

SCHOOL OF SCIENCE AND TECHNOLOGY

APPLIED SCIENCE-II

BSN 2306

ANATOMY



**BANGLADESH OPEN UNIVERSITY
SCHOOL OF SCIENCE AND TECHNOLOGY**

APPLIED SCIENCE–II

BSN 2306

Course Development Team

Writer

Dr. Farida Easmin Shelley

School of Science and Technology

Bangladesh Open University

Dr. A.K.M. Alamgir

Associate Professor

National Medical College and Hospital, Dhaka

Dr. Sirajul Islam

Bangabandhu Sheikh Mujibur Medical University

Editor

Dr. Farida Easmin Shelley

School of Science and Technology

Bangladesh Open University

Dr. Sharker Md. Numan

School of Science and Technology

Bangladesh Open University

Syeda Ifteara Khanum

School of Science and Technology

Bangladesh Open University

Style Editors

Dr. K. M. Rezanur Rahman

School of Science and Technology

Bangladesh Open University

Anwar Sadat

School of Science and Technology

Bangladesh Open University

Program Co-ordinator

Md. Abdul Mojid Mondol

School of Science and Technology

Bangladesh Open University

Supervision

Professor Khawja Jakaria Ahmad Chisty

Dean

School of Science and Technology

Bangladesh Open University



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Preface

Applied Science-II is one of the foundation courses of health science and is very important component of students in medical disciplines. B.Sc.-in-Nursing students have to learn the course very attentively for their career development. All modules for distance learners have some specificity and specialty in respect of the style or format of presentation. Here lesson begins with learning objectives and ends with exercises. Self-activities are so designed that the learner will have the base at the text and will have to work a little more for a completed answer. Important messages can easily be given the self-activity exercise that has not been totally covered in the short text. In fact learners will get the clue for further reading through the self-assessment questions. Most of the portions of the course are self-illustrating but some identified areas have been recorded for audio-visual aid. The assigned teacher will demonstrate practical portion of the course. This mark will be added at the final examination. This course has been prepared by active participation of the course development team and has been examined by the referee. In spite of it, any suggestion would be highly appreciated regarding further enrichment of the book.

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ANATOMY

Unit 1: Histology

Lesson 1: Structure of a Cell

1.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ know the basic component of cell.
- ◆ describe the function of different parts of cell.



1.2. Description

The human body consists of innumerable cells. These cells are the basic units of the body. Cells of a common origin and the same function, make up tissues, particular types of tissue perform specific functions for life. The understanding of cellular structure and function is very fundamental for the study of Anatomy.

The number of chromosomes in human cells is 46

The cell is the smallest structural and functional unit of the human body. A cell has two parts, the *cell membrane* and the *protoplasm*. The protoplasm is surrounded by the cell membrane. The protoplasm is again divided into two parts. The more dense central part is called the *nucleus*. The outer part is called *cytoplasm*. The nucleus is the most important part of the cell.

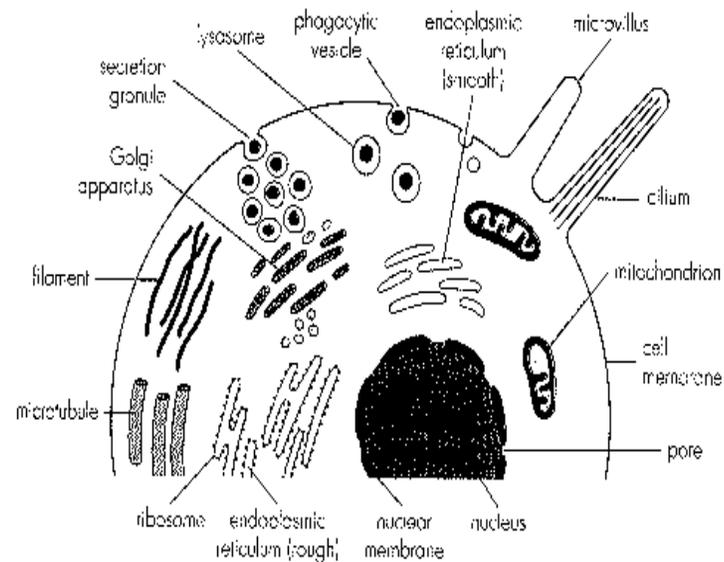
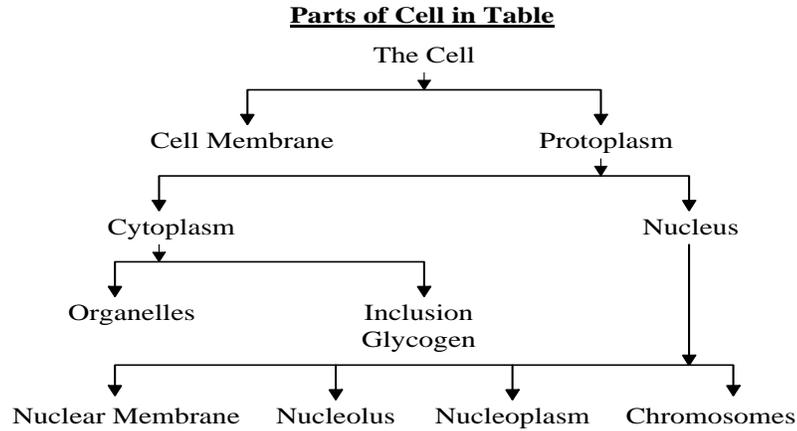


Fig.: Structure of cell.

(Reference from McMinn's Functional Clinical Anatomy, p-7)

Histology

It controls the functions of other parts of the cell. The nucleus has a membrane nucleolus, nucleo-plasm and chromosomes. The number of chromosomes in human cells is 46. These chromosomes contain genes. Genes carry the specific characteristics from parents to off springs.



Cell Membrane

Is an elastic membrane that limits the protoplasmic contents of cells? It also separates one cell from another. Its chemical composition is lipid protein and a small amount of carbohydrate.

Function of Cell Membrane

- i. To maintain the shape of a cell
- ii. To control the passage of substance into or out of the cell.

Protoplasm: It is the living material inside the cell. It is semi fluid in consistency. In the centre of the protoplasm, there is the nucleus and surrounding that is the cytoplasm.

Cytoplasm: Cytoplasm consists of water (75%), organic substances and inorganic substances. Inside the cytoplasm, there are highly specialized living bodies, called organelles. The organelles may be membranous and non-membranous.



Membranous organelles	Non-membranous Organelles
i. Mitochondria	i. Ribosomes
ii. Endoplasmic reticulum	ii. Centrosomes
iii. Golgi complex	iii. Microtubules
iv. Lysosomes	iv. Microfilaments

Mitochondria

An external and internal membrane bound mitochondria; the internal membrane is folded inside. This inside folding is called cristae. The space inside the mitochondria contains chemical substance known as matrix.

Function: This is the chief source of energy of the cell. It is also called the powerhouse of cell.

Endoplasmic Reticulum: It is a system of inters communicating channels in the form of vesicle and tubules. It is of two type -

- i. Smooth endoplasmic reticulum
- ii. Rough endoplasmic reticulum.

Rough endoplasmic reticulum has ribosomes on its external surface and smooth one has none.

Function

- i. Protein synthesis
- ii. Transmission of exportable protein.

Golgi complex: A membranous structure near the nucleus of almost all cells. It contains curved parallel series of flattened saccules. It has got three parts cisternae, small vesicles and large vacuoles.

Functions

- i. The "packaging house" of the cell.
- ii. Synthesis of lysosome.

Lysosomes: They are membrane-bound small round structures. They contain enzymes necessary for digestion of ingested microorganisms.

Function: Digestion of foreign materials and unwanted organelles.

Ribosomes: They are roughly spherical structures. They may be free in the cytoplasm or attached to the rough endoplasmic reticulum. They consist of RNA and protein.

Function: Protein synthesis.

Histology

Centrosomes: These are a special zone of the cytoplasm, which contain two sharply staining granules called centrioles.

Function: Help in the process of mitotic cell division.

