the radius has a sharp ridge facing ulna. Interosseous membrane connects radius and ulna.

Ulna : It is the inner bone of fore arm. It contains two extremities and a shaft.

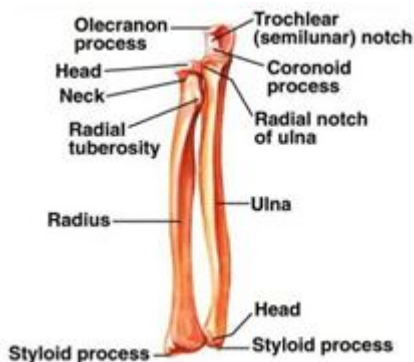


Fig 7.23 Radius Ulna

Upper extremity: It is shaped like a hook and contains -

- a) Olecranon process - upward projection at the back, which fits into olecranon fossa of humerus (when arm is kept straight). Its upper border forms elbow.
- b) Coronoid process - It is smaller projection to the forwards. It fits into coronoid fossa of humerus.
- c) Trochlear notch - formed by the above two processes which articulates with trochlear surface of humerus.
- d) Radial notch - It is a depression on upper part of coronoid process. It articulates with head of radius.

Shaft : It tapers towards lower end. It carries a sharp ridge for attachment of interosseous membrane lying between ulna and radius.

Lower extremity : It contains -

- a) Head - rounded part which articulates with lower extremity of radius.
- b) Styloid process - a projection giving attachment to a ligament of wrist joint.

Bones of wrist

Bones of wrist are called carpal bones. They are eight bones arranged in two rows.

- Bones of proximal row are scaphoid, lunate, triquetral and pisiform bones.
- Bones of distal row are trapezium, trapezoid, capitate and hamate bones.

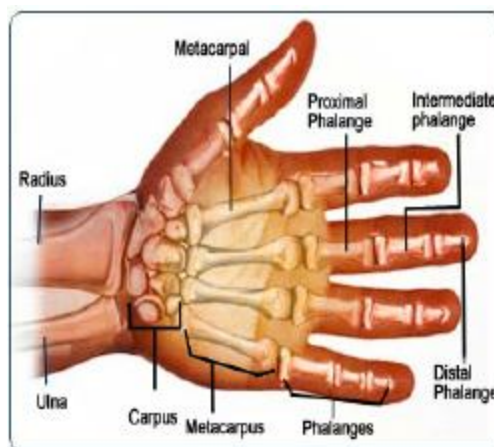


Fig 7.24 Bones of Wrist and Palm

Bones of palm : Bones of palm are called metacarpal bones. They are five miniature long bones each having base and head.

Bases of metacarpal bones articulate with distal row carpal bones and heads articulate with proximal row phalanges.

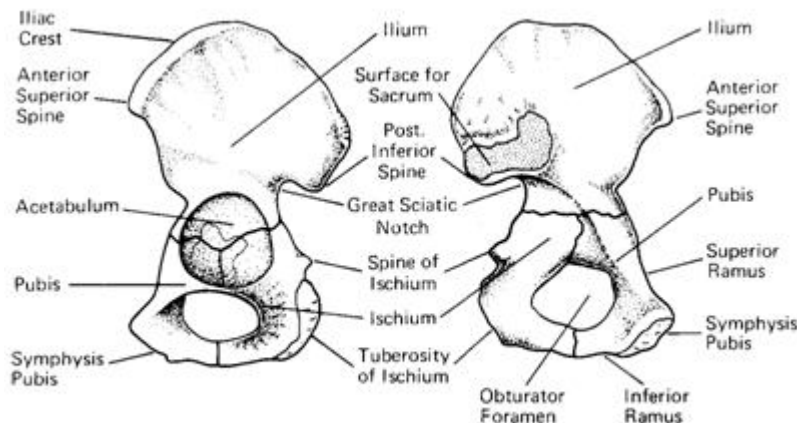
Bones of fingers : Bones of fingers are called phalanges. They are 14 miniature long bones arranged in rows. Thumb finger has two phalanges and the remaining fingers have three phalanges each. Three phalanges in a finger are called proximal phalange, middle phalange and distal phalange. Proximal row phalanges articulate with metacarpal bones and the joints are called metacarpophalangeal joints. Interphalangeal joints exist between phalangeal bones.

7.5.2.2 Bones of Lower Limbs and Pelvic Girdle

Bones of pelvic girdle : Pelvic girdle forms link between trunk and lower limbs. Pelvic girdle is formed by 2 innominate bones, 1 on each side with sacrum and coccyx behind. Pelvis is divided into Greater pelvis (false) and Lesser pelvis (true) by lineaterminalis and promontory of sacrum. Greater pelvis is upper expanded portion. It is bounded on each side by Ilium and at back by base of sacrum. Lesser pelvis consists of short curved canal. It is deeper at back than front.

Innominate Bone

It is called as pelvic bone or hip bone. Innominate bone is made of ilium, ischium and pubis. Ilium, ischium and pubis are united at deep cavity on outer aspect of bone called acetabulum. Ossification is incomplete among ilium, ischium and pubis between ages of 15-25 years. They are united by cartilage before this.



The left innominate bone. External (left) and internal surfaces.

Fig 7.25 Innominate Bone

Differences between male and female pelvis : Female pelvis is shorter than male pelvis. Female pelvis is wider than male pelvis. It is shallower than male pelvis. Sacrum is shorter and wider. Pubic arch forms obtuse angle in females whereas it forms acute angle in males. Sciatic notch is also wider. This variation in female pelvis adapts female pelvis for pregnancy and child birth.

Bones of the lower limb:

- Bones of lower limb are
- Femur (thigh bone) one on each side
- Patella (knee cap) one on each side
- Tibia and fibula (leg bones) two on each side
- Tarsal bones (ankle bones) seven on each side
- Metatarsal bones (instep bones) five on each side
- Phalanges (bones of toes) (3 x 4) + 2 on each side

Femur: It is the longest and the strongest bone of the body. It resembles humerus of upper arm. Features of femur : It contains -

1. Upper extremity 2. Shaft 3. Lower extremity

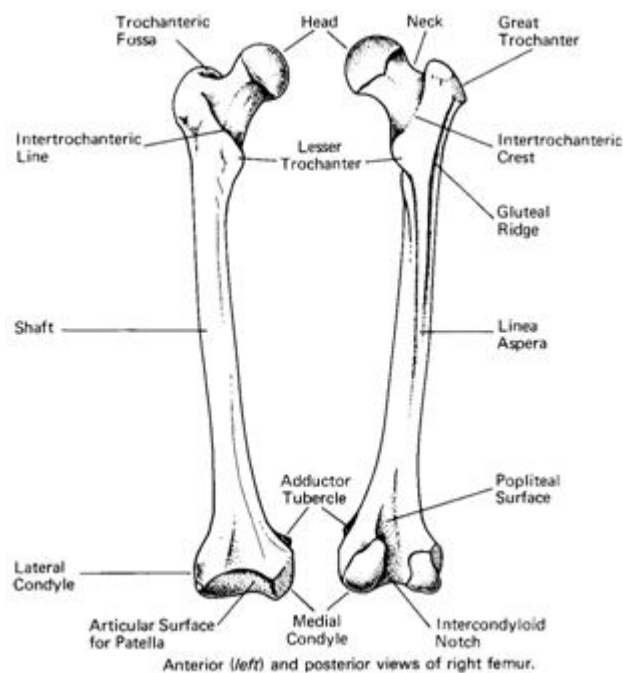


Fig 7.26 Femur

Upper extremity : It has following features.

- (a) Head - spherical in shape and covered with hyaline cartilage.
- (b) Neck - long and flat lying below head.
- (c) Greater trochanter- located on the outer side where neck and shaft join.
- (d) Lesser trochanter - located on inner side where neck and shaft join.
- (e) Anterior and posterior inter trochantric lines- unite greater and lesser trochanters.

Shaft : It has following features.

- (a) Linea aspera ridge on posterior aspect.
- (b) Gluteal ridge extending from linea aspera to the back of greater trochanter.
- (c) Spiral line extending at the inner aspect from linea aspera to lesser trochanter.

Lower extremity : It has following features.

- (a) Medial and lateral condyles
- (b) Inter condylar notch - separating the two condyles.
- (c) Adductor tubercle - lying above medial condyle.
- (d) Patellar surface.
- (e) Popliteal surface.

Patella : It is a small mobile disc located in front of knee joint in the tendon of quadriceps muscle. It forms knee cap. It is a sesamoid bone. It is triangular in shape with its apex facing downwards. Its posterior surface is smooth. It articulates with condyles of femur. Its anterior surface is rough.

Bones of leg: Bones of leg are - Tibia and fibula.

Tibia

It is inner bone of leg. It is stronger than fibula. It has following features - upper extremity, shaft and lower extremity

Upper extremity of has

- (a) Head, containing two condyles. They are (i) medial condyle (ii) lateral condyle. Surfaces of these condyles articulate with corresponding

condyles of femur.

(b) Popliteal notch, separating the two condyles at back.

(c) Tubercle below the condyles in the front.

Shaft : Shaft is triangular in shape. It has three borders and three surfaces. Crest of tibia is located at the middle third portion of anterior border. Soleal line is a ridge of bone. It is strong. It is present in the posterior surface.

Lower extremity : It is slightly expanded. Its surface articulates with talus and forms ankle joint.

Fibula : It is the outer bone. It does not participate in weight bearing. It has upper extremity, shaft and lower extremity.

Upper extremity has head & styloid process. Shaft is thin and gives attachment to muscles. Lower extremity has lateral malleolus and malleolar fossa.

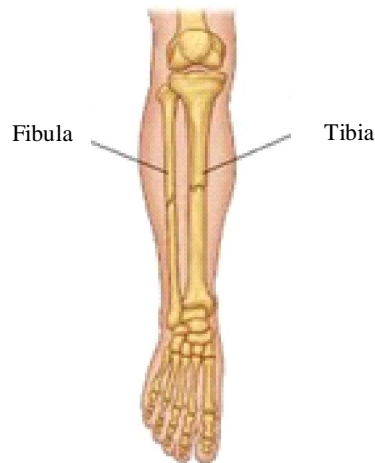


Fig 7.27 Tibia - Fibula

Bones of foot: Tarsal bones, metatarsal bones, and phalanges are collectively called bones of foot. Tarsal bones are seven bones in two rows. Tarsal bones are - Talus, calcaneum, navicular, cuboid, and 3 cuneiform. Talus and calcaneum are the most prominent bones among tarsals. Talus is the main connecting link between foot and leg. Calcaneum is the largest bone of foot. Navicular is disc shaped. Cuneiform bones are three in number. They are - Medial, intermediate, and lateral.

Metatarsal bones : They are 5 bones. Their heads articulate with phalanges.

Phalanges: They are 14 in number. Greater toe has two phalanges. Remaining toes have three phalanges each.

7.6 Joints

Definition : Joint or articulation is a junction between two or more bones.

Arthrology: Arthrology is study of joints.

7.6.1 Classification of Joints

Joints are classified depending on the degree of movement allowed. On this basis, there are three types of joints. They are-

1) Fibrous joints (Immovable) 2) Cartilaginous joints (Slightly movable) 3) Synovial joints (Freely movable).

Fibrous Joint

It is the type of joint where there is no movement of bones, fibrous tissue is the connecting medium between the bones.

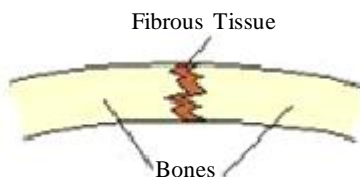


Fig 7.28 Fibrous Joint

Ex: 1. Sutures of skull. (a) Coronal suture between frontal and parietal bones. (b) Sagittal suture between parietal bones 2. Tibiofibular joint between tibia and fibula 3. Joints between teeth and jaws.

Cartilaginous Joints

It is the type of joint where bones forming the joint are slightly movable. Surfaces of the bones at the joint are covered with hyaline cartilage and fibrous cartilage or fibrous ligaments act as connecting medium.

Ex: 1. Intervertebral joints

2. Joint between manubrium sterni and body of sternum.

Synovial Joints

It is the joint between the bones where bones are freely movable. Joint forming bone surfaces are covered with articular hyaline cartilage. Cavity around

the joint is called synovial cavity. Fluid in the cavity lubricating the articulating surfaces is called synovial fluid. Joint is completely surrounded by a fibrous capsule lined with synovial membrane.ex: elbow joint.

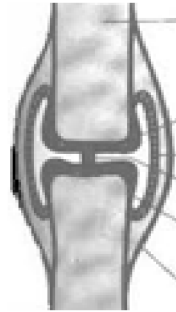


Fig 7.29 Synovial Joints

Types of Synovial joints : On the basis of type of movement, synovial joints are divided into several classes.

They are - 1. Hinge joints

2. Pivot joints

3. Condylloid joints

4. Ball and socket joint

5. Gliding joints

6. Saddle joint

1. **Hinge Joint** : It is the type of joint allowing unidirectional movement as in knee and elbow.

2. **Pivot Joint** : It is the type of joint allowing rotation only.

ex: (i) Atlas and axis

(ii) Radius and ulna.

3. **Condylloid joint** : It is the type of joint allowing movement in two planes.

ex : Ankle joint, Wrist joint.

4. **Ball and socket joints** : It is the type of joint allowing movement in all directions as a ball in cup shaped socket cavity.ex:shoulder joint and hip joint.

5. **Gliding Joints** : It is the type of joint allowing the joint forming surfaces of bones to glide over each other.Ex: Carpal joints, Tarsal joints.

6 Saddle Joint : It is the type of joint allowing free movement in all directions.

Ex : Joint between metacarpal bone of thumb and trapezium.

7.6.2 Types of Movements at the Joints

Various types of movements at joints are -

1. Rotation movements
2. Angular movements
3. Gliding movements

Rotation movements: Movements due to one bone moving within another bone are rotation movements.

Ex: 1. Movements of femur in acetabulum of hip bone.

2. Movement of head rotation of radius over ulna.

3. Movement of ball of humerus in shoulder joints.

2. **Angular movements :** They are different types.

(a) Flexion : Bending of parts towards each other.

(b) Extension : Straightening out of a part from other.

(c) Adduction : Movement of a part towards medial axis.

(d) Abduction: Movement of a part away from medial axis.

(e) Pronation : Bending of ventral surface downwards or turning of palm downwards as in blessing.

(f) Supination : Turning of palm upwards as in begging.

(g) Circumduction : Movement involving flexion, abduction, extension and adduction in a sequence. ex: Movement in shoulder.