Microtubules: They are hollow cylindrical unbranched structure.

Function

- i. They help in maintaining the shape of the cell.
- ii. They form the structural basis for other cytoplasmic organelles like centrioles, flagella and cilia.

Microfilaments: These are thin threads like structure. They are present throughout the cytoplasm of all cells.

Function

- i. They provide a cytoskeleton structural framework of the cell.
- ii. They participate in muscular contraction.

i. **Membranous** Fat globules

Mitochondria Pigments
Endoplasmic Reticulum
Golgi Complex
Lysosome

ii. **Non-membranous**

Ribosome
Centrosomes
Microfilaments.



1.3. Exercise

1.3.1. Multiple choice questions

Tick (✓) the correct answer

1. Number of chromosomes in human cells are
 - a. 44
 - b. 46
 - c. 48.

2. The most important part of cell is
 - a. cytoplasm
 - b. nucleus
 - c. protoplasm.

3. The "packaging house" of cell is
 - a. lysosomes
 - b. golgi complex
 - c. ribosome
 - d. mitochondria.

4. Membranous organelles is
 - a. ribosome
 - b. mitochondria
 - c. microtubules
 - d. chromosome.

5. Genes carry the specific characteristics from
 - a. parents to offsprings
 - b. parents to relatives
 - c. father to mother
 - d. mother to father.

1.3.2. Short Questions

1. What is cell?
2. Write short note Mitochondria.
3. What is Golgi complex?
4. What are the types of Endoplasmic Reticulam?

1.3.3. Analytical Questions

1. What is cell?
2. Draw and diagram of a cell.
3. Write the name of different part of a cell
4. What are the functions of cell?

Lesson 2: Basic Types of Tissues

2.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ define tissue and its types
- ◆ understand the function of different type of tissues.



2.2. Description

Tissue is a collection of cells of similar shape, function and origin.

There are Four Types of Basic Tissue

- i. Epithelial tissue
- ii. Connective tissue
- iii. Muscular tissue
- iv. Nervous tissue.

Epithelial Tissue: May be defined as a collection of closely packed cells with very little intercellular substance. It covers the external and internal surface of the body.

Glands are aggregation of epithelium in a definite structure for the purpose of secretion or excretion

Principal Functions of Epithelial Tissue

- i. Covering and lining surface for protection
- ii. Absorption
- iii. Secretion
- iv. Sensory function neuro-epithelium
- v. Contraction function myoepithelial cell.

Characteristics of Epithelial Tissue

- ◆ Has the maximum cellular element with little intercellular substance.
- ◆ Has little blood supply
- ◆ Capacity for repair is excellent
- ◆ Covers the surface of the body and lines all the passages which communicate with the outside (e.g., Alimentary canal, Respiratory passages etc.).

Depending on the function of the epithelium, it can be divided into-

- i. Covering epithelium and
- ii. Glandular epithelium.

According to the number of cell layers- Covering epithelium is divided into -

- i. Simple- single layer e.g., lining of blood vessels, serous cavity, Thyroid. Intestine, gall bladder.
- ii. Stratified- two or more layers e.g., epidermis, oesophagus. Larynx, vagina, urinary bladder, ureter etc.

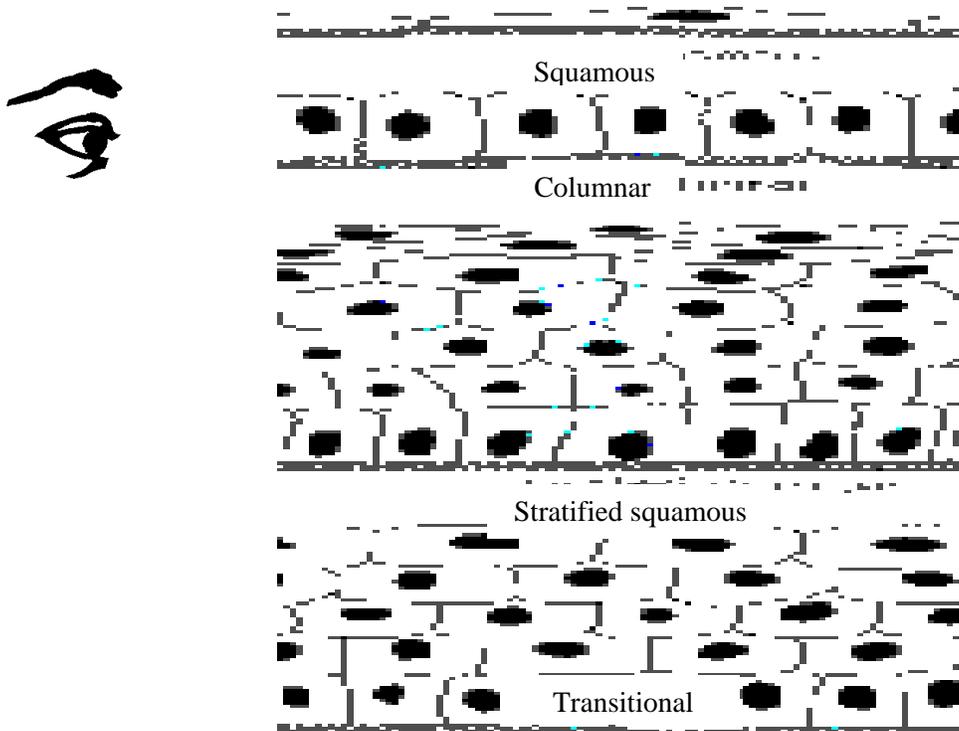


Fig. Different kinds of epithelium.

Besides: simple and stratified epithelium, there is another type of covering epithelium. This is called pseudostratified. This type of epithelium consists of cells of different height. All the cells do not reach the surface; these cells have nuclei at different levels. This character of cells gives an impression of many layers.

Site: Lining of trachea, bronchi and nasal cavity.

Glands or Glandular Epithelium

As mentioned earlier, epithelium is divided into surface and glandular epithelium. Glands are aggregation of epithelium in a definite structure for the purpose of secretion or excretion.

Glands can be unicellular or multicellular. Muticellular glands can be divided into endocrine and exocrine glands; Endocrine glands have no ducts to let their secretion out. These glands pour their secretions directly into the blood.

Exocrine glands have ducts through which their secretion flows. Exocrine glands are simple or compound depending on the complexity of their ducts. In simple glands, the duct has no branches. In compound glands before opening to the surface the duct branch a number of times. According to the shape of glands, both simple and compound glands are of three types. They are tubular, alveolar and tubulo-alveolar.



2.3. Exercise

2.3.1. Multiple choice questions

Tick (✓) the correct answer

1. Epithelial tissue may be collection of
 - a. few cell
 - b. loosely packed cell
 - c. closely packed cell
 - d. tightly packed cell.

2. Epithelial cell has
 - a. no blood supply
 - b. more blood supply
 - c. little blood supply
 - d. high blood supply.

3. Lining of urinary bladder is
 - a. columnar cell
 - b. transitional cell
 - c. stratified squamous cell
 - d. flat cell.

4. Endocrine glands have
 - a. one duct
 - b. two duct
 - c. no duct
 - d. three duct.

5. Lining of bronchi is
 - a. stratified epithelium
 - b. pseudostratified epithelium
 - c. pseudotransitional epithelium
 - d. none of the above.

2.3.2. Short Questions

1. What is a gland?
2. What are the types of covering epithelium?
3. What do you mean "Exocrine gland"?

2.3.3. Analytical Questions

1. What is tissue?
2. What are the types of basic tissue?
3. Write down the principal function of epithelial tissue?
4. What are the characteristics of epithelial tissue?

Lesson 3: Connective Tissue

3.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ know the structure of connective tissue
- ◆ explain the function of connective tissue
- ◆ classify connective tissue.



3.2. Description

Connective tissue consists of small cellular elements with much intercellular substance. It has two components-cells and intercellular substance.

Cells of Connective Tissue are the Followings-

- i. Fibroblasts
- ii. Macrophages
- iii. Mast cells
- iv. Plasma cells
- v. Fat cells
- vi. Leucocytes
- vii. Pigment cells.

Inter cellular substance contains ground substance and fibres. Ground substance consists of

- i. Glycoprotein
- ii. Glycosaminoglycons.

Fibres are Three Types-

- i. Collagen Fibres
- ii. Elastic Fibres and
- iii. Reticular Fibres.

Characters of Connective Tissue-

- i. Minimal cellular elements with maximal intercellular substance

- ii. It has both blooded and nerves supply.

Functions of Connective Tissue-

- ◆ Binds all organs of the body
- ◆ Gives tight covering to deeper structures
- ◆ Holds bone ends together at the joints
- ◆ Produce passage to lymphatic, blood vessels and nerves to their destinations
- ◆ Macrophage and plasma cells destroy foreign particles
- ◆ Acts as storage for nutrients.

Classification of Connective Tissue-

There are three main types of connective tissue.

1. Connective tissue proper
2. Cartilage
3. Bone.

Connective Tissue Proper is Again Divided into two Types-

- a. General and
- b. Special.
 - a. General type is again divided two subtypes. They are
 - i. Loose and
 - ii. Dense.
 - b. Special variety includes
 - i. Reticular
 - ii. Adipose and
 - iii. Pigmented types.

Cartilage is of Three Types-

- i. Hyaline
- ii. Fibrous
- iii. Elastic.

Bone is of Two Types-

- i. Cancellous bone or spongy bone
- ii. Compact bone.

Cells of Connective Tissue and Their Function

- a. Fibroblasts:** These are the most common and numerous cells of connective tissue. The young fibroblasts are large, flat and branching and the mature fibroblasts (fibrocytes) are spindle shaped.

Function of Fibroblasts-

- i. Synthesis of collagen and elastic Fibres and intercellular substance.
 - ii. Through continued proliferation fibroblast assist in healing.
- b. Macrophages:** These are spindle shaped or star shaped. They have kidney shaped nucleus.

Functions

- ◆ Kill foreign particles that have attached the body
 - ◆ Participate in the defensive mechanism of the body in different complex ways.
- c. Mast Cells:** These are ovoid shaped and the nucleus is spherical and centrally placed. They contain membrane bound granules. Contents of the granules are heparin, histamin slow reacting substance of anaphylaxis.

Function: They play an important role in allergic reactions.

- d. Plasma Cells:** They are large and ovoid in shape. Nucleus is pushed to one side of the cell. They are rich endoplasmic reticulum.

Functions: They produce antibodies for the body defense mechanisms.

- e. Fat Cells:** These are specialized cells for the storage of fat. The cells become almost filled with fat droplets and the cytoplasm appears as a thin rim beneath the cell membrane. The nucleus of the cell is also pushed to one side.



3.3. Exercise

3.3.1. Multiple choices the questions

Tick (✓) the correct answer

1. Connective tissue have
 - a. only blood supply
 - b. no blood supply but have nerve supply
 - c. have both blood and nerve supply
 - d. all above.

2. Ground substance consists of
 - a. fibroblasts
 - b. collagen fibres
 - c. glycoprotein
 - d. lipo protein.

3. Cartilage is of
 - a. four types
 - b. three types
 - c. five types
 - d. seven types.

4. Cancellous is a type of
 - a. tissue
 - b. bone
 - c. cartilage
 - d. cell.

3.3.2. Short Questions

1. What are the types of Fibres?
2. What are the characters of connective tissue?
3. What are the types of cartilage?

3.3.3. Analytical Questions

1. What is connective tissue?
2. What are the cells of connective tissue?
3. Write down the function of connective tissue?
4. Write down the classification of connective tissue?

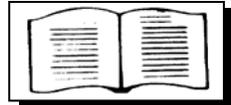
Lesson 4: Muscles and Tissue

4.1 Learning Objectives



At the end of this lesson you will be able to-

- ◆ know the structure of muscle tissue
- ◆ character and function of muscle tissue
- ◆ different kinds of muscles.



4.2. Description

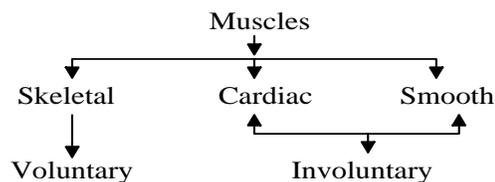
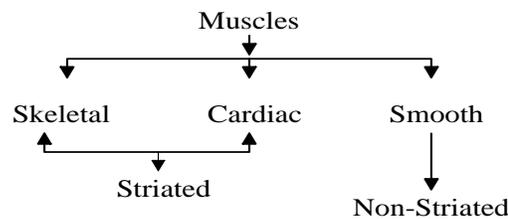
Muscle tissue is one of the basic tissues of the body. Muscles form the great bulk of the body. In muscle cells, the property of contractility is well developed. To a lesser extent the conductivity is also developed. Each muscle fibre is a muscle cell. Fibres are grouped together into bundles. There are three types muscles-

- i. Skeletal muscle
- ii. Cardiac muscle
- iii. Smooth muscle.

Regular transverse bands present across the length of skeletal and cardiac muscles.

These two types of muscles are called striated and smooth muscle is called non-striated.

Again, only skeletal muscle is under control of will, it is called voluntary muscles. The smooth muscle and cardiac muscle are not under direct control of the individual, so they are called involuntary.



4.3. Functions of Muscles

- i. They help movement of the body as a whole and many with respect to each other.
- ii. They produce heat to maintain temperature of body.
- iii. They maintain posture of body.
- iv. They maintain stability of joint.

4.4. Skeletal Muscle

Skeletal muscle consists of bundles of long cylindrical multinucleated cells. Each fibre is surrounded by a delicate connective tissue sheath called endomysium. A number of muscle fibres form a fasciculus. Each fasciculus is surrounded by a sheath of connective tissue called perimysium. A number fasciculi form a muscle, which is surrounded by a thick connective tissue called epimysium.

4.5. Each Muscle Fibre Consist of the Following Things

- i. Sarcolemma - The cell membrane.
- ii. Sarcoplasm- The cytoplasm of the cell.
- iii. Nucleus - They are multiple in a single cell situated peripherally-beneath the sarcolemma.
- iv. Myofibrils and Myofilaments - They are contractile elements.
- v. Sarcosomes - They are the mitochondria of the muscle cell.
- vi. Sarcoplasmic reticulum - They are the endoplasmic reticulum of muscle fibre.

Intercalated disc is a peculiarity of cardiac muscle fibre

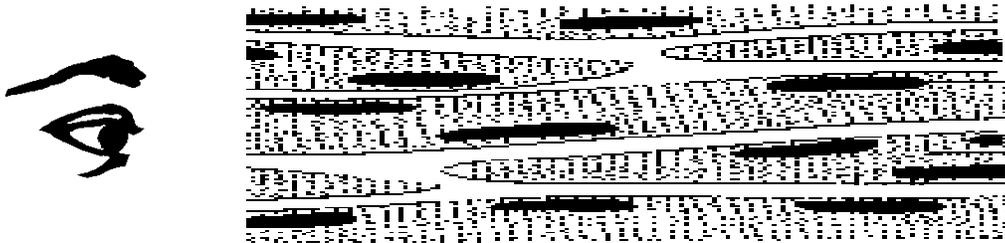
Cardiac muscle: Cardiac muscle is found in the heart and great vessels adjacent to the heart. They have many similarities with skeletal muscle but have also some differences. The fibres of cardiac muscle show side branches to join with the adjacent fibres. The nucleus is situated centrally in the muscle fibre. The cross striation is less prominent than in skeletal muscles. Intercalated disc is a peculiarity of cardiac muscle fibres.

4.6. Smooth Muscle

Smooth muscle cells are elongated and spindle shaped. Their ends are tapering and the central zone is wide. The nucleus is situated in the central zone. They have no cross striation. The cytoplasmic organelles (mitochondria, endoplasmic reticulum, golgicomplex) are few in number. The smooth muscles cells are intimately connected with fibroblastic tissue.