3. **Gliding movements:** Gliding movement is type of movement in which two flat surfaces move on each other.

Ex : 1. Movement of carpal bones in wrist.

2. Movement of tarsal bones in foot.

7.6.3 Joints of Human Body

Joints of human body can be classified on the basis of anatomical location

into - 1. Joints of head 2. Joints of trunk 3. Joints of upper limbs 4. Joints of lower limbs.

Joints of Head

The only movable joint in head is temporomandibular joint. It lies between temporal bone and head of mandible. Sutures of the skull are immovable joints. Sutures are already described in the previous sections of this chapter. Unossified membranous areas at the junctions of bones of skull are called fontanelles. They have also been dealt in the previous sections of this chapter.

Joints of trunk: Joints of trunk are -

1. Intervertebral Joints
2. Costovertebral Joints
3. Sternocostal Joints.

Inter vertebral joints : They are the joints between all vertebrae from second cervical vertebra to sacrum. Joints between vertebral bodies are slightly movable where as joints between vertebral arches are synovial joints.

Costovertebral Joints : Joints between ribs and vertebrae are called costovertebral joints. They allow gliding movements.

Sternocoatal Joints : Joints between ribs and sternum are sternocostal joints . They also allow gliding movements.

Joints of upper limbs

Joints of upper limb are -

1. Sernoclavicular joint : Sternoclavicular joint is gliding type of joint between sternum and clavicle.

2. Acromio - clavicular joint: The acromioclavicular joint, or AC joint, is a joint at the top of the shoulder. It is the junction between the acromion (part of the scapula that forms the highest point of the shoulder) and the clavicle.

3. Shoulder joint: It is ball and socket joint between scapula and humerus. Flexion, extension, adduction, abduction, rotation and circumduction occur at this joint.



Fig 7.30 Shoulder Joint

4. Elbow Joint: It is hinge joint between humerus and ulna, humerus and radius. Flexion and extension occur at this joint.

5. Radio ulnar joints: It is pivot joints between radius and ulna. They are superior radio ulnar joint and inferior radio ulnar joint. Pronation and supination movements occur at these joints.

6. Wrist joint: It is condyloid joint between radius and carpal bones. It is also known as radiocarpal joint. Flexion, extension, abduction and adduction occur at this joint.

7. Intercarpal joints: They are gliding joints between carpal bones.

8. Carpometacarpal joints: Gliding joints between carpal bones and metacarpal bones. Carpometacarpal joint of thumb is saddle type joint.

9. Metacarpo phalangeal joint: They are condyloid type of joints between metacarpal bones and proximal row phalanges. Flexion, extension, adduction and abduction occur at these joints.

10. Interphalangeal joints: Hinge joints between phalanges. Flexion and extension occur at these joints.

Joints of lower limbs

1. Hip Joint: Ball and socket type joint between hip bone and femur is called hip joint. Flexion, extension, abduction, adduction and circumduction occur at this joint.

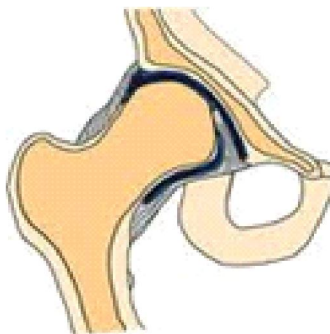


Fig 7.31 Hip Joint

2. Knee joint: Knee joint is hinge joint between femur and tibia. Patella is present on smooth surface of femur. It helps in gliding movements. Flexion and extension occur at this joint.

3. Tibiofibular joints: Tibio fibular joints are fibrous joints between tibia and fibula at their lower and upper extremities.

4. **Ankle joint:** Ankle joint is hinge joint between tibia and tarsals. Dorsiflexion and plantar flexion occur at this joint.
5. **Tarsometatarsal joints:** They are gliding joints between tarsal bones and metatarsal bones.
6. **Metatarso phalangeal joints:** They are gliding joints between metatarsal bones and phalanges.
7. **Inter phalangeal joints:** They are gliding joints between phalanges.



Fig 7.32 Knee Joint

8. **Mediotarsal joints:** They are joints between talus with navicular and calcaneum with cuboid.
9. **Talocalcaneal joint:** It is the joint between talus and calcaneum. It is also called as subtalar joint. Movement is rocking type.

Conclusion

Bones form the skeleton of human body. It gives frame work to body and also protection to the inner organs. Joint is a junction between two or more bones.

Summary

Bone is the hardest connective tissue of body. Joint is any connection between two bones. Bones are classified into long bones, short bones, flat bones, irregular bones and sesamoid bones. Totally there are 206 bones in the human skeleton. They can be classified into bones of the skull, bones of the trunk, bones of upper limb and bones of lower limb. Joints are classified into fibrous joints, cartilaginous joints and synovial joints. Synovial Joints are classified into gliding joint, hinge joint, pivot joint, ball and socket joint, condyloid joint and saddle joint.

Short Answer Type Questions

1. Write the number of bones in human skeleton. What are the functions of skeletal system?
2. Give the composition of bone.
3. What are the functions of bone marrow?
4. Define ossification. What are the types?
5. What are various classes of bones?
6. Where are long & short bones found in human body?
7. Mention the bones of cranium.
8. Write the sutures of cranium.
9. Mention the features of frontal bones.
10. Write the features of parietal bones.
11. Name the bones of joint with parietal bone.
12. Mention the bones of joint with temporal bone.
13. What are the parts of a temporal bone?
14. Write the features of an occipital bone.
15. Name the parts of ethmoid bone.
16. What are different cranial fossae?
17. Define fontanelles.
18. Give the list of bones of trunk.
19. Write the bones of upper limb.
20. Mention the bones of lower limb.
21. How many bones are there in cranium? Mention.
22. Mention the important sutures of cranium.
23. Write the features of frontal bone.
24. What are different parts of temporal bones?
25. What are fontanelles? Mention the types.
26. Mention the sinuses of skull.

27. Write the functions of sinuses.
28. Mention the bones of the face.
29. What is mandible? Name the parts.
30. Name the bones of upper limb.
31. What are the surfaces of scapula?
32. Write the bones of wrist.
33. Mention bones of thorax.
34. What are different classes of vertebrae?
35. Mention the number of 1) Thoracic vertebrae 2) Lumbar vertebrae
36. Mention the bones of pelvic girdle.
37. What are the features of pubis bone?
38. Write the parts of pelvis.
39. Differentiate between male and female pelvis.
40. Mention the bones of lower limb.
41. Describe fibula.
42. Write the features of upper extremity of femur.
43. What are the bones of foot? Mention with number.
44. Mention the classes of joints.
45. Write the characteristics of synovial joints.
46. Define a) Gliding joint b) Hinge joint
47. Write the movements of a) Wrist joint b) Humeroulnar joint
48. Mention joints of lower limb.
49. Write the joints of foot.
50. Mention the bones joined by a) Tarsal joints b) Inter phalangeal joints.
51. Name the joints joining a) Tarsal and metatarsal bones b) Metatarsal and phalangeal bones.
52. What are interphalangeal joints?

Long Answer Type Questions

1. Classify bones of human skeleton and write about bones of cranium.
2. Write about bones of face.
3. Write note on bones of upper limb, lower limb and bones of wrist and hand.
4. What are the bones of thorax? Write about ribs.
5. Write about bones of foot.
6. Classify joints. What are different synovial joints?
7. Write the joints of body.

Nervous System - CNS

Structure

- 8.1 Introduction
- 8.2 Nervous Tissue
- 8.3 Neuron
- 8.4 Types of Nerve Fibres
- 8.5 Neuroglia
- 8.6 Synapse
- 8.7 Central Nervous System

Learning Objectives

- Student should know about nervous system and its divisions.
- Student should understand CNS.

8.1 Introduction

Nervous system controls and integrates the functions of human body. The nervous system is essentially a biological information highway. It consists of the Central Nervous System (CNS), essentially the processing area and the Pe-

ipheral Nervous System which detects and sends electrical impulses that are used in the nervous system. Nervous system consists of neurons, its fibres, dendrites and axons.

8.2 Nervous Tissue

It is composed of neurons and neuroglia. Neurons are structural and functional units whereas glial cells are supportive cells. Glial cells provide nutrients to neurons. They also protect neurons.

8.3 Neuron

It is the structural and functional unit of nervous system. It is made of nerve cell body, dendrites and axons. Nerve cell body consists of large nucleus, neurofibrils and Nissl granules, which are present in neuroplasm. Nerve cell body also contains mitochondria and other cell organelles. Dendrites are the receptive fibres receiving impulses and transmitting them to the nerve cell body. Axons carry impulses away from the nerve cell body.

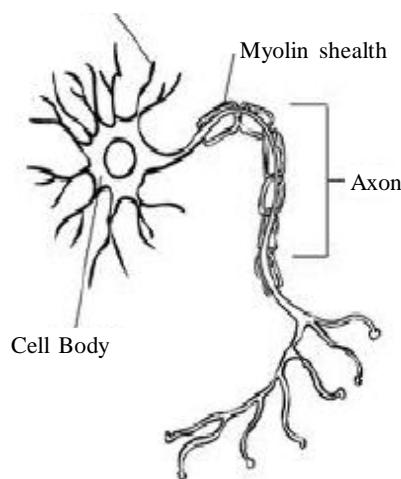


Fig 8.1 Neuron

8.3.1 Types of neurons

On the basis of no. of processes, they are classified into

- (a) Apolarneurons – Neurons having no processes
- (b) Unipolarneurons – Neurons having only one process axon.

These two types are found only in foetal life.

- (c) Bipolarneurons – Neurons having one axon at one pole and dendrite at

the other pole.

- (d) Pseudounipolar neurons – Neurons, which are typically bipolar at first and spindle shaped, but cell processes converging to meet at one side of the cell body as the development proceeds. They are found in all spinal ganglia and ganglia of cranial nerves except 8th cranial nerve.
- (e) Multipolar neurons – Neurones having most varied form. They are found in cerebral cortex, nuclei of trigeminal nerve and motor neurons of spinal cord.

8.4 Types of Nerve Fibres

Histologically there are two types of nerve fibres.

1. Medullated nerve fibres
2. Non medullated fibres

In medullated or myelinated nerve fibres, axon is covered by myelin sheath except at the nodes of Ranvier. In nonmedullated or non myelinated nerve fibres, axons are not covered by myelin sheath.

8.5 Neuroglia

Neuroglia is a special type of interstitial tissue present both in grey and white matter. There are three types of neuroglia.

1. Astrocytes a) protoplasmic astrocytes b) fibrous astrocytes
2. Oligodendroglia or oligodendrocytes (having few processes)
3. Microglia (having small size)

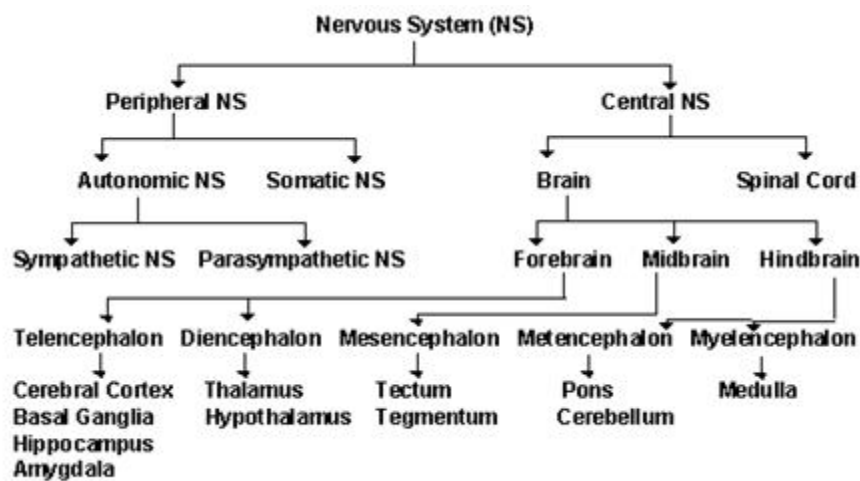
Astrocytes and oligodendrocytes are ectodermal in origin. Microglia is mesodermal in origin.

8.6 Synapse

Synapse is the junction where one neuron ends and another neuron begins.

Classification of synapses:

- They are
1. Axosomatic synapse
 2. Axo dendritic synapse
 3. Axo-axonic synapse.



Division of Nervous System

In axosomatic synapses, presynaptic terminal of the axon ends in the cell body of neurone. In axodendritic synapse, presynaptic fibres of any axon end in the dendrites of postsynaptic cell. In axo-axonic synapse, presynaptic fibres of any axon ends in the axon of the postsynaptic cells.

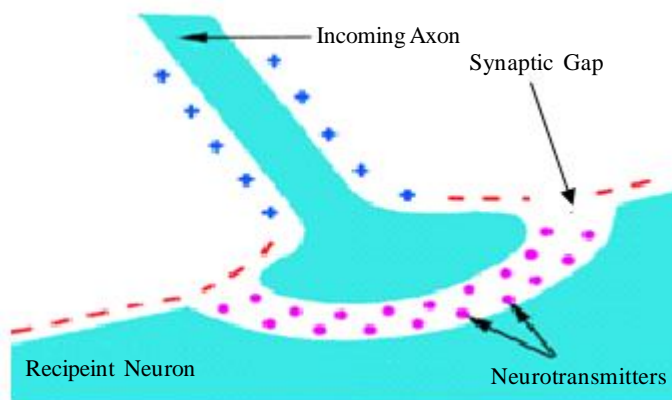


Fig 8.2 Synapse

Anatomy of the synapse: Microscopic anatomy of a motor neurone of the anterior horn cells of the spinal cord shows the main body of the neurone—soma, dendrites, axon and multiples presynaptic terminals (synaptic knobs) ending in the soma and dendrites. These presynaptic terminals are the ends of the neurofibrils of other neurones. Presynaptic fibres end in an expanded terminal called synaptic knob. Synaptic knob and soma have intact membrane. Membrane of the synaptic knob is called presynaptic membrane. Membrane of the soma is called postsynaptic membrane.

8.7 The Central Nervous System (CNS)

The Central Nervous System is effectively the centre of the nervous system. The CNS consists of the brain and spinal cord. This information highway called the nervous system consists of many nerve cells, also known as neurones. As mentioned in the above table, brain and spinal cord are the components of CNS. They are continuous with each other. Both of them have nerve cells and glial cells. In brain, all cell bodies of neurons are present in the outer layers. The outer layers of brain look dullish gray coloured. Due to this this matter is called Gray matter. Deeper layers of the brain have the axons of cell bodies present in the top layers. Most of these axons are myelinated. Hence they appear white coloured and this matter is called white matter. In spinal cord, white matter is on the surface and the gray matter is in deeper layers.