Sites of Smooth Muscle

- i. In the wall of digestive tract beginning from mid oesophagus to anus.
- ii. In the ducts of the glands of G.I tract.
- iii. Respiratory, Urinary and Genital System.
- iv. In the wall of arteries, veins and large lymphatics.



Skeletal muscle



Cardiac muscle



Smooth muscle



Arrangement of myofilaments in skeletal and cardiac muscle.

Fig.: Showing different types of muscle.

There are cross band at the site of adhesion between cardiac muscle cells.



4.7. Exercise

4.7.1. Multiple choice the questions

Tick (✓) the correct answer

1. Muscle fibre is consist of
 - a. nerve cell
 - b. muscle cell
 - c. blood cell
 - d. all above.

2. Smooth muscle have
 - a. no cross striation
 - b. many cross striation
 - c. few cross striation
 - d. all above.

3. Skeletal muscle have
 - a. one nucleus
 - b. two nucleus
 - c. multi nucleus
 - d. all above.

4.7.2. Short Questions

1. Write short notes on cardiaie muscle.
2. Write down the contents of muscle fibre.
3. What do you mean smooth muscles?

4.7.3. Analytical Questions

1. What are the types of muscle? Give its function.
2. Write down the structure of muscle fibres.
3. What are the sites of smooth muscles?

Lesson 5: Nervous Tissue

5.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ know structure of nervous tissue
- ◆ describe the function of the nervous tissue.



5.2. Description

Nervous tissue has excellent property of excitability and conductivity.

Nervous tissue is made of two types of cells

- i. Neurons-which are excitable cells.
- ii. Supporting cells-which are non-excitable cells.

The Neurons

A single nerve cell is called neurons. It is the structural and functional unit of nervous tissue. They are excitable cells. They have the property of reception, integration transformation and onward transmission of information. A neuron has got two parts-

- i. Cell body
- ii. Cell processes -
 - a. Axon
 - b. Dendrite

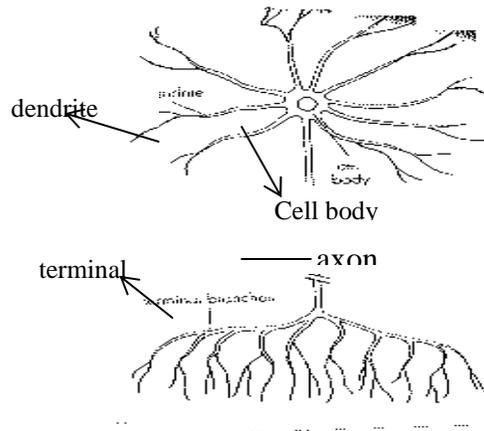


Fig. : Microscopic Structure of a Neuron.

(Reference from McMinn's Functional Clinical Anatomy, p14)

Classification of Neurons

On the basis of number of processes, neurons are of four types -

- i. Unipolar-with a single process.
- ii. Bipolar-with two processes.
- iii. Pseudounipolar-Two processes fuse to form a pseudo unipolar cell.
- iv. Multipolar-with one axon and multiple dendrites.

On the basis of branching pattern and shape of dendritic fields- neurons are of four types -

- i. Stellate - with small cell body and dendrites arise from all sides of cell body.
- ii. Pyramidal - The cell body is pyramidal and conical in shape.
- iii. Fusiform - They are spindles shaped.
- iv. Glomerular - These neurons have few dendrite highly convoluted branches at their tips.

Nerve Fibres

The nerve fibres are the long processes of neurone. The fibres have central core of cytoplasm called axoplasm. The axoplasm is surrounded by an outer membrane. It is called axolemma. Axoplasm and axolemma sheath together constitutes axon cylinder.

This is again surrounded by myelin sheath. Each nerve fibre has a connective tissue support, called endoneurium. A group of nerve fibre form a bundle or fascicles. A connective tissue sheath called perineurium surrounds this bundle. A number bundles of nerve fibre are held together by connective tissue covering, called epineurium.



5.3. Exercise

5.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. Neuron consist of
 - a. multiple nerve cell
 - b. single nerve cell
 - c. no nerve cell
 - d. all above.

2. Each neurons are
 - a. multiple nerve cell
 - b. three types
 - c. five types
 - d. all above.

3. Fusiform are
 - a. spindle shape
 - b. ovale shape
 - c. conical shape
 - d. concave shape.

1.3.2. Short Questions

1. What are the types of cell with in nervous tissue?
2. What are the types of neurons on the basis of processes?
3. What are the types of neurons on the basis of branching pattern?

5.3.2. Analytical Questions

1. Define neurous. What are the classifications of neuron?
2. Draw and label of a Neuron.
4. Describe a nerve fibre.

Unit 2: Bone

Lesson 1: Histology and General Structure



1.1. Learning Objectives

At the end of this lesson you will be able to-

- ◆ know histological structure of bone
- ◆ define chemical structure of bone
- ◆ understand the functions of bones
- ◆ describe different types of bones.



1.2. Bone

Bone is a highly vascular and mineralized type of connective tissue. It forms the framework of our body. Bone consists of cells and intercellular substances.

Bone Cells

- ◆ Osteocytes
- ◆ Osteoblasts
- ◆ Osteoclasts.

Bone is a highly vascular and mineralized type of connective tissue. It forms the framework of our body. Bone consists of cells and intercellular substances

Intercellular substances- consist of water and solids. The solid substance of bone is either organic or inorganic.

Organic Substances are the Followings-

- ◆ Collagen fibres
- ◆ Cement substance that binds the collagen fibres together, such as Glycos aminoglycons.

Inorganic Substances

- ◆ Calcium, sodium, potassium, magnesium, phosphorus, bicarbonate and citrate.

Histological Structure of Bone

Bone consists of numerous cylindrical units. These units are called the Haversian system. Haversian systems consists of -

Bone

- ◆ Haversian canals
- ◆ Lamellae
- ◆ Lacunae
- ◆ Canaliculi.

The Haversian canal is the center of the unit. It runs parallel to the long axis of long bone. It contains the neuromuscular bundle.

The lamellae surround each Haversian system. They are made of bony matrix. The small spaces between the lamellae are called lacunae and they contain the osteocytes

Canalicule: Are fine radiating channels. They connect the lacunae with each other and with the haversian canal. Cytoplasmic processes from the osteocytes occupy these channels.

Function of Bones

- ◆ Bones provide shape and support to the body.
- ◆ They provide the site of for the attachment of tendons, muscles and ligaments.
- ◆ They provide mechanical protection to the vital structures of the body, Such as the brain, heart and lungs.
- ◆ Bone marrow produces blood cells.
- ◆ They are the storehouse of most of the calcium and phosphorus of the body.
- ◆ Bones form joints. In the joints they serve as lever for muscular actions.

Classification of Bone

According to the size and shape, bones can be divided into

- i. Long bones (e.g., humerus and femur)
- ii. Short bones (e.g., carpal bones)
- iii. Irregular bones (e.g., carpal bones)
- iv. Flat bones (e.g., sternum, scapula)
- v. Pneumatic bones (e.g., maxilla, sphenoid)
- vi. Sesamoid bones (e.g., patella bone).

Blood vessels from the periosteum supply nutrition to the bone

Periosteum

Periosteum is the covering of bones. It covers the whole bone except the articular surface. It is formed of dense connective tissue. It consists of an outer fibrous layer and inner layer. The outer layer contains a network of blood vessels and the inner layer consists of loosely arranged connective tissue.

Function of Periosteum

- ◆ The site for the attachment of muscles, tendons and ligaments.
- ◆ It forms bone during growth and repair.



1.3. Exercise

1.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. Bone marrow produces
 - a. blood cell
 - b. nerve cell
 - c. muscle cell
 - d. liver cell.

2. Patella is a
 - a. irregular bone
 - b. short bone
 - c. sesamoid
 - d. long bone.

3. Maxilla is a
 - a. irregular bone
 - b. pneumatic bone
 - c. sesamoid bone
 - d. all above.

1.3.2. Short Questions

1. What is bone?
2. What is the bone cell?
3. What is canalicule?

Bone

1.3.3. Analytical Questions

1. What are the compositions of bone?
2. Describe histological structure of bone?
3. Enumerate the function of bone.
4. Classification of bone.
5. What is periosteum? Give its function.

Lesson 2: Cartilage

2.1 Learning Objectives



At the end of this lesson you will be able to-

- ◆ know structure of cartilage
- ◆ define the character of cartilage
- ◆ describe the function of cartilage.



2.2. Description

Cartilage is specialized type of connective tissue. it consists of cells, fibres and ground substances.

Cartilage cells are chondroblasts and chondrocytes. Chondroblasts are immature cells with surface projections. Chondrocytes are mature cells with few surface projections. The chondrocytes are situated in the little space in the intercellular substance. The fibres are mostly collagen. The ground substance contains water, some lipid, non-protein and electrolytes. It supports the soft tissue and provides a sliding area for joints.

Types of Cartilage

- i. Hyaline cartilage
- ii. Elastic cartilage
- iii. Fibro cartilage.

Cartilage is specialized type of connective tissue. it consists of cells, fibres and ground substances

Hyaline Cartilage

This is the most common cartilage of the body. It is translucent and bluish white in colour. All hyaline cartilage, except articular cartilage is covered by define.

Site of Hyaline Cartilage

- ◆ Costal cartilage
- ◆ Articular cartilage
- ◆ Thyroid and cricoid cartilage of the larynx
- ◆ Cartilage of the trachea and bronchi
- ◆ Parts of the nasal septum and lateral wall of the nose
- ◆ Epiphysial plate of growing long bones.

Bone

Elastic Cartilage

In addition to the composition of hyaline cartilage, elastic cartilage is rich in fine elastic fibres.

Distribution

- ◆ Auricle (pinna) of the ear
- ◆ The wall of external auditory canal.
- ◆ Epiglottis.

Fibro Cartilage

It contains chondrocytes similar to those of hyaline cartilage. They may occur singly or in-groups.

Site of Fibro Cartilage

- ◆ Intervertebral disc
- ◆ Symphysis pubis
- ◆ Menisci of knee joint
- ◆ Glenoid labrum and acetabular labrum.



2.3. Exercise

2.3.1. Multiple Choice Questions

Tick (✓) the correct answer

1. Cartilage is a
 - a. connective tissue
 - b. epithelium tissue
 - c. nervous tissue
 - d. muscular tissue.

2. Periostum is the
 - a. colls of the bone
 - b. covering of the bone
 - c. tissue of the bone
 - d. surface of the bone.

3. Bone marrow produce
 - a. bone cells
 - b. blood cells
 - c. tissue cells
 - d. nerve cells.

4. Carpal is a
 - a. short bone
 - b. irregular bone
 - c. flat bone
 - d. circular bone.

5. Patella is a
 - a. sesamoid bone
 - b. flat bone
 - c. pneum bone
 - d. lone bone.

1.3.2. Short Questions

1. Write down the short note on.
2. Describe Fibro-cartilage Hyaline cartilage.
3. What do you, mean elastic cartilage?

Bone

2.3.3. Analytical Questions

1. What is cartilage?
2. What are the types of cartilage?
3. Write down the site of hyaline cartilage?

Lesson 3: Joints

3.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ know structure of joint
- ◆ describe the different kinds of joints.



3.2. Description

Joints are the sites where two or more components of the skeleton meet. Long bones articulate with the ends, flat bones articulate with their margins and short and irregular bones with their surface.

Joint are classified into three groups, they are-

- i. Synovial
- ii. Cartilagineous and
- iii. Fibrous.

Joints are the sites where two or more components of the skeleton meet

In synovial joints, considerable movement is possible. Fibrous joints are held together by dense connective tissue and no movement is allowed in this type of joint. In cartilagionus joints, bones are held together by cartilage and only little amount of movement is possible in this type of joints.

Synovial Joints

Characteristic of a Synovial Joint

- i. Bones of these joints are held together by an articular capsule.
- ii. Articular surface of the bone is covered by articular cartilage. This articular cartilage is mostly hyaline in nature.
- iii. This joint has a joint cavity. The cavity contains colourless fluid called synovial fluid.
- iv. Inside of the joint cavity is covered with a synovial membrane, except on the articular surfaces of bones and articular cartilage.
- v. The articulating bones held together by a number of ligaments.
- vi. Some of the joint cavities contain an articular disc meniscus. Fat of pad. Sometimes the joint cavity divided by this structure.
- vii. A variable amount of movement is possible in these types of joints.

Bone

Types of Synovial Joints

According to the shape of articular surfaces, synovial joints are classified in the following types-

1. **Hinge joints:** One articular surface is concave. They are uniaxial in nature. Example: Interphalangeal joint of finger and humero-ulnar joint of elbow.
2. **Pivot joints:** One bone acts as a pivot. This pivot is encircled by ring made of bone and ligament. Movement in this joint is uniaxial. Example: Proximal radioulnar joint and joint between dens and atlas.
3. **Condylar joints:** In condylar joints each bone consists of a distinct articular surface called condyles. The pair articular surfaces may be enclosed in the same articular capsule or in a separate capsule. Example: Knee joint and temporomandibular joint.
4. **Ellipsoid joints:** One articular surface is oval and convex and the other articular surface is elliptical and concave. They are biaxial joints. (e.g.,) Radio Carpal joint.

Fibrous Joints

These joints are held together by dense fibrous tissue. They are of three types-

- i. Sutures-present in the Skull.
- ii. Syndesmosis-Radio-ulnar joint.
- iii. Gomphosis-for the fixation of teeth in mandible and maxilla.

Cartilaginous Joints

The binding material in this joint is cartilage. A small amount of movement is possible in this joint. There are two types of cartilaginous joints.

- i. Primary
- ii. Secondary.

In primary cartilaginous joint. The bones are united by plate of hyaline cartilage. This hyaline cartilage is later replaced by bone. No movement is possible in this joint. Example- Basisocciput and basisphenoid.

In secondary cartilaginous joints the bony surfaces are covered with hyaline cartilage. A plate of fibro cartilage holds the articular surfaces together. A little amount of a movement is possible in joints. Example: i). Pubic symphysis ii). Manubrio sternal joints.

Movements in Joints

Four kinds of movement are possible in joints. They are-

- ◆ Gliding movements
- ◆ Angular movements
- ◆ Circumduction
- ◆ Rotation.

Gliding Movement Occurs in Plain Joints

Angular movements: May be flexion or extension and abduction or adduction. Flexion means bending or decreasing or angle between bones. Extension means straightening out or increasing the angle between bones. Abduction means movement away from midline and adduction means movement towards midline.

Circumlocution: combination of four angular movements. Flexion, extension, abduction and adduction occur successive order to form cone.

Rotation: This movement occurs around the long axis of bone.

Bone



3.3. Exercise

3.3.1. Multiple Choice Questions

Tick (✓) the correct answer

1. Synovial fluid is a
 - a. colour less fluid
 - b. turbid fluid
 - c. yellowish fluid
 - d. none of above.

2. Articular cartilage is mostly
 - a. hard in nature
 - b. hyaline in nature
 - c. soft in nature
 - d. liquid in nature.

3. In case of ball and socket joint
 - a. movement is possible
 - b. no movement is possible
 - c. sometime movement is possible
 - d. all of the above.

3.3.2. Short Questions

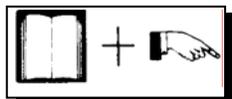
1. Write short note on angular movements.
2. Circumduction.
3. Rotation.

3.3.3. Analytical Questions

1. What are the types of joint? Write down the characteristic of a synovial joint.
2. Describe the types of synovial joints.
3. What are the different movements of the Joints? Mention names.

Unit 3: Superior Extremity

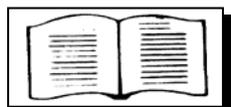
Lesson 1: Bones of the Upper Limb



1.1. Learning Objectives

At the end of this lesson you will be able to-

- ◆ know the bones of the upper limb
- ◆ describe the different parts of the bone.