Both the brain and spinal cord are covered by three membranes. They are

1. Duramater (Outer most layer)
2. Arachnoid membrane (Middle layer)
3. Piamater (Innermost layer)

A fluid flows between the outer and middle membranes, which is called cerebrospinal fluid (CSF). This fluid flows from brain to spinal cord and back to brain. It is protective to brain and spinal cord from injuries. It supplies nutrients to the cells in brain and spinal cord.

8.7.1 Brain

The adult human brain weighs on average about 3 lb (1.5 kg) with a size (volume) of around 1130 cubic centimetres (cm³) in women and 1260 cm³ in men, although there is substantial individual variation. The brain is very soft, having a consistency similar to soft gelatin or soft tofu. It is surrounded by a bony case called cranium. It is made up of skull bones, which protects brain from injuries. Brain is divided into three parts.

1. Fore brain
2. Mid brain &
3. Hind brain (continues as spinal cord)

Fore brain is the biggest part of brain. This is also called cerebrum.

Cerebral hemispheres form the largest part of the human brain and are situated above most other brain structures. They are covered with a cortical layer with a convoluted topography. Underneath the cerebrum lies the brainstem,

resembling a stalk on which the cerebrum is attached. At the rear of the brain, beneath the cerebrum and behind the brainstem, is the cerebellum, a structure with a horizontally furrowed surface that makes it look different from any other brain area. Cerebellum is not so large relative to the rest of the brain. As a rule, the smaller the cerebrum, the less convoluted the cortex.

Cerebrum: A deep groove is present in the middle of the cerebrum. It divides cerebrum into two halves. These are called cerebral hemispheres. Right and left hemispheres are connected to each other by a bundle of axons. Outer portion of cerebrum is gray in colour and is called cerebral cortex. There are several ridges on the surface of brain called GYRI. SULCI are the grooves on the brain's surface. They increase the surface of cortex to accommodate more number of neurons. Deep grooves present across a cerebral hemisphere are three in number and they divide a hemisphere into four lobes. They are-

1. Frontal lobe 2. Parietal lobe 3. Temporal lobe 4. Occipital lobe

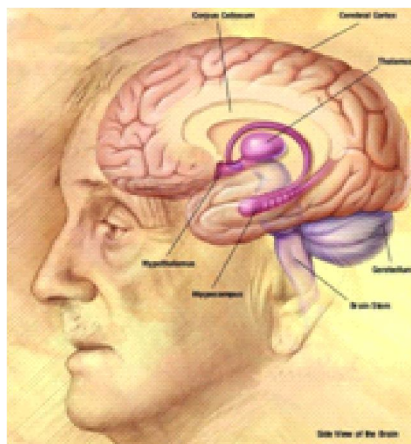


Fig 8.3 Brain

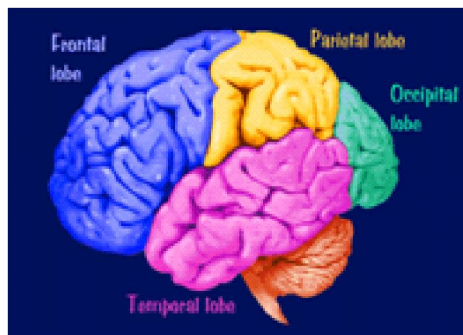


Fig 8.4 Lobes of a cerebral hemisphere

Cerebrum is the highest centre for controlling several functions in the body. Right hemisphere controls the functions of left side of body and vice versa. In cerebral cortex, several centres are there to receive and analyse informations. Some of them are

1. Visual centre for sight
2. Auditory centre for hearing
3. Olfactory centre for smell etc.

Parts of the brain below the cerebrum are together known as Diencephalon. It has centres controlling emotions like anger, pain and pleasure. This por-

tion connects the fore brain with mid brain. Hypothalamus is present in this section. Pituitary gland is attached to hypothalamus by a stalk.

Thalamus

Thalamus and Hypothalamus are present in Diencephalon. Thalamus is a large, dual lobed mass of grey matter buried under the cerebral cortex located at the top of midbrain. It is involved in sensory perception and regulation of motor functions. Thalamus is a limbic system structure and it connects areas of the cerebral cortex that are involved in sensory perception and movement with other parts of the brain and spinal cord that also have a role in sensation and movement.

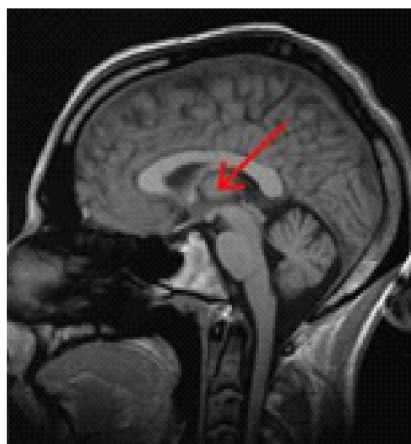


Fig 8.5 Thalamus

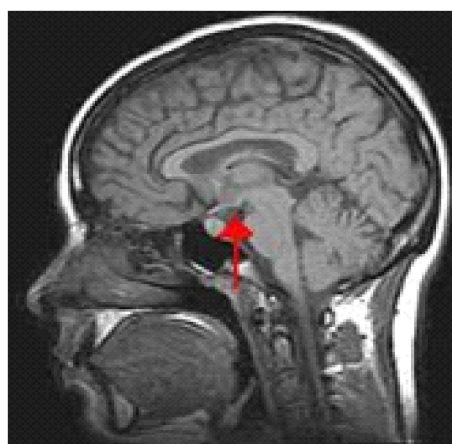


Fig 8.6 Hypo Thalamus

As a regulator of sensory information, the thalamus also controls sleep and awake states of consciousness.

Hypothalamus

Hypothalamus is located at interpeduncular space below thalamus. It has close relation with Pituitary gland. It is the highest centre for A.N.S.. It is derived from basal plate of diencephalon. It forms complex nuclei and fibres. It consists of the following nuclear masses. 1) Anterior group 2) Middle group 3) Posterior group.

Midbrain

Midbrain is the connection between fore brain and hindbrain. Dorsal part of midbrain contains four round eminences. These four rounded eminences are called corpora Quadrigemina.

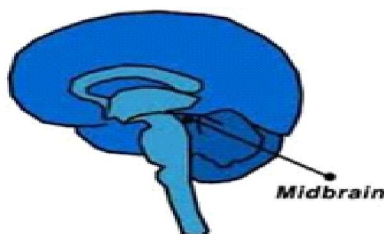


Fig 8.7 Mid Brain

Ventral part of midbrain contains a pair of cerebral peduncles. These are cylindrical bodies. Cerebral peduncles consist of Basis pedunculi, substantia nigra, tegmentum. Rednucleus consists of two groups of cells-nucleus magnocelluforis and nucleus parvocellularis.

Ponsvaroli: It is located above medulla oblongata. Anteriorly, it appears as a bulging mass of transverse fibres, posteriorly, it is separated from cerebellum by fourth ventricle. T.S. of pons varoli shows two main portions.

Hind brain

Hind brain consists of two parts.

1. Cerebellum
2. Brain stem.

Cerebellum: Cerebellum is the largest part of hind brain. It lies behind pons and medulla oblongata. Cerebellum is a separate structure attached to the bottom of the brain, tucked underneath the cerebral hemispheres. Average weight of cerebellum in adults is about 150gm. It consists of grey mater on the surface and white mater in the deeper layers. The surface of the cerebellum is covered with finely spaced parallel grooves, in striking contrast to the broad irregular convolutions of the cerebral cortex.

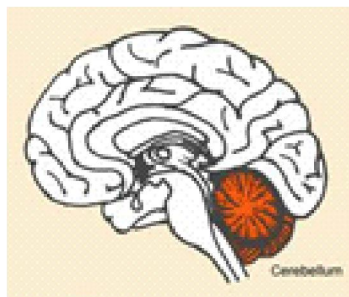


Fig 8.8 Cerebellum

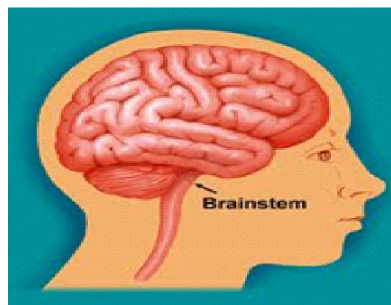


Fig 8.9 Brain stem

These parallel grooves conceal the fact that the cerebellum is actually a continuous thin layer of tissue (the cerebellar cortex), tightly folded in the style of

an accordion. Within this thin layer are several types of neurons with a highly regular arrangement, the most important being Purkinje cells and granule cells. This complex neural network gives rise to a massive signal-processing capability, but almost all of its output is directed to a set of small deep cerebellar nuclei lying in the interior of the cerebellum.

Cerebellum consists of right and left cerebellar hemispheres. They are joined by vermis. From functional and morphological point of view, cerebellum consists of two parts. They are

- 1) Floculondular lobe
- 2) Corpus cerebelli

Floculonodular lobe is separated from corpus cerebelli by posterior lateral fissure. Phylogenetically cerebellum is divided into- 1) Archicerebellum 2) Palaeocerebellum 3) Neo cerebellum

Afferent and efferent fibres connecting the cerebellum with extra cerebellar regions run through three large bundles. They are known as superior, middle and inferior cerebellar peduncles. It is divided into a) Anterior limb b) Posterior limb c) Genu.

Brain stem: Brain stem includes Medulla oblongata and Pons varoli. Medulla oblongata continues as spinal cord. In medulla oblongata there are several centres to control several vital functions of body such as heart beat, respiration, temperature, blood pressure, secretions of salivary glands etc. All the nerve fibres pass from brain to spinal cord through this part.

Medulla oblongata: It is also called spinal bulb. It is approximately 28mm long. It conically expanded. In medulla oblongata, white matter is on the surface and grey matter is in the deeper layers. The medulla is often thought of as being in two parts.

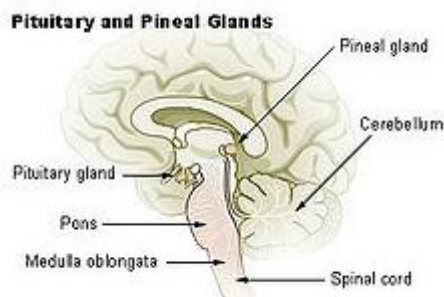


Fig 8.10 Medulla oblongata and Pons Varoli

1. Open part or superior part where the dorsal surface of the medulla is

formed by the fourth ventricle.

2. Closed part or inferior part where the metacoel lies within the medulla oblongata. It extends from foramen magnum to the caudal border of pons. It continues as spinal cord.

Sulci present on surface of spinal cord also continue upward into medulla oblongata.

Pons Varoli: Pons Varoli is a structure located on the brain stem. It is superior to the medulla oblongata, inferior to the midbrain, and ventral to the cerebellum. In humans and other bipeds this means it is above the medulla, below the midbrain, and anterior to the cerebellum. This white matter includes tracts that conduct signals from the cerebrum down to the cerebellum and medulla, and tracts that carry the sensory signals up into thalamus.

The pons measures about 2.5 cm in length. Most of it appears as a broad anterior bulge rostral to the medulla. Posteriorly, it consists mainly of two pairs of thick stalks called cerebellar peduncles. They connect the cerebellum to the pons and midbrain.

Internal capsule: It is a 'V' shaped band of fibres. It is bounded medially by thalamus and caudate nucleus. It is laterally bounded by lentiform nucleus.

Basal ganglia: Basal ganglia includes corpus striatum, claustrum, red nucleus, body of Luys and substantia nigra. Corpus striatum includes caudate nucleus, lobus pallidus and putamen.

Corpus striatum: It is a mass of gray matter lateral and anterior to thalamus. Anterior limb of internal capsule divides corpus striatum into two parts incompletely. They are caudate nucleus and lentiform nucleus. Caudate nucleus is small anterior part and lentiform nucleus is larger posterior part.

Substantia nigra: It is a crescentic mass of nerve cells. It contains melanin. It lies between crus cerebri and tegmentum of midbrain.

Body of Luys: It is also called corpus luyisi or subthalamic nucleus. It lies laterally and ventrally to red nucleus. It lies dorsal to substantia nigra. It is connected to red nucleus, substantia nigra and globus pallidus etc.

Subthalamus: It is dorsally bounded by thalamus. It is bounded medially and rostrally by hypothalamus. It is bounded laterally and ventrally by pes pedunculi and neighbourhood area of internal capsule.

Reticular Formation: Diffused ill defined mass of nerve cells and fibres form mesh work in the central portion of brainstem. It is collectively called reticular formation. It extends upward into thalamus and subthalamus. It extends downwards into spinal cord. Parts of reticular formation which play roles in wakefulness are called ascending reticular activating system.

Vestibular apparatus: It consists of bony labyrinth lodging membranous labyrinth. Bony labyrinth includes vestibule, semi circular canals and cochlea. These three cavities are filled with perilymph. Perilymph is a clear fluid of high sodium. Membranous labyrinth lies within bony labyrinth. Membranous labyrinth is filled with endolymph. Endolymph contains high potassium content.

Semi circular canals: They are three in number and lying in three planes at right angles to one another. These are lateral, anterior and posterior canals. Lateral canal is horizontal and other two are vertical. Histologically, these canals contain

1. Outer vascular and fibrous coat
2. Middle thicker, homogeneous and transparent coat forming basement membrane.
3. Inner layer made up of cubical epithelium.

Otolithic Organ: It consists of saccule and utricle. Histologically it consists of same coats as that of semicircular canals. Both in saccule and utricle, a sense organ is present. It is called 'macula'.

Cerebral Ventricles: These are the cavities in the brain where CSF flows and bathes the whole brain. There are four ventricles two lateral ventricles, a third ventricle and a fourth ventricle.

Lateral ventricles are present in the cerebrum. Third ventricle lies in between two halves of the thalamus. Fourth ventricle lies in front of cerebellum and behind the medulla oblongata and pons varoli.

8.7.2 Spinal cord

Spinal cord is a long cylindrical structure which passes through vertebral column extending all along the dorsal surface of trunk.

T.S. of spinal cord : T.S. of Spinal cord shows 1) Central canal 2) Gray matter & 3) White matter.

Central Canal : Central canal is in the middle of the spinal cord. It is lined by cubical ciliated epithelium. Cerebrospinal fluid (C.S.F) circulates through this

canal. The central canal actually pierces through the isthmus (commissure) of the two symmetrical lateral halves of the gray matter. Parts of the gray matter in front of the central canal is known as anterior (ventral) gray commissure and the same on behind the central canal is known as posterior (dorsal) gray commissure.