1.2. Introduction

Upper limb includes *bones and soft tissues*. We shall discuss bones of upper limb in this lesson. In connection with the bone, joints will also be described.

Description

The bones of upper limb are the following-

- i. Bones of shoulder girdle-scapula and clavicle
- ii. Bone of arm- humerus
- iii. Bones of forearm-radius and ulna
- iv. Bones of hand (s)- 8 carpal bones, 5 metacarpal and 14 phanlanges.

The total number of bone in each upper limb is 32.

The Clavicle

It is a long bone. It has medial and lateral ends and a shaft. The medial end articulates with sternum and lateral end articulates with acromion of scapula.

It transmits weight of the upper limb to sternum.

The Scapula

The scapula forms the shoulder girdle with the clavicle. It has two surfaces costal and dorsal. It has three borders superior, lateral and medial borders. It has three angles superior, inferior and lateral angles. It has three processes-the spine, acromion and coracoid processes.

Superior Extremity

The lateral angle contains the glenoid cavity for articulation with the head of humerus and forms shoulder joint. The acromion process articulates with the lateral end of the clavicle and forms the acromio-clavicular joint.

The Humerus

The humerus is the bone of upper arm. It has an upper and lower end and a shaft. The upper end has following parts –

- i. The head
- ii. The greater tubercle
- iii. The lesser tubercle.

The line separating the head from the rest of upper end is called the anatomical neck. The junction between the shaft and upper end is called the surgical neck.

The shaft has three borders and three surfaces

The borders are anterior, lateral and medial

The surfaces are- antromedial, antroleteral and posterior.

Scapula and
humerus

The lower end has the following parts

a. The articular parts-

- i. Capitulum
- ii. Trochlea.

b. The non-articular parts-

- i. Medial epicondyle
- ii. Lateral epicondyle
- iii. Coronoid fossa
- iv. Radial
- v. Olecranon fossa.

The Radius

The radius is the lateral bone of the forearm and consists of an upper end, a shaft and a lower end.

The upper end consists of the head, neck and tuberosity.

The shaft has an anterior, posterior and a medial border. It also has anterior, posterior and lateral surfaces.

The lower end is the widest part of the bone. Inferior surface takes part in the formation of the wrist joint.

The Ulna

Radius Ulna

The ulna is the medial bone of the forearm. It has upper and lower ends and a shaft. The upper end has olecranon process, coronoid process, trochlear notch and radial notch. The shaft has interosseus, anterior, and posterior borders it has anterior, posterior and medial surfaces.

The lower end is made of head and styloid process.

The lower end is made of head and styloid process.

The Carpal Bones

The carpus is made of eight carpal bones. They are arranged in two rows -

- i. The upper row contains, from the lateral to medial side-
 - a. scaphoid b. lunate c. triquetral d. pisiform.
- ii. The lower row contains from lateral to medial side-
 - a. trapezium b. trapezoid c. capitate d. hamate.

The Metacarpal Bone

These are five miniature long bones. They are numbered from lateral and medial side. Each bone has a base a shaft and a head.

The Phalanges

There are 14 phalanges in each hand, 3 for each finger and 2 for the thumb.

Superior Extremity



1.3. Exercise

1.3.1. Multiple Choice Questions

Tick (✓) the correct answer

- a. total number of bones in the upper limb is 32, 34, 36.
- b. the carpus is made of 7, 9, 8 number of carpal bones.
- c. bones of shoulder girdle - Radius and Ulna/ Scapular and clavicle.
- d. scapular/ Clavicle/ Humerus transmits weight of the upper limb to sternum.

1.3.2. Short Questions

1. What are the metacarpal bones?
2. What are radices?
3. What is ulna?

1.3.3. Analytical Questions

1. What are the bones of shoulder girdle?
2. What are the anatomical neck and surgical neck?
3. Describe the carpal bones.

Lesson 2: Arm, Forearm and Hand

2.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ structure of arm, Forearm and hand
- ◆ name of the muscle of the hand.



2.2. Arm

The arm extends from the shoulder joint to elbow joint. It is divided into two compartments, anterior and posterior, by the medial and lateral septum.

The muscles of the anterior compartment of the arm are -

- i. Coracobrachialis
- ii. Biceps
- iii. Brachialis.

Arteries of the arm: The Brachial artery is the continuation of the axillary artery. It extends from the lower border of the triceps major muscle to the level of the neck of the radius.

Branches of the Artery

- i. Profunda brachii artery
- ii. Superior ulnar collateral artery
- iii. Inferior ulnar collateral artery
- iv. Nutrient artery to humerus
- v. Terminal branches of radial and ulnar arteries.

Large Nerves in the Arm

- i. Median nerve
- ii. Ulnar nerve
- iii. Radial nerve.

Cubital fossa: This is a triangular space located in front of the elbow. It is bounded medially by the lateral border of pronator teres. Laterally, by the

Superior Extremity

medial border of brachioradialis and its base is formed by the imaginary line joining the two epicondyles of the humerus.

The back of the forearm: contains the following structures

Muscles of the Superficial Group

- i. Anconus
- ii. Brachioradialis
- iii. Extensor carpi radialis longus
- iv. Extensor carpi radialis brevis
- v. Extensor digitorum
- vi. Extensor digiti minimi
- vii. Extensor carpi ulnaris.

Deep Muscles of the Back Offorearm

- i. Supinator
- ii. Abductor pollicis longus
- iii. Extensor pollicis brevis
- iv. Extensor pollicis longus
- v. Extensor indicis.

Nerves of the Back of the Forearm

The posterior interosseous nerve is the chief nerve of the back of the forearm. It is a branch of radial nerve. It arises in the cubital fossa.

Palmar Aspect of the Wrist and Hand

The posterior interosseous nerve is the chief nerve of the back of the forearm. It is a branch of radial nerve

Flexor retinaculum: This is a strong fibrous band. It bridges the anterior concavity of the carpus and makes a tunnel called the carpal flexor tunnel. Some structure from the forearm pass to the hand superficial to this tunnel and some pass deep to it.

Palmar aponeurosis: This is the thickened deep fascia of the central part of the palm. It is triangular in shape. It protects the tendon, blood vessels and nerves of the palm of hand.

Muscles and Tendon of Palmar Aspects of the Hand

Muscles of the front of the forearm become tendons as they enter into the hand. These tendons are inserted in different bones of the hand. Besides these long tendons there are muscles in the hand called "intrinsic muscles." They have both their origin and their insertion in the hand.

The twenty intrinsic muscles of the hand are as follows -

- i. Four thenar muscles
- ii. Abductor pollicis brevis
- iii. Flexor pollicis brevis
- iv. Opponens pollicis
- v. Adductor pollicis.

2. Four Hypothenar Muscles

- i. Palmaris brevis
- ii. Abductor digiti minimi
- iii. Flexor digiti minimi
- iv. Opponens digith minimi

3. Four lumbricals

4. Four palmar interossee

5. Four dorsal interossee.

These intrinsic muscles of the hand perform the functions of adjusting the hand during gripping and other fine, skilled movements.

Arteries of the Hand

The ulnar artery in the hand forms the superficial palmar arch by union with a branch of radial artery. The deep branch of the ulnar artery completes the radial artery in the hand forms the deep plamar arch and it.



2.3. Exercise

2.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. Brachial artery is the continuation of
 - a. subclavian artery
 - b. axillary artery
 - c. radial artery
 - d. extra artery.

2. Cubital fossa is a
 - a. triangular space
 - b. quadrangular space
 - c. pyramidal space
 - d. circular space.

3. Supinator is a
 - a. superficial muscles of the back of forearm
 - b. deep muscles of the back of forearm
 - c. cutaneous muscles of the back of forearm
 - d. all of the above.

4. Palmer aponeurosis is a
 - a. muscle of the palm
 - b. thickened deep fascia of the palm
 - c. superficial deep fascia of the palm
 - d. muscle of the hand.

2.3.2. Analytical Questions

1. What are the branches of brachial artery?
2. Define cubital fossa. Write down the content of cubital fossa.
3. What are the muscles of forearm?
4. Write the name of intrinsic muscle of hand.

Lesson 3: Joints of the Upper Limb

3.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ say different joints of the upper limb
- ◆ describe the different bones forming the joint
- ◆ understand the movements of the joint.



3.2. Names of the Joints of the Upper Limb

- i. Sternoclavicular joint
- ii. Acromioclavicular joint
- iii. Shoulder joint
- iv. Elbow joint
- v. Wrist joint
- vi. Superior and inferior radioulnar joint
- vii. Inter carpo-metacarpal joint and inter metacarpal joints
- viii. Meta carpo phanlangeal joint
- ix. Inter phanlangeal joints.

Sternoclavicular Joint

The sternal end of the clavicle, clavicular notch of the sternum and the upper surface of the first costal cartilage form this joint.

Type of Joint: Synovial

Acromioclavicular Joint

The lateral end of clavicle and acromion process of the scapula forms this joint.

Type of Joint: Plain synovial joint

Shoulder Joint

The glenoid cavity of the scapula and the head of the humerus form this joint.

Type of Joint: Ball and socket synovial joint

Superior Extremity

Movement

- i. Flexion
- ii. Extension
- iii. Abduction
- iv. Adduction
- v. Rotation
- vi. Circumduction.

Elbow Joint

This joint is formed by the articulation of -

Upper: Capitulum and trochlea of the humerus.

Lower: The upper surface of the head of the radius articulates with the capitulum and trochlear notch of the ulna and with the trochlea of humerus.

Type of joint: Hinged synovial joint

Movement

- i. Flexion
- ii. Extension

Wrist joint

Articular Surfaces

1. Upper

- i. The inferior surface of the lower end of the radius.
- ii. The articular disc of inferior-radio-ulnar joint.

2. Lower

- i. Scapheoid
- ii. Lunate
- iii. Triquetral

Movement

- i. Flexion
- ii. Extension
- iii. Abduction
- iv. Adduction
- v. Circumduction.

Type of joint: Synovial Joint of ellipsoid variety.

Superior Extremity



3.3. Exercise

3.3.1. Multiple choice the questions

Tick (✓) the correct answer

- a. movement of elbow joint is flexion and extension/ supination and pronation.
- b. wrist joint is a synovial joint of hing variety/ synovial joint of ellipsoid variety.
- c. shoulder joint is hing type of joint/ ball and soclel synovial joint.
- d. sternoclavicular joint is a synovial joint/ ellipsoid type.

3.3.2. Analytical Questions

- 1. Name the joints of upper limb.
- 2. What are the movements of shoulder joint?
- 3. Describe-elbow joint.

Unit 4: Thorax (External)

Lesson 1: Thoracic Cage

1.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ skeleton of the thorax
- ◆ parts of the vertebra
- ◆ features of a typical rib.



1.2. Description

Thoracic cage is formed anteriorly by the sternum, posteriorly by the twelve thoracic vertebrae and on each side by twelve ribs with their cartilage.

Sternum

The sternum is a flat bone. It is divided into three parts, the manubrium, body and xiphoid process.

The Manubrium is the uppermost part of the bone. It has a notch called the suprasternal notch. On each side of this notch there is a facet for the clavicle. The manubrium forms angle with the body called the sternal angle. Body is longer, thinner and narrower than the manubrium. Its upper end forms a secondary cartilagenous joint with manubrium and the lower end forms a primary cartilagenous joint with the xiphisternum. On each side the mauubrium articulates with costal cartilage.

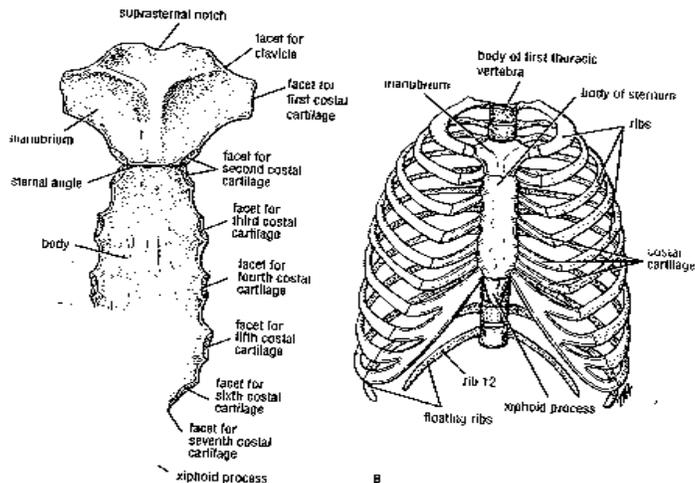


Fig.: Sternum and skeleton of the thorax.

Thorax (External)

Xiphoid process is the small part of the bone; it is in the center of the chest.

Vertebral Column

The vertebral column is called the spinal column or the backbone. It is the central axis of the body. The vertebral column is made of 33 vertebrae. They are 7 cervical, 12 thoracic, 5 lumbar, 5 sacral and 4 coccygeal.

Parts of a Typical Vertebra

A typical Vertebra has Following Parts

- i. Body
- ii. Pedicles
- iii. Lamina
- iv. Spine
- v. Transverses process
- vi. Superior and inferior articular process.
- vii. Vertebral foramen is bounded anteriorly by the posterior surface of the body, on each side by the pedicle and behind by the lamina. Each vertebral foramen forms a part of a vertebral canal, which lodges the spinal cord.

Character of a Typical Thoracic Vertebra

The body of the vertebra is heart shaped.

The vertebral foramen is comparatively small and circular.

The spine is long and directed downwards and backwards.

Rib

There are twelve ribs on each side of the thorax. The length of ribs increases from the first to the seventh ribs and then gradually decreases from the 7th to the 12th ribs. The first seven ribs are connected to the sternum through their costal cartilage and called true ribs. The remaining five ribs are called false ribs. The costal cartilage of 7th to the 10th ribs forms the costal margin. The anterior ends of 11th and 12th ribs are free and called the floating ribs. The 3rd to 9th ribs have feature in common and are called the typical ribs and the first two and last three ribs are called the atypical ribs.

Features of a Typical Rib

Each rib has two ends and a shaft. The anterior end joins with the costal cartilage. The posterior end is made up of a head, neck and tubercle. The head articulates with the vertebrae. The shaft has an upper and lower border and inner and outer surfaces.

Joint of Thorax

- i. Manubrio sternal joint
- ii. Costovertebral joint
- iii. Costotransverse joint
- iv. Costochondral joint
- v. Chondro sternal joint
- vi. Intervetebral joint.

Each rib has two ends and a shaft

Manubrio sternal joint: It is a secondary cartilaginous joint. Formed by the body of the sternum and the manubrium.

Costovertebral joint: The head of a typical rib articulates with its own vertebra and also with the body of next higher vertebra and forms a plain synovial joint.

Costotransverse joint: The tubercle of a typical rib articulates with the transverse process of the corresponding vertebra and forms a synovial joint plain variety.

Costochondral joint: Each rib joins anteriorly with its cartilage and forms a primary cartilagenous joint.

Chondrosternal joint: Costal cartilages of the first seven ribs articulate with sternun to form this joint. The first joint is a primary cartilagenous joint and the next six joints are synovial joints.

Intervertebral joint: It is a secondary cartilagenous joint. This is one on each side of the thorax. One plain synovial joint is formed between the articular processes. There is a fibro-cartilagenous disc between two adjacent vertebera. It's made of two parts, the central nucleus pulposus and peripheral annulus fibrosus.



1.3. Exercise

1.3.1. Multiple choice questions

Tick (✓) the correct answer

1. Vertebral column is made of
 - a. 35 Vertebrae
 - b. 33 Vertebrae
 - c. 34 Vertebrae.

2. First two and last three ribs are
 - a. Atypical ribs
 - b. Typical ribs.

3. Thorax consist of
 - a. 12 pair ribs
 - b. 13 pair ribs
 - c. 14 pair ribs.

4. Each rib has
 - a. one end
 - b. two end
 - c. three end.

5. Vertebral column is called
 - a. baell bone
 - b. spinal column
 - c. skeletal bone.

1.3.2. Short Questions

1. What is sternum?
2. What is rib?
3. What is vertibra?

1.3.3. Analytical Questions

1. What is thoracic cage?
2. What are the parts of a typical vertibra?
3. What are the characters of a typical thoracic vertibra?
4. Describe the joint of thorax.
5. Write features of a typical rib.