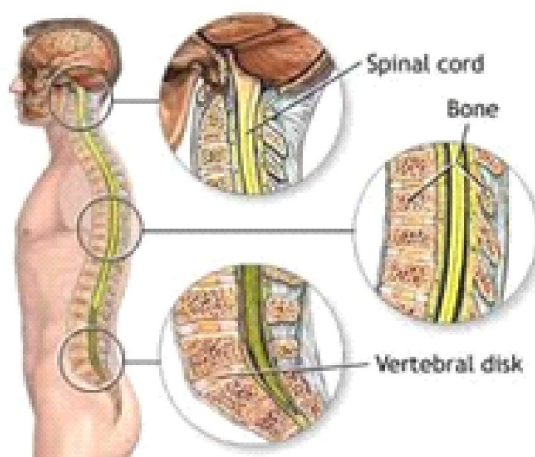


Fig 8.11 Spinal cord

Gray matter: It is in the form of a rough crescent one on each side. Each crescent has three parts - anterior horn, lateral horn and posterior horn. Gray matter is chiefly composed of three elements-a)nerve cells, b) neuroglia& c) nerve fibres.Lateral horn projects in the thoracic region of spinal cord.

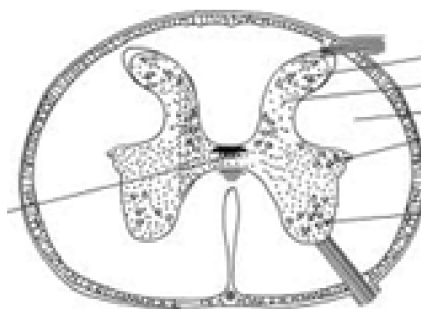


Fig 8.12 T.S. of Spinal cord

White matter: White matter of the spinal cord surrounds the gray matter and consists of myelinated and unmyelinated fibres. Myelinated fibres are predominating. The lateral half of white matter on each side is divided into three compartments- anterior white column, lateral white column and posterior white column.

Conclusion

Nervous system controls and integrates the functions of human body. The nervous system is essentially a biological information highway. It consists of the Central Nervous System (CNS), essentially the processing area and the Peripheral Nervous System which detects and sends electrical impulses that are used in the nervous system.

Summary

Nervous system consists of neurons, its fibres, dendrites and axons. Nervous tissue is made of neurons and neuroglia. Neuron is the structural and functional unit of nervous system. Synapse is the junction where one neuron ends and another neuron begins. Brainstem includes mid brain, medulla oblongata and pons varoli. Cerebellum is the largest part of hind brain. Thalamus is located at the top of mid brain. Corpus striatum includes caudate nucleus, globus pallidus and putamen. Reticular formation is ill defined mass of nerve cells and fibres forming mesh work in the central portion of brainstem. Cerebrum consists of two symmetrical hemispheres. Histologically cortex has three divisions. Brain and spinal cord are covered by pia mater, arachnoid matter and dura mater. Diencephalon contains thalamus and hypothalamus. Histologically spinal cord consists of central canal, Gray matter and white matter.

Model questions

Short Answer Type Questions

1. What is nervous tissue?
2. Define neuron and mention its types.
3. What is synapse?
4. Write the histology of spinal cord.
5. What are the parts of brainstem?
6. Write about medulla oblongata.
7. Write the lobes of each cerebral hemisphere.
8. Name the coverings of brain and spinal cord.
9. Name the divisions of ANS.
10. Write the parts of Diencephalon.
11. Where is speech centre located?

Long Answer Type Questions

1. Write the anatomy of brain.
2. Explain the anatomy of brain stem.

UNIT

9

Excretory System - Urinary System

Structure

- 9.1 Introduction
- 9.2 Urinary System
- 9.3 Other Channels of Excretion

Learning Objectives

- Student should know the channels of excretion and their anatomy.
- Student should know about structure of kidney.

9.1 Introduction

Excretory system consists of organs concerned with excretion of waste products formed in the cellular metabolism of body. Such channels concerned with excretion are called as channels of excretion. They are-

KIDNEYS-2

SKIN

LIVER

LUNGS-2

DIGESTIVE TRACT

SALIVARY GLANDS

9.2 Urinary System

Urinary system consists of -

KIDNEYS-2

URETERS -2

URINARY BLADDER

URINOGENITAL TRACT/URETHRA

9.2.1 Kidneys

Kidneys are the main organs of urinary system. They are 2 bean shaped organs lying on the posterior wall of upper abdomen, one on each side of vertebral column. They lie at the level of twelfth thoracic to third lumbar vertebrae. Right kidney is located slightly lower than left kidney. Dimensions of each kidney are $11 \times 5 \times 3 \text{ cm}^3$. Each kidney weighs 150g. approximately. On each kidney, an adrenal gland is present

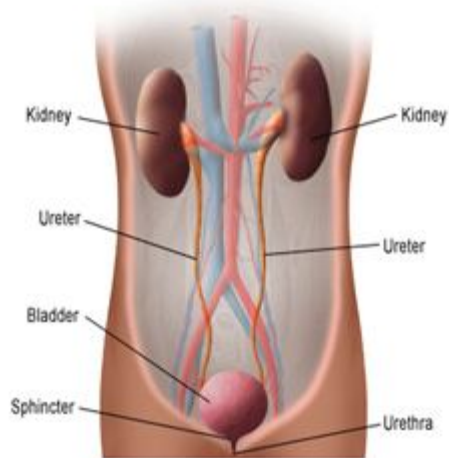


Fig 9.1 Urinary System

Each kidney is embedded by fat called perirenal fat. Right kidney bears the impression of part of duodenum on its front. Pancreas crosses the left kidney transversely in its front. Each kidney is convex on its outer border and concave in the centre of its inner border. At this point, blood vessels, nerves and ureter enter and leave kidney. This point of kidney is called Hilus.

Ureters transport urine formed in kidneys to urinary bladder. From urinary bladder, urine is passed to the exterior through urethra. Urethra in males is also passage for semen. Hence it is also called urinogenital tract in males. In females,

it is independent.

Structure of Kidney

Longitudinal section of Kidney :

Kidney is surrounded by a fibrous capsule. It can be stripped off easily. Portion inside this fibrous capsule can be divided into- 1) Cortex 2) Medulla.

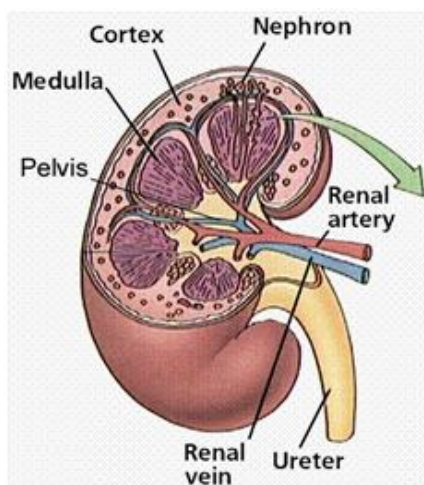


Fig 9.2 A longitudinal section of right kidney

Cortex is the outer reddish brown coloured portion and medulla is the inner lighter area.

Medulla is subdivided into 10 to 15 conical areas called renal pyramids. Pyramids have their broad base towards cortex and apex projecting into lumen of minor calyx. Columns of Bertin are the projections of cortex. They form the boundaries of the pyramids.

Microscopic structure of kidney

Kidneys consist of number of minute units called nephrons. They are basic structural and functional units of kidney. They are about one million nephrons in each kidney. Nephrons drain into pelvis of ureter and then into urinary bladder.

Nephrons : Uriniferous tubules consist of two portions 1) Nephron 2) Collecting tubule. Nephron is the secretory portion of uriniferous tubule. About 85% of total number of nephrons lie in outer two third portion of cortex. They are called superficial nephrons. About 15% of total number of nephrons occupy inner one-third of cortex and they are called Juxtamedullary nephrons. Superficial

nephrons are smaller than Juxtamedullary nephrons. Superficial nephrons are functional in normal conditions where as Juxtamedullary nephrons are functional in conditions of stress.

Parts of Nephron : Nephron consists of the following parts in succession.

- 1) Malphigian body
 - a) Glomerulus
 - b) Bowman's capsule
- 2) Renal tubule :
 - a) Proximal convoluted tubule
 - b) Loop of Henle
 - c) Distal convoluted tubule

Proximal and distal parts of the convoluted tubule lie in cortex where as loop of Henle extends from cortex to medulla. Malphigian body : It is also called as renal capsule. It lies in cortex of kidney. Malphigian capsule consists of two parts a) Glomerulus and b) Bowman's Capsule

Glomerulus is tuft of about 6-8 renal capillaries invaginating into the end of tubule. Glomerulus has two poles

- 1) Vascular pole - where bloods vessels are attached
- 2) Tubular pole - Where renal tubule begins.

Afferent arteriole brings blood to glomerular tuft. It is short and wide. This capillary tuft reunites and forms efferent arteriole. It is long and narrow. This arrangement builds up a pressure gradient of 70 mmHg. and facilitates filtration. Bowman's capsule is the dilated end of nephron. It is invaginated by glomerular tuft. It is made of two layers called parietal and visceral layers. It gradually continues with tubule.

Renal tubule : Renal tubule begins at the tubular pole of glomerulus. Renal tubule is about 3 cm. long and 20-60 microns wide. Short constricted part of tubule just below the glomerulus is - neck. Parts of the renal tubule after neck are

- Proximal convoluted tubule
- Loop of Henle and
- Distal convoluted tubule

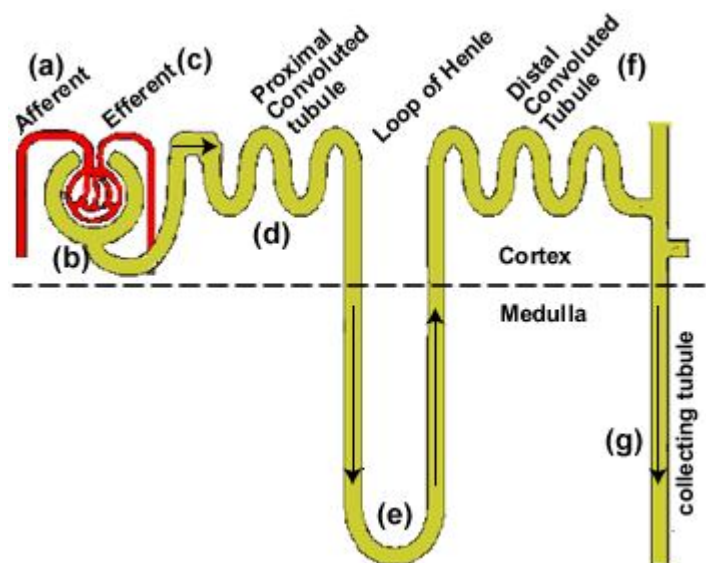


Fig 9.3 Structure of a Nephron

Proximal convoluted tubule: It is also called as pars convoluta. Length is about 14 mm. Outer diameter is 60 microns and inner diameter is 15- 25 microns. It is lined by cubical cells arranged in single layers. Free borders of the cells are brush bordered. This portion of nephron lies in cortex of kidney.

Loop of Henle: It is also called as Pars recta. Pars recta is a U shaped loop. It is anatomically divided into -

Descending limb of loop of Henle

Thin walled ascending limb of loop of Henle

Thick walled ascending limb of loop of Henle

Variable length of loop of Henle lies in medulla. It is made of epithelial cells with variable shape in different portions of loop.

Distal convoluted tubule : Average length is about 4.9 mm. Diameter is 20 to 50 microns. It is lined by cubical epithelium.

Collecting tubule : It is non-secretory portion of uriniferous tubule. It is collecting system. It is about 20mm long. It is lined by pale cuboidal cells. Several collecting tubules from nephrons join to form duct of Bellini. It opens at apex of renal pyramid. Nephrons ultimately drain into pelvis of ureter. From here urine collects into urinary bladder. Urine is passed out into exterior through urethra.

Renal Circulation : There are two circulations in kidney.

1. Greater circulation 2. Lesser circulation

Greater circulation carries 85% of blood and lesser circulation carries 15% of blood. Renal arteries enter into kidneys through respective hilus. On or before entering the hilus, renal artery on each side divides into anterior and posterior divisions. Primary branches of divisions are called segmental arteries. Segmental arteries divide into lobar branches one for each pyramid. Branches passing between pyramids are called inter lobar arteries. Inter lobar arteries divide into arcuate arteries. These arteries subdivide to give small branches called inter lobular arteries. Inter lobular arteries break up into afferent arterioles. Each afferent arteriole forms capillary tuft called glomerulus. This tuft reunites to form efferent arteriole and again breaks up to form second capillary tuft called peritubular network around renal tubule. All these peritubular capillaries drain into venous plexus. From this plexus, blood passes through inter lobular veins. Inter lobular veins reunite to form arcuate veins. Arcuate veins form interlobar veins. Interlobar veins form renal vein.

Nerve supply : Kidneys are mainly supplied by sympathetic nervous system, partly by parasympathetic system.

9.2.2 Ureters

There are two ureters carrying urine from kidneys to urinary bladder.

They are continuous from renal pelvis to urinary bladder and are about 25-30 cm long. Diameter is about 3 mm. Ureter is slightly constricted at three places.

Ureter has three layers and they are-

1. Outer fibrous coat which is continuous with the fibrous coat of kidney.
2. Muscular coat containing outer circular layer and inner longitudinal layer.
3. Lining of mucous membrane continuous with that of bladder.

9.2.3 Urinary bladder

Urinary bladder is sac serving as distensible reservoir of urine evacuating its contents at suitable intervals of time. It lies in pelvic cavity behind symphysis pubis. Urinary bladder consists of two portions.

1. Body - sac of detrussor muscle.
2. Trigone - triangular region connecting the three openings of bladder - two of ureters and one of urethra.

Urinary bladder has two sphincters. They are-

1. Internal sphincter
2. External sphincter

Internal sphincter is formed by smooth muscles surrounding the opening of urethra. External sphincter is formed by striated muscle of urogenital diaphragm.

9.2.4 Urethra

Urethra is the canal through which urine from bladder is passed to the exterior. It extends from base of the bladder. It has two sphincters. They are-

1. Internal sphincter - involuntary
2. External sphincter - voluntary

It has two orifices. They are-

1. Internal urethral orifice in the bladder.
2. External urethral orifice.

Male urethra serves as common tract for urinary and reproductive systems and thus it is called urinogenital tract. In females it serves for urinary system only.

Male urethra : It is about 20 cm. long. It is divided into three portions.

1. Prostatic portion - surrounded by prostate gland and 3 cm. long. Prostatic and ejaculatory ducts open into this point.
2. Membranous portion - passing through pelvic floor and 1-2 cm. long.
3. Spongy portion - lying within penis and 15 cm. long.

Female Urethra : It is about 4 cm. long. It serves for urinary system only. It extends from the base of the bladder. It passes downwards behind symphysis pubis. It opens to the exterior in front of vaginal orifice.

9.3 Other Channels of Excretion

Other channels of excretion are Skin, Liver, Lungs, Colon and Salivary Glands.

Skin : Skin excretes water, salts, little urea etc. in the form of sweat. Fats are also excreted by skin. For more details of anatomy - Refer to Anatomy of Sense organs.

Liver : Liver excretes fatty substances through bile. It also excretes heavy metals. For more details of anatomy refer to - Anatomy of Digestive system and Hepato Biliary system.

Lungs : Lungs excrete CO_2 , water vapour, alcohol, ammonia etc. for details

of anatomy refer to - Anatomy of Respiratory system.

Colon : It excretes heavy metals.

For more details of anatomy refer to - Anatomy of Digestive system and Hepato Biliary system.adults.

Salivary Glands: For more details of anatomy, refer to Anatomy & Hepatobiliary System.

Conclusion

Excretory system consists of organs concerned with excretion of waste products formed in the cellular metabolism of body. Such channels concerned with excretion are called as channels of excretion.

Summary

Excretory system consists of organs concerned with excretion of waste products formed in the cellular metabolism of body. Such channels concerned with excretion are called as channels of excretion. Urinary system consists of - kidneys-2, ureters -2, urinary bladder, urethra. Longitudinal section of kidney shows fibrous capsule surrounding outer cortex and inner medulla. Microscopic structure of kidney shows nephrons. Nephrons are basic structural and functional units of kidney.

Short Answer Type Questions

1. What are the channels of excretion?
2. Mention the parts of urinary system.
3. Give the anatomical location of kidneys.
4. Write the L.S. of kidney.
5. What are the parts of uriniferous tubule?
6. Mention the parts of Malphigian body.
7. Write the parts of Renal tubule.
8. Mention the two types of circulation in kidneys.
9. Write about nerve supply to kidneys.
10. Mention the muscles of bladder.
11. Write the sphincters of urethra.
12. What are the portions of male urethra?

Long Answer Type Questions

1. Write the structure of kidney.
2. Explain renal circulation.
3. Discuss anatomy of ureters, bladder and urethra.

UNIT

10

Endocrine System**Structure**

10.1 Introduction

10.2 Endocrine Glands

Learning Objectives

- Student should know the locations of endocrine glands.
- Student should know the anatomy of endocrine glands.

10.1 Introduction

Endocrine system consists of endocrine glands of body.

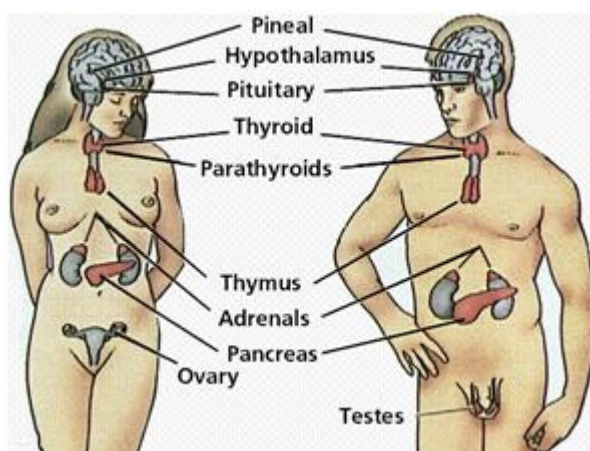
There are two types of glands in body. They are -

1. Exocrine glands
2. Endocrine glands

Exocrine glands

They are glands of the body with ducts.

Ex: Mammary glands, sweat glands, lacrimal glands, salivary glands.

**Fig 10.1 Endocrine System**

10.2 Endocrine Glands

Endocrine glands are ductless glands which pour their secretions directly into blood circulation from where these secretions reach their site of action. These secretions are called hormones.

Endocrine glands in the human body :

Endocrine glands of human body are:

1. Pituitary gland (Master gland)
2. Thyroid gland
3. Parathyroid gland.
- 4) Adrenal glands
- 5) Pancreas
- 6) Testes
- 7) Ovaries
- 8) Placenta (during pregnancy)

Thymus and pineal body are glands with probable endocrine function. Stomach, small intestine and kidneys also have endocrine activity.

Hypothalamus

Hypothalamus : Hypothalamus is a complex neurohormonal regulatory part. Diencephalon contains thalamus and hypothalamus. Hypothalamus forms lower part of lateral ventricle. It forms anterior wall of third ventricle. It is

situated at the interpeduncular space below thalamus. It forms complex nuclei and fibres.

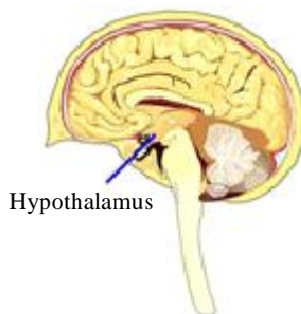


Fig 10.2 Hypothalamus

Pituitary gland

It is called the master gland of the body. It is substituted by the term hypophysis. It is reddish gray coloured and small oval shaped structure. It is located at the base of the brain in the sella turcica of sphenoid bone. A stalk attaches hypophysis to the floor of third ventricle. Average weight is 0.5 to 0.6 g. In females it weighs from 0.6-0.7 g. Its dimensions are -

- 10 mm (anterio posteriorly)
- 6 mm (dorsoventrally)
- 13 mm (laterally)

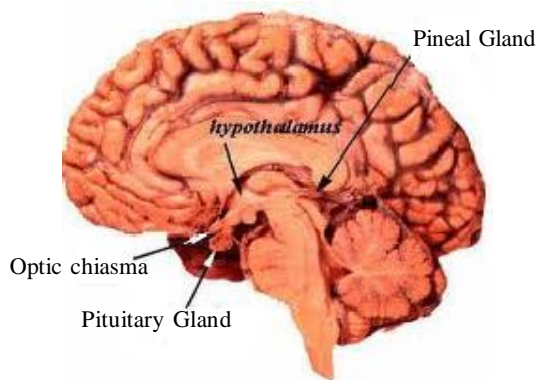


Fig 10.3 Pituitary gland

Anatomically, it has two lobes -

1. Anterior lobe of pituitary gland
2. Posterior lobe of pituitary gland

Its histology shows 6 parts. They are -

1. Pars distalis (pars anterior)
2. Pars tuberalis
3. Pars intermedia
4. Pars nervosa (pars posterior or processus infundibulis or lobus nervosus)
5. Median eminence of tubercinerium.
6. Infundibulum or pituitary stalk.

Anterior lobe consists of pars distalis and pars tuberalis. Posterior lobe consists of pars intermedia and pars nervosa. Adenohypophysis consists of pars distalis, pars tuberalis and pars intermedia. Neurohypophysis consists of pars nervosa (lobus nervosus) and infundibulum (pituitary stalk or neural stalk).

Pars distalis contains acidophils, basophils and chromophobes. Pars intermedia contains basophilic polygonal or prismatic cells. Pars tuberalis contains mainly cuboidal columnar cells.

Blood Supply

Blood supply of anterior lobe : Anterior lobe of pituitary gland is supplied blood by several hypophyseal arteries. These originate from internal carotid artery and circle of willis. There are two sets of blood vessels. One set supplies the lobe directly. Second set reaches capillary plexus of median eminence and infundibular stem. Capillary plexus is drained by a long portal vein.

Blood supply to neural lobe : Neural lobe is supplied blood by inferior hypophyseal arteries. Vessels form capillary network while ending in pars nervosa.

Nerve supply : Few fibres from hypothalamohypophyseal tract or carotid plexus or from greater superficial petrosal nerves have control over this gland. Probably, they may be vasomotor nerves.

Thyroid

This gland is situated at the root of the throat. It has two fairly lateral lobes, which are symmetrical. Each measures $5 \times 2 \times 2 \text{ cm}^3$ approximately. These lobes are present one on either side of trachea. They are connected by a thin portion of thyroid tissue called as isthmus. Pyramidal lobe extends upwards from isthmus. Thyroid gland moves upwards during swallowing. Weight in adults is between 20-25 g. It is highly vascular gland.

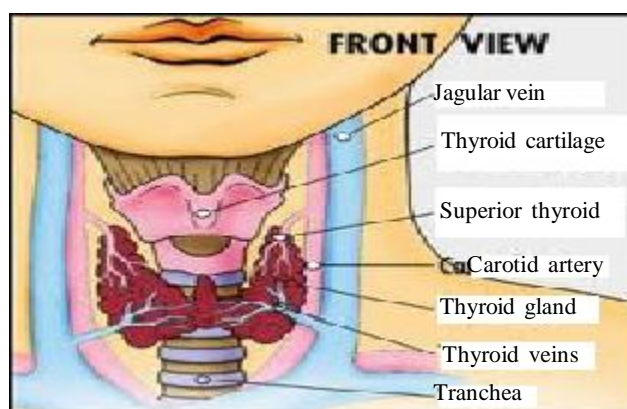


Fig 10.4 Thyroid

Microscopical examination of thyroid shows follicles or vesicles. They are lined by low cuboidal epithelium. Thyroid follicles are spherical or oval shaped with irregular size of 15-150 microns diameter. They are lined by single layer of granular cubical cells with mitochondria and clear golgi apparatus. Bases of cells are in contact with fine basement membrane. Follicles are surrounded by highly vascular stroma. Cytoplasmic vesicles are found within the cell. Electron microscopy reveals two types of cells - Principal cells and para follicular cells. Solid clumps cells, lymphocytes and macrophages are seen between vesicles.

Blood supply : Superior and inferior thyroid arteries supply thyroid gland. Internal jugular vein and innominate vein drain the gland.

Lymphatic drainage : Lateral lymph nodes of neck commonly drain lymph. Anterior mediastinal lymph nodes drain to some extent.

Nerve supply: Sympathetic fibres derive from superior, middle and inferior cervical ganglia. Parasympathetic fibres derive from superior and inferior recurrent laryngeal branches of vagus.

Parathyroid

It consists of four oval bodies embedded in posterior surface of thyroid. Each body measures $6 \times 3 \times 2 \text{ mm}^3$. Each of the two pairs are present vertically behind each of the two lobes of thyroid. Total weight is about 140 mg. Gland is highly vascular. Superior and inferior thyroid arteries supply blood. Nerve supply is same as for thyroid. There are two types of cells in parathyroid.

1. Chief cells or principal cells
2. Oxyphil cells or eosinophil cells.

Adrenal glands

Adrenal glands are two in number. They are also called suprarenal glands as each of the two glands are located on upper pole of each kidney. Right suprarenal gland is smaller of the two. Left one is large of the two. Dimensions of each gland are $50 \times 30\text{-}40 \times 10 \text{ mm}^3$. Average weight of each is 5-9 g. in

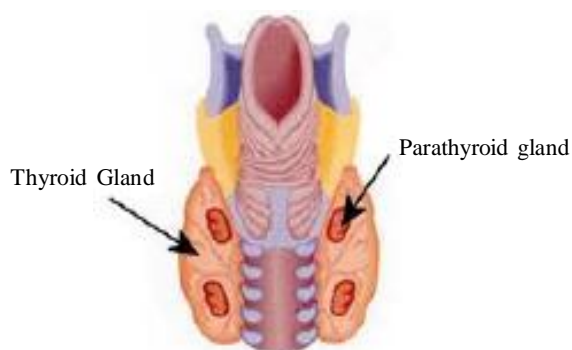


Fig 10.5 Parathyroid

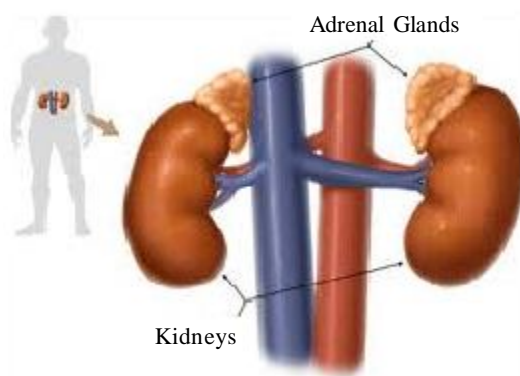


Fig 10.6 Adrenal Glands

There are two parts in adrenal gland.

1. Adrenal cortex - outer part consisting of
 - (a) Zona glomerulosa (outer)
 - (b) Zona fasciculata (middle)
 - (c) Zona reticularis (inner)

- (2) Adrenal medulla - Inner part consisting of irregular masses of polyhedral granular cells.

Pancreas

Human pancreas is large gland which is both exocrine and endocrine in its functions. It lies transversely across posterior abdominal wall behind the stomach at the level of 1st and 2nd lumbar vertebrae. It contains both exocrine cells and endocrine cells. Endocrine cells are distributed all over the gland. They are called as islets of Langerhans. These islets are not connected with duct system of the gland. There are mainly three distinct types of islet cells in human pancreas. They are- (1) α - cells of islets of Langerhans.

(2) β - cells of islets of Langerhans.

(3) δ - cells of islets of Langerhans.

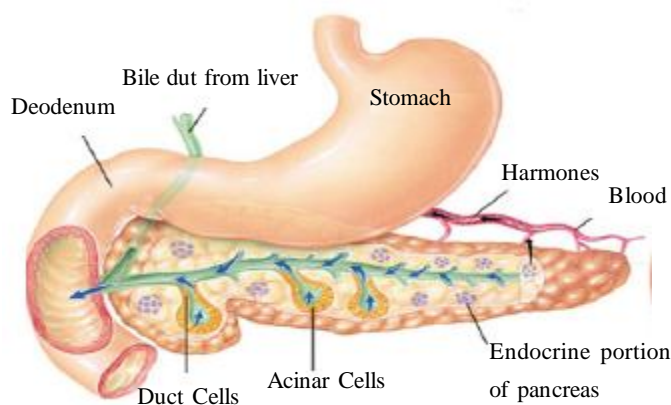


Fig 10.7 Pancreas

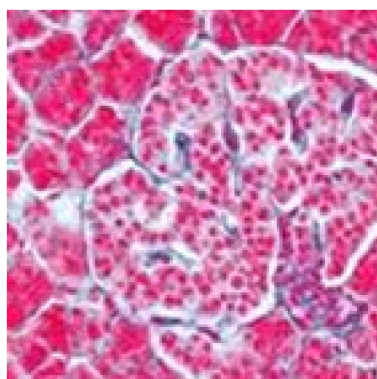


Fig 10.8 Islets of Langerhans

α - cells are also called A2-cells and constitute 10-15%, β - cells are also called B-cells and constitute 30-40%. δ - cells are also called A1 cells and constitute 5%. In higher vertebrates, ratio of α cells and β cells is 1:4 and other cell types are X or F, E & C.

Testes

Testes are the male reproductive organs concerned with spermatogenesis. For anatomy refer to Anatomy of Reproductive system.

Ovaries

Refer to Anatomy of Reproductive system.

Placenta

Refer to Anatomy of Reproductive system.

Thymus

It is both endocrine and lymphoid structure, located in the anterior and superior mediastinum of thorax behind sternum. It extends from pericardium upwards upto the lower border of thyroid. There are two lobes in thymus gland. They are fused and asymmetrical. Right lobe is bigger than left lobe. Numerous lobules are present in each lobe. Follicles of lobules have diameter of 1 mm each.

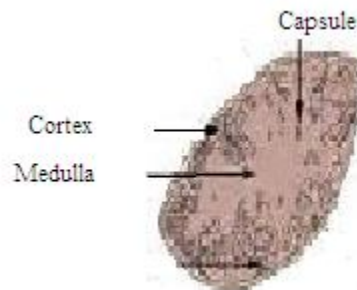


Fig 10.9 Thymus

Histology of Thymus shows -

(a) Capsule - dense connective tissue, rich in macrophages, mast cells, granulocytes and fat cells etc.

b) Cortex - which is similar to lymph tissue of ordinary lymph nodes, but deficit of primary follicles.

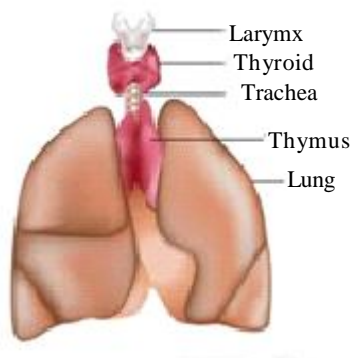


Fig 10.10 Thymus Gland

(c) Medulla - broad, branched band of thymic tissue.

Pineal body

Pineal body is also called epiphysis cerebri. It is flat, cone shaped and grey colored. It's length is about 5-8 mm and breadth is about 3-5 mm. Pineal body is attached to the roof of third ventricle by means of a short hollow stalk.

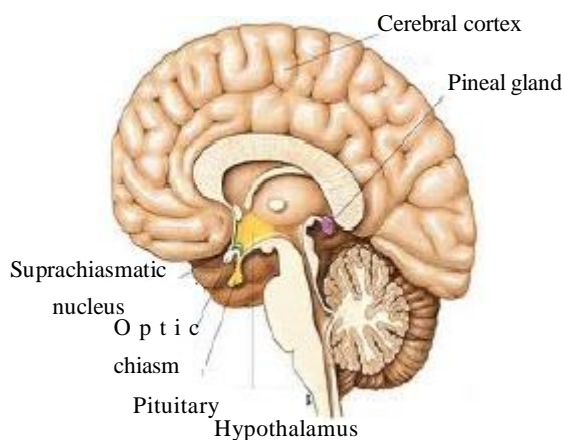


Fig 10.11 Pineal Body

Its histology shows two major types of cells, which are neutral in origin. They are-

1. Parenchymal or chief cells.

2. Interstitial or supportive cells.

GIT as endocrines

Certain localised area of GIT acts as endocrine to secrete gastro intestinal hormones. Cells responsible for endocrine activity in GIT are not known with certainty. Gastrin I and II are produced in modified epithelial cells of glandular mucosa of pyloric part of stomach. Mucosa of upper part of small intestine secretes cholecystokinin - pancreozymin hormone. Duodenal muscosa produces secretin. Wall of stomach and small intestine produce gut glucagon hormone. Human gastric muscosa contains gastrone. Mucosa of upper small intestine produces villikinin. Intestinal lumen secretes enterocrinin.

Refer to digestive system for more anatomy.

Kidneys as Endocrine

Juxtaglomerular cells produce renin. Erythropoietin is largely produced by kidneys. Prostaglandins are also produced by kidneys.

Refer to Excretory system for anatomy.

Summary

Endocrines system consists of endocrine glands of body. Endocrine glands are ductless glands. Endocrine glands of human body are pituitary, thyroid, parathyroid, adrenals, pancreas, testes, ovaries and placenta (during pregnancy). Pituitary has two lobes - anterior and posterior lobes. It is located at the base of brain in sella turica of sphenoid bone. Thyroid is located at the root of the throat. It has two lobes. Parathyroid consists of four oval bodies. Each of the two pairs are present vertically behind each of the two lobes of thyroid. Adrenal glands are present on upper pole of each kidney. Pancreas lies transversely across posterior abdominal wall behind the stomach at the level of 1st and 2nd lumbar vertebrae. Testes, ovaries and placenta have endocrine activity of producing sex hormones.

Thymus is located in the anterior and posterior mediastina of thorax behind sternum.

Conclusion

There are two types of glands in body. They are -

1. Exocrine glands
2. Endocrine glands.

Endocrine system consists of endocrine glands of body. Endocrine glands are ductless glands which pour their secretions directly into blood circulation from where these secretions reach their site of action.

Short Answer Type Questions

1. Define a) Endocrine glands
b) Exocrine glands
2. Write any four endocrine glands of body.
3. Give the anatomical location of hypophysis.
4. What are the lobes of pituitary?
5. Write the parts shown in histology of hypophysis.
6. Write about blood supply to pituitary gland.
7. What are the parts of anterior and posterior lobes of pituitary?
8. Mention the parts of adenohypophysis and neurohypophysis.
9. Write about nerve supply to pituitary.
10. Write the location and blood supply to thyroid gland.
11. Name the types of cells in parathyroids.
12. What are the two parts of adrenal glands?
13. Name the three types of cells of pancreas.
14. Write the histology of thymus.
15. What are the types of cells in pineal body?

Long Answer Type Questions

1. What are different endocrine glands of body? Write the anatomy of pituitary.
2. Discuss anatomies of thyroid and parathyroid.
3. Describe the anatomies of adrenals and pancreas.
4. Write the anatomical descriptions of thymus and pineal body. Write about GIT as endocrine.
5. Discuss anatomies of testes and ovaries.

Reproductive System - Male and Female

Structure

- 11.1 Introduction
- 11.2 Male Reproductive System
- 11.3 Spermatozoa
- 11.4 Female Reproductive System

Learning Objectives

- Student should have knowledge of male and female reproductive parts.
- Student should also know their anatomy.

11.1 Introduction

Continuity of any species is maintained by reproduction. Reproduction is the process of producing same type of offsprings. Mode of reproduction is sexual in human being.

Reproductive System

System consisting sex organs is called reproductive system. Primary sex organs are testes in males and ovaries in females. They are also called as gonads. Remaining structures are called secondary sex organs.

11.2 Male Reproductive System

Parts of male reproductive system are- Testes, Epididymis, Vas deferens, Seminal vesicles, Ejaculatory ducts, Prostate gland, Bulbo urethral glands & Penis.

Testes : They are two oval shaped bodies lying one on each side in scrotum. They are male reproductive glands. They are spermatogenic. Testis is covered by a fibrous capsule called tunica albuginea. Each testis consists of 200-300 lobules. Each lobule is filled with seminiferous tubules. Convolved seminiferous tubules are about 500 mm long. Straight tubule is formed by union of several seminiferous tubules. Straight tubules again unite forming rete testis. Seminiferous tubules are supported by loose connective tissue which contains interstitial cells of Leydig. These cells are responsible for secretion of testosterone.

Epididymis is a fine coiled tube, which is tightly packed into the form of a long narrow body. It is attached to the back of testis. Seminiferous tubules open into it.

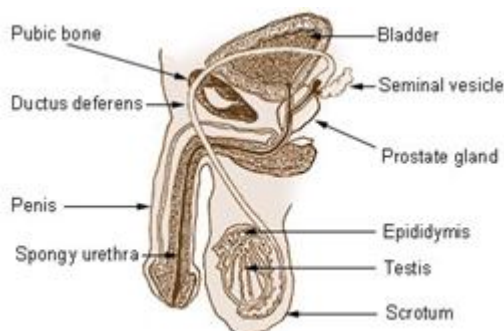


Fig 11.1 Male Reproductive System

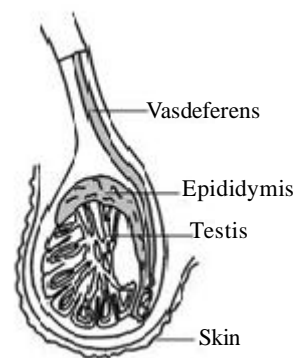


Fig 11.2 A testis(testicle)
looking from left side

Vas Deferens : Vas deferens is continuation of epididymis. It enters pelvic part of abdomen and enters into prostatic part of urethra. It joins ejaculatory duct here.

Seminal Vesicles : Seminal vesicles are secretory glands. They are located between base of bladder and rectum. They secrete semen. Spermatozoa produced in testes adds to it. Seminal secretion from prostate also adds to it. Secretion of seminal vesicles is alkaline in nature. It constitutes large part of seminal fluid.

Ejaculatory ducts : Ducts of seminal vesicles and Vas deferens unite to form ejaculatory ducts. They begin at the base of prostate gland and at the

opening of prostatic utricle in urethra.

Prostate gland: It is a nut sized secretory gland. It is present at the opening of bladder into urethra. It contains lobes. It consists glandular tissue and involuntary muscular tissue. Prostatic secretion is alkaline in nature and adds to semen. It nourishes spermatozoa. Prostaglandin is also secreted by prostate.

Bulbo urethral glands : They are situated on either side of membranous part of urethra. Ducts open into spongy portion of urethra. Their secretion also forms part of semen.

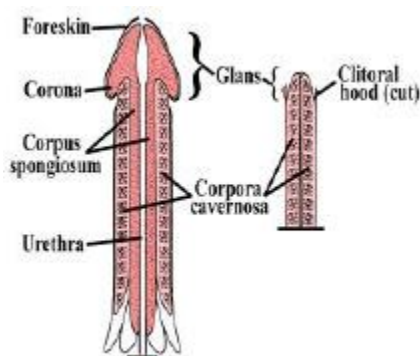


Fig 11.3 T.S. of Male Penis

Penis: Penis is tubular male copulatory organ. Penis is supplied with large venous sinuses, which can fill with blood causing erection of the organ. Tip of penis is enlarged and is called glans penis. Glans penis contains urinary meatus in the centre. Glans penis is covered by loose double fold of skin. It is called prepuce or foreskin.

T.S. of penis shows three cylindrical bodies of erectile tissue. Erectile tissue is also called cavernous tissue. Two of the cylindrical bodies are corpora cavernosa. Third long body of erectile tissue is corpus cavernosum urethra. It contains urethra in it. It is also called as corpus spongiosum. Corpora cavernosa are arranged side by side in the dorsal half of the organ. Corpus spongiosum lies ventral to corpora cavernosa. Tunica albuginea Spongiosum is a stout sheath surrounding each erectile cylindrical body. All the three erectile cylindrical bodies are covered by fascia penis. It is elastic areolar tissue. Epidermis of penis is thin. Hair is absent on epidermis except at the root of penis.

11.3 Spermatozoa

It is the last descendent of male germ cell. It is a specialised cell which differs from ordinary cell in many ways. It is about 60 microns in length.

Parts of mature spermatozoon are

1. Head
2. Tail

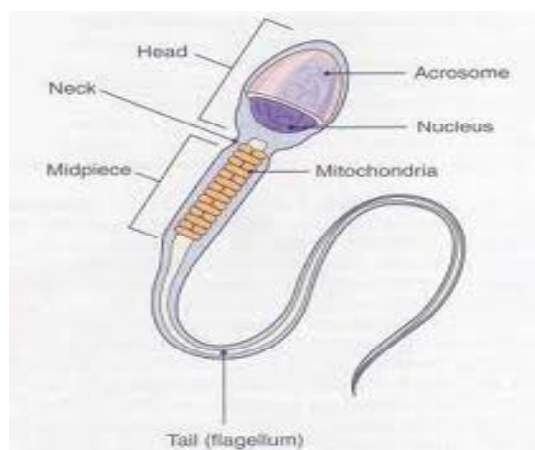


Fig 11.4 Spermatozoa

Head

Shape : Oval from surface view. Pear shaped from side view. Length : 4.5 microns. Diameter: 2.5 - 3.5 microns

Head is nucleus with nuclear membrane surrounded by plasma membrane without cytoplasm in between. Head cap or acrosome covers interior two thirds of nucleus.

Tail: Tail is divided into- 1.Neck 2.Body 3.Main piece of tail 4. End piece of tail.

Neck : It is a short, weak segment connecting head and body. Proximal centriole lies between head and neck where as distal centriole lies between neck and body.

Body : It is middle piece of tail. It is also called engine room of spermatozoon. It is cylindrical in shape. It has rings of fibrils with a sheath.

Length - 5-7 μ m

Thickness - 1 μ m

Main piece of tail : Length - About 45 μ m Thickness - 1/2 micron at the base. It is tapering towards end piece. It consists of core of longitudinal filaments surrounded by fibrous sheath.

End piece of tail : Length - 5 μ m. Cross section is same as that of a cilium.

Normal sperm count : 40-300 millions/ml. of semen. Count of spermatozoa less than 20 million per ml. of semen is called oligospermia & it can cause infertility.

11.4 Female Reproductive System

From outside inwards it contains the parts as follows :

- Vagina - Uterus - Fallopian tubes - Ovaries

Vagina : Vagina is female genital organ extending from uterus to Labia. It is a musculo membranous tube. It is situated in front of rectum and anus. It is behind bladder and urethra. Cervix enters anterior wall of vagina at right angles.

Vagina has two coats

(a) Muscular coat having longitudinal and circular fibres.

(b) Inner lining of mucous membrane

- This lining becomes thick after puberty and is rich in glycogen.

- Vaginal canal is normally closed and wrinkled.

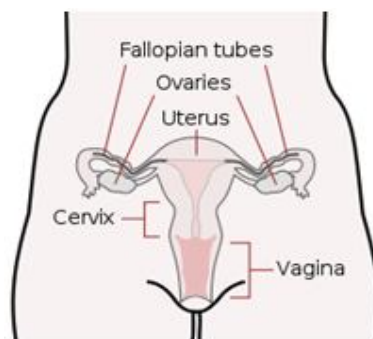


Fig 11.5 Female Reproductive System

Uterus: Uterus is a hollow muscular organ. It is thick walled and situated in lesser pelvis between rectum and bladder. It is inverted pear shaped.

Length : about 7.5 cm.

Width : about 5 cm.

Thickness : about 2.5 cm.

Weight : about 30 g.

Uterus has two parts. They are

1. Body and 2. Cervix

Body : It is the upper broader part. Fallopian tubes open into uterus from sides in the upper part. Part of body above the entrance of fallopian tubes is called fundus.

Cervix : It is the lower part of uterus, narrower and more cylindrical than body.

Cervix has two openings. They are - internal OS, External OS.

Internal OS is the opening of cervix at its upper end which is continuous with body of uterus (above). External OS is the opening of cervix at its lower end which is continuous with vagina (below). Cervix of uterus protrudes into vagina at right angle.

Uterine wall has two coats.

1. Myometrium and 2. Endometrium.

Myometrium is outer muscular coat. It is made of smooth muscle fibres arranged in three layers. They are inner longitudinal layer, middle thick oblique layer and outer thin longitudinal layer.

Endometrium is inner mucous membrane. It is lined by epithelial cells. Endometrium undergoes cyclic changes during menstrual cycle. Perimetrium is the outer serous coat.

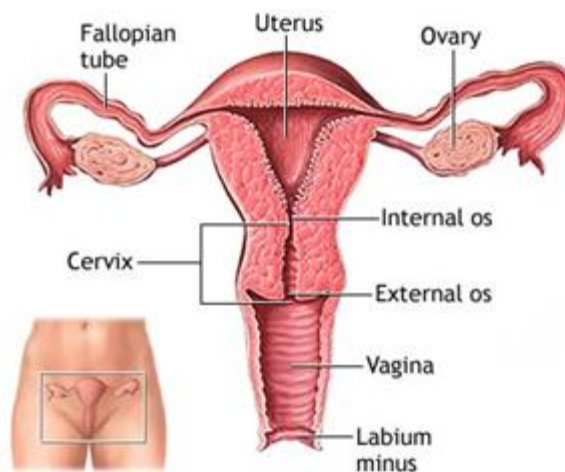


Fig 11.6 Parts of Uterus

Fallopian tubes : They are two in number. They are situated in the upper part of broad ligaments of uterus. Length of each uterine tube is about 10 cm.

They transmit ova from ovaries to uterus

Each tube has the following parts.

1. Infundibulum - trumpet shaped expansion, close to the ovary and having number of processes called fimbriae.
2. Ampulla - thin walled tortuous part. It forms more than half of uterine tube.
3. Isthmus - round and forming one third of tube.
4. Uterine part : Passes through wall of uterus. It is 1 cm. long.

Ovaries : Ovaries are two in number. They are bean shaped bodies lying one on each side at the free end of uterine tube. They hang from broad ligament by a fold of peritonium. This fold of peritonium is called mesovarium. They are supplied richly by blood vessels and nerves. Structure of ovaries shows variations at various stages of life such as childhood, puberty, pregnancy and menopause.

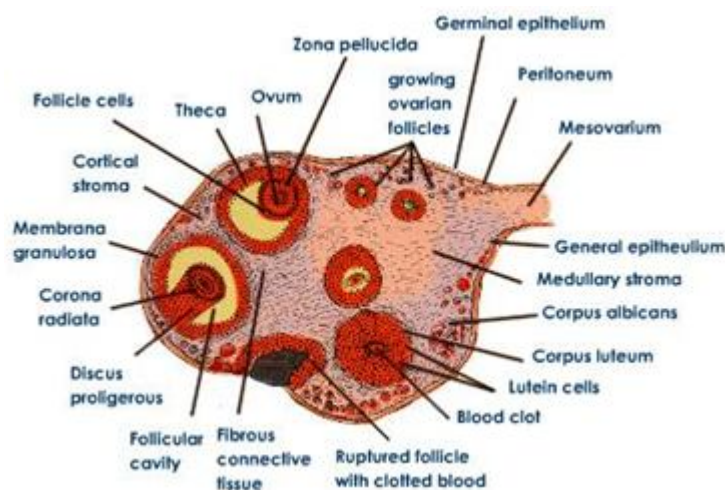


Fig 11.7 T.S. of Ovary

There are six features in the histology of ovaries. They are-

1. Germinal epithelium
2. Tunica albuginea
3. Stroma

4. Graffian follicles
5. Corpus luteum
6. Interstitial cells

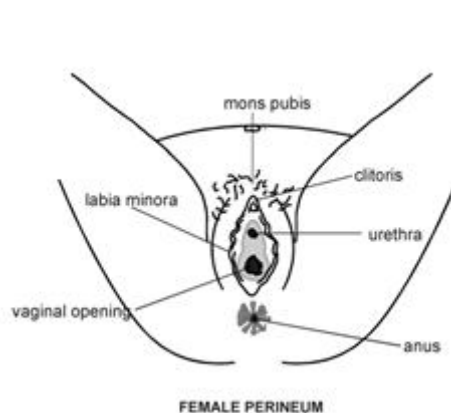


Fig 11.8 Female External Genitalia

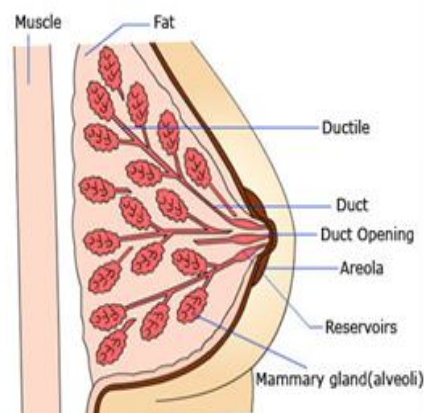


Fig 11.9 Structure of Breast

Germinal epithelium : Germinal epithelium is the outermost covering. It is single layer of cuboidal cells.

Tunica albuginea : Tunica albuginea is a thin layer of eosinophilic collagenous connective tissue.

Stroma : Stroma is network of connective tissue, continuous with tunica albuginea. It is containing spindle shaped cells.

Graffian follicles : Graffian follicles are also called as vesicular follicles. They are small islands of cells in various stages of development. They are scattered at the periphery of ovary. Immature follicles are called primordial follicles. Ovum is the central cell. Remaining cells surround ovum in single layer.

Corpus luteum : Corpus luteum develops on ruptured graffian follicle. It is temporary.

Interstitial cells : Interstitial cells are groups of polyhedral cells developed from cells of stroma or unruptured follicles.

- In infancy, follicles do not mature. There is no ovulation. No corpus luteum.
- At puberty, germinal epithelium contains flattened cells, large number of

ruptured or unruptured maturing follicles and small size corpora lutea.

- In pregnancy, there is large size corpus luteum.
- At menopause, ovaries atrophy, follicles disappear and are replaced by fibrous scars, interstitial cells degenerate & little oestrogen is produced.

Placenta: It is the functional connection between embryo and uterus, which is formed by dilatation and proliferation of maternal blood vessels. It consists of two parts 1) Maternal part & 2) Foetal part.

External female genitalia: They are- 1. Mons pubis 2. Labia majora 3. Labia minora 4. Clitoris 5. Vestibule 6. Hymen 7. Greater vestibular glands 8. Perineum

Mons pubis : Mons pubis is a pad of fat covered with skin. It lies over symphysis pubis. Pubic hairs grow here after puberty.

Labia majora : Labia majora are two folds of fatty tissue covered with skin. They extend backwards from mons on either side of vulva. It disappears into perineum behind. They develop at puberty and atrophy after menopause.

Labia minora : Labia minora are two smaller folds within labia majora. These fleshy folds meet in front to form prepuce. Prepuce is a hood like structure protecting clitoris.

Clitoris : Clitoris is small sensitive organ containing elastic tissue. It lies below mons pubis, protected by prepuce.

Vestibule : Vestibule is the cleft between labia. Vaginal orifice and urethral orifice open into it.

Hymen : Hymen is double fold of mucous membrane blocking vaginal orifice and leaving gap at the front to allow menstrual flow in virgin woman.

Greater vestibular glands : Greater vestibular glands are two small glands lying under labia majora. They secrete a lubricating fluid, which facilitates sexual intercourse.

Perineum : Perineum is expanse of skin from the back of vaginal orifice back to the anus. It is 5 cm. long and bears hair.

Perineal body : Perineal body is a mass of muscular and fibrous tissue, separating vagina from rectum. Perineal skin is covering perineal body. Levator ani is the name of the muscle of perineal body. It is the chief muscle of pelvic floor.

Mammary glands : They are accessory organs of female reproductive system. They secrete milk after parturition. They are circular in shape. They are convex

Anteriorly. Nipple is in the centre of breast, projecting from skin. Nipple is pink in virgin woman. It is pigmented after first child birth. Areola surrounds nipple.

Mammary gland is divided into lobes. Lobes are sub divided into lobules. Lobules open through ducts into nipple. Breast of female before puberty is undeveloped. In males, it is rudimentary. After puberty in females, there is growth under hormonal influence. During pregnancy, there is further development and proliferation under hormonal influence. Development of breasts is completed during pregnancy. After parturition, there is lactation.

Conclusion

System consisting sex organs is called reproductive system. Primary sex organs are testes in males and ovaries in females. They are also called as gonads. Remaining structures are called secondary sex organs.

Summary

Reproductive system consists of sex organs. Male sex organs are Testes, epididymis, vas deferens, seminal vesicles, ejaculatory ducts, prostate gland and penis. Female sex organs are - Vagina, uterus, fallopian tubes and ovaries. External female sex organs are - Mons pubis, labia majora, labia minora, clitoris, vestibule, hymen, greater vestibular glands, perineum and perineal body. Mammary glands are accessory organs of female reproductive system.

Short Answer Type questions

1. Mention the primary sex organs.
2. What are male reproductive organs?
3. What is vas deferens?
4. Describe prostate gland.
5. Name the parts of spermatozoa.
6. Name female reproductive organs.
7. Mention the parts of uterus.
8. Explain a) Myometrium b) Endometrium
9. What are the parts of fallopian tubes?

Long Answer Type Questions

1. Mention organs of male reproductive system. Explain their anatomy.
Draw the figure of testes.
2. Mention female reproductive organs and female external genitalia. Write about their anatomy briefly. Draw the figure.

UNIT

12**Sense Organs****Structure**

- 12.1 Introduction
- 12.2 Eye
- 12.3 Ear
- 12.4 Tongue
- 12.5 Nose
- 12.6 Skin

Learning Objectives

- Student should know the sense organs.
- Student should know their anatomy.

12.1 Introduction

Sense organs are the organs of senses of body. They are- Eye, ear, tongue, nose and skin. Of these five organs, first four are organs of special senses. Skin is the organ of general sensations.

12.1 Eye

Eye is the organ of special sense of vision. It consists of eyeball accessory structures. Eye ball is almost spherical in shape. It is situated in anterior part of orbital cavity. Accessory structures of eye are - eyebrows, eye lids, eachrymal operatus and extrinsic muscles of eye.



Fig 12.1 Human Eye

Eye Ball : Eye ball contains three coats and light transmitting structures.
Layers of eye ball : Layers of eye ball are-

1. Outer fibrous coat- containing posterior opaque part called sclera and anterior transparent part called cornea.
 2. Middle vascular coat - containing choroid, ciliary body and iris.
 3. Inner nervous coat - also called retina.
- Sclera forms 5/6th of outer fibrous coat.
 - Cornea forms 1/6th of outer fibrous coat.
 - Choroid is highly vascular. It forms 5/6th of middle coat. It is dark.
 - Ciliary body is in between choroid and iris.
 - Iris is anterior continuation of ciliary body and is a pigmented membrane. Its central opening is called pupil. Pupil is controlled by circular and radial muscles.
 - Circular muscles are pupillary constrictors and radial muscles are pupillary dilators.
 - Retina is the innermost nervous coat of eye ball. It contains special structures called 'Rods and Cones'. They are for reception of light. Each retina

contains 6 million cones and 120 million rods. Rods are for critical vision and cones for dim vision.

Optic disc: It is the point where optic nerve leaves eye ball. This point doesnot contain retina and thus it is photo insensitive. It is also called blind spot.

Macula: It is a small area of retina. It is also called yellow spot. situated opposite to the centre of pupil lateral to the entrance of optic nrvve. It is for focussing near vision.

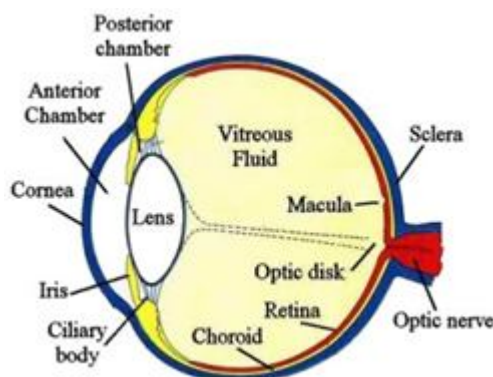


Fig 12.2 Structure of Human Eye

Conjunctiva : It is the thin stratified mucous membrane covering the exposed part of eye ball

Light transmitting structures of Eye ball : They are :

1. Aqueous humour.
 2. Lens and.
 3. Vitreous humour.
- Aqueous humour is fluid present in anterior chamber of eye.
 - Lens is behind iris and pupil. It is trhe organ of refraction of light onto retina.
 - Vitreous humour is jelly like fluid in between lens and retina. It is respon-sible for maintenance of shape of eye.

Accesory structures of eye: They are eye brows, eyelids, lachrymal apparatus.

Eyebrows: They are arches of thick skin present over the eyes and containing thick hairs.

Eyelids: They are musclocutaneous curtain like structures in front of eye. Upper eyelids are bigger than lower eyelids. Eye lashes are hairs projecting from eyelids.

Lachrymal apparatus: It consists of:-

1. Lachrymal gland situated in the lateral end of upper eyelid.
2. Lachrymal duct through which tears come out.
3. Lachrymal sac
4. Naso lachrymal duct through which tears flow into nasal cavity.

Extrinsic muscles of eye

There are six muscles moving the eyeball. They are

1. Superior rectus- upward movement of eye.
2. Inferior rectus- downwards movement of eye.
3. Medial rectus- inwards movement of eye.
4. Lateral rectus- outwards movement of eye.

These four are straight muscles.

5. Inferior oblique- upward and outward movement of eye.
6. Superior oblique- Downward and outward movement of eye.

These two are oblique muscles

12.3 Ear

Ear is the organ of special sense of hearing. It is also responsible for equilibrium. It is divided into three parts.

Parts of ear are

1. External Ear

Lying outside the skull

2. Middle Ear

Lying inside the skull

3. Internal ear

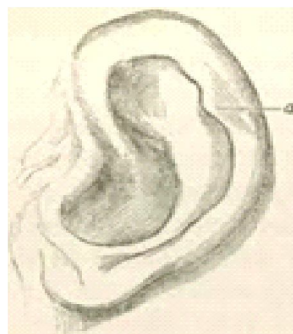


Fig 12.3 Ear

External ear : It contains two parts. They are

- **Pinna** - Funnelshaped organ made of fibroelastic cartilage. It is the organ of collection of sound waves .

- **External auditory meatus** - small channel of about 3cm length. It is lined with skin and wax creating glands are contained in this part. Hair and wax present in its outer part prevent dust particles. Its inner part is closed by a thin membrane called tympanic membrane or ear drum. This canal is the organ of conveyance of vibrations of sound to the tympanic membrane.

Middle ear : It is a small cavity in the temporal bone, intrnal to eardrum. i.e. tympanc membrane forms its outer wall. It contains air. It contains

1. Fenestra ovalis (oval window) and fenestrarotundum (round window). Round window is also called fenestra cochleae.
2. Eustachian tube - which communicates with nasopharynx. It helps in equalisation of pressure on both sides of tympanic membrane.
3. Auditus - Channel connecting middle ear posteriorly with mastoid an trum of temporal bone.
4. Auditory ossicles - Malleus, incus and stapes arranged across middle ear.

These are minute bones of middle ear and are bound by ligaments. They vibrate as a single unit when sound waves impinge on tympanic membrane.

Internal ear: It contains

1. Bony labyrinth - present in petrous portion of temporal bone.
2. Membranous labyrinth - lyeing with the bony labyrinth.

Fluids of Internal ear : Perilymph is the fluid of bony labyrinth. Endolymph is the fluid of membranous labyrinth. Structures of bony labyrinth :Bony labyrinth contains vestibule, cochlea and semi circular canals.Cochlea is the organ of hearing and semicircular canals for equilibrium.

Vestibule : It is present between vestibule and semicircular canals.Vestibule contains utricle and saccule. Utricle and saccule are parts of membranous labyrinth Cochlea. It is a bony spiral canal. These spirals wind around a central bony pillar Modiolus. Basilar membrane is membranous septum dividing cochlea into two parts. Organ of Corti is the neuroepithelium of cochlea. It is auditory receptor resting on basilar membrane. Cochlear nerve fibres enter the organ of Corti. Vestibulocochlear nerve collects sensation of equilibrium from vestibular division. It collects sensation of hearing from cochlear division. Auditory nerve fibres reach special nucleus on the back of thalamus and then cerebral cortex.

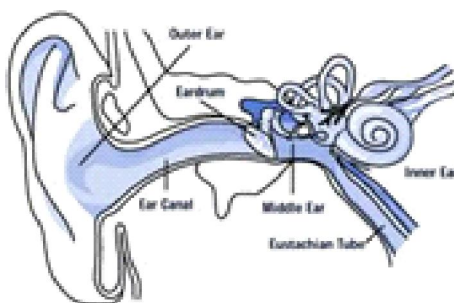


Fig 12.4 Structure of Ear

Semicircular Canals: Each ear contains three semicircular canals. They are arranged at right angles to each other. They are superior, posterior and lateral canals. Ampulla is enlarged end of each canal. Vestibular nerve endings are present in ampullae. Ampullae help cerebellum in maintaining equilibrium. Semicircular canals are for informing dynamic equilibrium and otolithic organ for static equilibrium.

12.4 Tongue

Tongue is the organ containing taste buds. Taste buds are receptors of special sensation of taste. Epithelium of tongue is modified into papillae and taste buds. Papillae are 1. Filiform 2. Fungiform and 3. Circumvallate.

Taste buds are located on the sides of papillae. Taste buds are oval clusters of cells with a small pore on the surface in the epithelial layer. They measure 60-80 microns in length and 40 microns in diameter. Few taste buds are located on soft palate, epiglottis and pharynx.

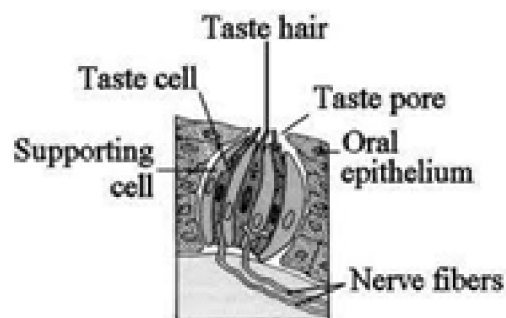


Fig 12.5 Taste Bud

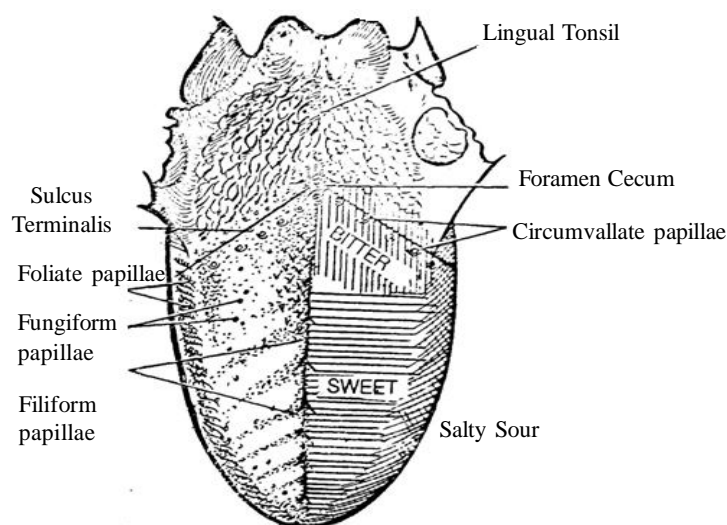


Fig 12.6 Tongue

Cells within taste buds are two types. They are (1) Taste cells or gustatory cells or hair cells (2) Supporting cells. Nerve fibres arise from hair cells and form nerve plexus near basement membrane. They finally join with glossopharyngeal or facial nerve. Branch of facial nerve innervates anterior 2/3rds of tongue. Glossopharyngeal nerve innervates posterior 1/3rd of tongue. Vagus nerve receives impulses from pharynx and throat. Taste buds are surrounded by stratified squamous epithelium of tongue. These nerves are connected to taste centre present in medulla. It is connected to thalamus and cerebral cortex. There are four types of taste buds based on sensation of taste - bitter, sour, salt and sweet.

12.5 Nose

Olfactory Receptors

Olfactory receptors are specialised bipolar nerve cells present in the olfactory area of mucous membrane of upper part of nasal cavity. They are about 10-20 millions in man.

They receive sensation of smell. Total surface area of olfaction on each side in man is about 250 mm². Olfactory area in man is comparatively small and man is called microsmatic animal.

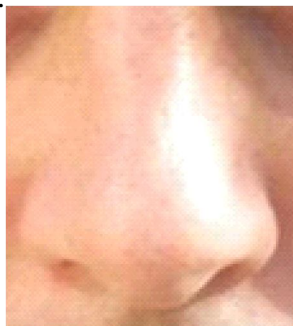


Fig 12.7 Nose

Olfactory area in dog being large, it is macrosmatic animal. Ends of olfactory receptors join to form olfactory nerve (1st cranial nerve). Olfactory nerve passes through root of nose and ends in olfactory bulb. Olfactory bulb is connected to olfactory centre in the cerebrum through olfactory tract. Some fibres of trigeminal nerve are also present in olfactory mucous membrane. They respond to irritating substances like ammonia. Surrounding the olfactory receptors in the olfactory area are supporting cells called sustentacular cells.

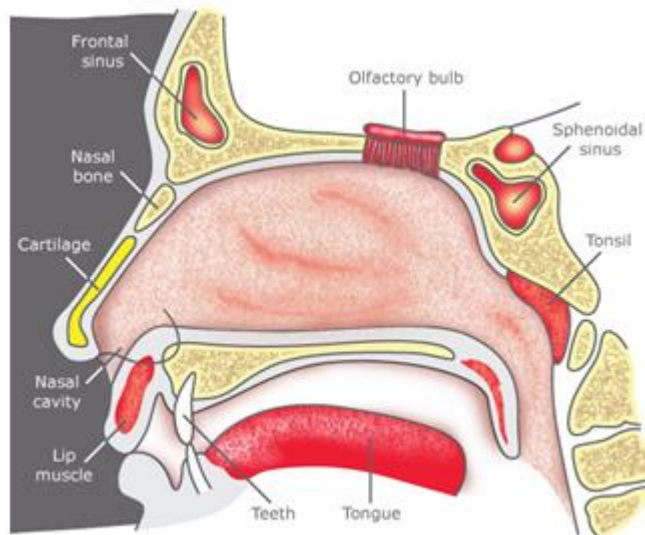


Fig 12.8 Structure of Nose

12.6 Skin

Skin consists of two layers. They are

1. Epidermis - outer layer
2. Dermis - Inner layer

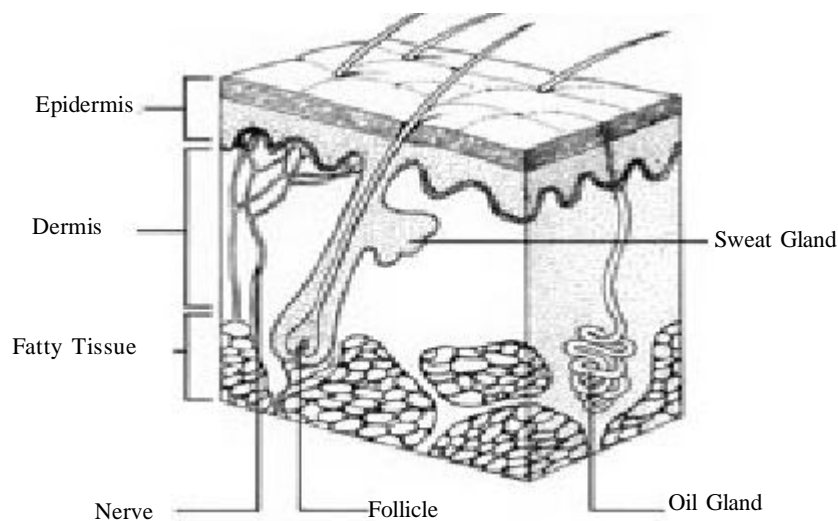


Fig 12.9 Structure of Skin

Epidermis is made of stratified epithelium. Layers of epidermis are-

1. Stratum corneum
2. Stratum lucidum
3. Stratum granulosum
4. Stratum germinatum.

- Stratum corneum contains scale like cells. They have keratin protein and these cells are constantly replaced.
- Stratum lucidum is a glistening layer.
- Stratum granulosum is made of spindle shaped cells. They have granules in their cytoplasm.
- Stratum germinatum is made of cuboidal cells. Multiplication of skin cells takes place in this layer.

Dermis: Dermis is inner layer of skin. It contains melanophore cells containing melanin pigment, arterial and venous capillaries & also-

- Sensory nerve endings.

- Sweat glands and sebaceous glands.
- Roots of hairs.
- Erector pili muscles (Hair straightening muscles)

Various sensory nerve endings of skin are encapsulated in connective tissue and are responsible for receiving various sensations. They are as follows.

S.No	Corpuscles/fibres	Name of receptor	Sensation
1.	Meissner's corpuscles	Mechanoreceptors	Touch or light pressure
2.	Pacinian Corpuscles	Mechanoreceptors	Deep pressure
3.	Krause's end bulbs	Thermoreceptors	Temperature
4.	Some naked nerve fibres	Nociceptors	Pain, excess pressure etc
5.	Some naked nerve endings	-----	or algesiceptors Itch sensation

Conclusion

Sense organs are the organs of senses of body. They are- Eye, ear, tongue, nose and skin. Of these five organs, first four are organs of special senses. Skin is the organ of general sensations.

Summary

Eye, ear, tongue and nose are special sense organs. Skin is organ of general sensations. Eye consists of Eye ball and accessory structures. Layers of Eyeball are outer fibrous coat, middle vascular coat and inner nervous coat. Light transmitting structures of eyeball are aqueous humour, lens and vitreous humour. Accessory structures of eye are eyebrows, eyelids, lachrymal apparatus and extrinsic muscles. Ear consists of external ear, middle ear and internal ear. External ear contains pinna and external auditory meatus. Middle ear contains fenestra ovalis and fenestra rotundum, eustachian tube, auditory and auditory ossicles. Internal ear contains bony labyrinth and membranous labyrinth. Tongue consists of taste buds surrounded by stratified squamous epithelium. Taste centre is present in medulla. It is connected to thalamus. Olfactory receptors of nose are present in the mucous membrane of upper part of nasal cavity. Total area of olfaction on each side is about 250 mm² in man. Skin consists of epidermis and dermis. Epidermis contains stratum corneum, stratum lucidum, stratum granulosum and stratum germinatum. Several receptors of skin are mechanoreceptors, thermoreceptors, nociceptors or algesiceptors, naked nerve endings etc.

Short Answer Type Questions

1. Mention organs of special senses ?
2. What are the layers of Eyeball ?
3. List the accessory structures of Eye ?
4. Explain (a) Sclera, (b) Cornea.
5. Write the extrinsic muscles of eye ?
6. Describe choroid, ciliary body and iris ?
7. Explain (a) Blindspot (b) Macula
8. What are the light transmitting structures of eyeball ?
9. Name the parts of lachrymal apparatus.
10. Mention the three main parts of ear.
11. What are the parts of external ear ?
12. Mention parts of middle ear.
13. Name the main parts of internal ear.
14. What are the fluids of internal ear ?
15. Write the auditory ossicles (bones of middle ear).
16. Mention types of taste buds.
17. Define (a) Taste buds (b) Olfactory receptors
18. Write the shapes of cells of (a) Stratum granulosum (b) Stratum germinatum.
19. What are layers of epidermis ?
20. Write about dermis.
21. Name different sensory receptors of skin.
22. What are the types of receptors of skin?

Long Answer Type Questions

1. Write the structure of Eye, draw the diagram and label.

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2. Discuss the Anatomy of ear with diagram.
 3. Write the Anatomy of Tongue as sense organ.
 4. Describe the structure of skin. Draw diagram.