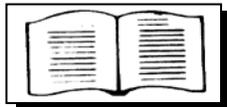
Lesson 2: Thoracic Wall and Inlet and Outlet of Thorax

2.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ know structures which in addition to thoracic cage, form the thoracic wall
- ◆ describe the diaphragm and its openings.



2.1. Description

Thoracic wall is covered from outside to inside by skin, superficial fascia, deep fascia and extrinsic muscles. The three groups of extrinsic muscles that cover the thoracic wall are as follows-

- ◆ Muscles of upper limb
- ◆ Muscles of the abdomen
- ◆ Muscles of back.

Thoracic wall proper: The gap between the ribs is called the intercostal space. Intercostal muscles, intercostal nerves vessels and lymphatics fill this space.

The intercostal muscles are three in number -

- ◆ External intercostal muscle
- ◆ Internal intercostal muscle
- ◆ Transverses thoracic muscle.

Nerves and Blood Vessels of the Thoracic Wall

Intercostal nerves: The intercostal nerves are anterior primary ramie of the spinal nerve T1 to T11. The anterior primary ramus of 12th thoracic nerve forms the subcostal nerve.

Intercostal vessels: Each intercostal space contains one posterior and two anterior intercostal arteries.

Intercostal Arteries

The first and second posterior intercostal arteries arise from the superior intercostal artery, which is a branch of costocervical trunk (branch of subclavian artery).

Thorax (External)

The third to eleventh arteries arise from the descending thoracic aorta.

Anterior intercostal arteries are a branch of the internal thoracic artery in the upper six spaces. The 7th to 9th spaces have anterior intercostal arteries from musculophrenic artery (a terminal branch of the internal thoracic artery).

Boundary of the Thoracic Inlet

Anteriorly: The upper border of the Manubrium sterni bound the thorax inlet.

Posteriorly: The thorax the inlet is bounded by the upper surface of the body of the first thoracic vertebra.

On each side: The first rib with its cartilage, Bounds the side of the thorax. This inlet is covered by the suprapleural membrane. The trachea, oesophagus, a piece of lung blood vessels, nerve and some muscles occupy the thoracic inlet.

Outlet of the Thorax

The outlet of the thorax is separated from the abdomen by the diaphragm. The outlet of thorax is bounded,

Anteriorly: Infra sternal angle

Posteriorly: The lower surface of the body of the 12th thoracic vertebra.

On each side: The costal margin of the 11th and 12th ribs.

The Diaphragm

This is a partition between the thoracic cavity and the abdominal cavity. Structurally, it is partly muscular and partly tendinous. There are three large openings and many small openings in the diaphragm for the passage of structures from the thorax to the abdomen and vice versa.

The Large Openings in the Diaphragm

- ◆ The opening for the aorta (the largest artery that carries blood from the heart). It is in front of the 12th thoracic vertebra.
- ◆ The oesophageal opening in the muscular part of the diaphragm for the passage of the esophagus and vagus nerves. It is at the level of 10th thoracic vertebra.

- ◆ The vena caval opening-lies in the central tendon at the level of 8th thoracic vertebra. It transmits inferior vena cava (The great vein collecting blood from the lower part of the body).



2.3. Exercise

2.3.1. Multiple choice questions

Tick (✓) the correct answer

1. The opening for the aorta is in front of
 - a. 12th thoracic
 - b. 13th thoracic
 - c. 14th thoracic.
2. The vena caval opening-transmit
 - a. oesophagus
 - b. inferior vena cava
 - c. stomach.
3. The large opening in the diaphragm
 - a. stomach
 - b. oesophageal
 - c. the heart.

2.3.2. Short Questions

1. What are types of intercostal muscles?
2. Describe intercostal arteries.
3. What is thoracic wall proper?

2.3.3. Analytical Questions

1. Name the boundary of thoracic inlet.
2. What is diaphragm? What are the openings in the diaphragm?
3. Write down the boundary of thoracic outlet.

Lesson 3: The Thoracic Cavity, Pleura and Lungs

3.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ the pleura and thoracic cavity
- ◆ the structure and function of lungs.



3.2. The Thoracic Cavity and the Pleura

The cavity of the thorax contains the right and left pleural cavities. The lungs occupy the pleural cavities. The two-pleural cavities are separated by a thick median partition called the mediastinum.

There is two-pleural sac on each side of the mediastinum. The pleura are serous memberane lined with simple squamous epithelium.

Each pleural sac invaginated from its medial side by the lung. This process divides the pleural membrane into two parts. The outer- parietal pleura and the inner- visceral pleura.

These two layers are continuous with each other at the hilum of lung and between the two layers there is a potential space called the pleural cavity. The visceral pleura cover the surfaces and fissures of the lungs except the hilum. The parietal pleura is subdivided into four parts -

- i. Costal
- ii. Diaphragmatic
- iii. Mediastinal
- iv. Cervical.

The coastal pleura line the thoracic wall the ribs and intercostal spaces.

The mediastinal pleura cover the corresponding surface of mediastium.

The cervical pleura extend into the neck.

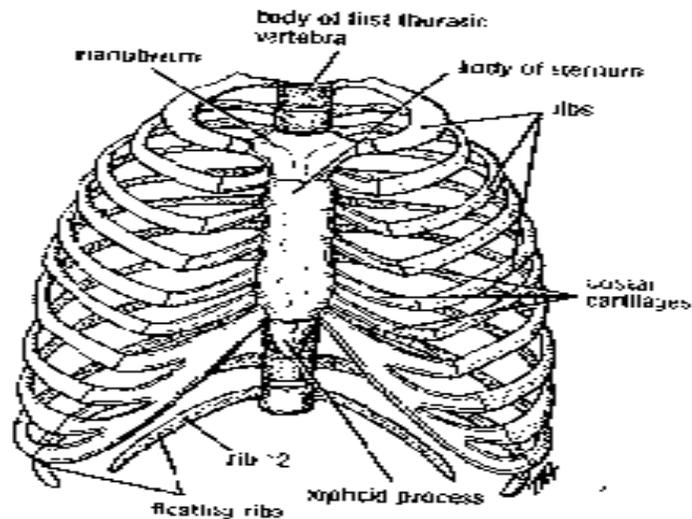


Fig.: Thoracic cage.

Nerve Supply to the Pleura

The nerves of the wall supply the parietal pleura and it is pain sensitive. The autonomic nerve supplies the pulmonary pleurae and it is pain sensitive.

The diaphragmatic pleura cover the upper surface of the corresponding half of the diaphragm.

The Lungs

The lungs are the respiratory organs in which the exchange of gases occurs. Each lung invaginates the corresponding pleural cavity. The right and left lungs are separated by the mediastinum. The right lung weights approximately 625 grams and the left lung weights approximately 575 grams.

Each lung in conical in shape. Each lung has-

- i. An apex
- ii. A base
- iii. Three borders: Anterior, posterior and inferior
- iv. Two surfaces: Costal and medial.

Medial surfaces are divided into the vertebral part and the mediastinal part.

Thorax (External)

Lobes and Fissures of Lungs

The right lung is divided into three lobes by two fissures. The fissures are oblique and horizontal and the lobes are upper, middle and lower. The left lung is divided into upper and lower lobes by the oblique fissure.

Roots of Lung

The roots of the lungs are formed by the structures, which either enter or come out of the lungs. The roots of lungs are opposite the bodies of 5th-6th and 7th thoracic vertebra.

Contents of Roots

- i. Principal branches on the left side
- ii. One pulmonary artery
- iii. Superior and inferior pulmonary veins
- iv. Bronchial veins
- v. Pulmonary plexus of nerves
- vi. Lymphatics of the lungs
- vii. Bronchopulmonary lymph node
- viii. Areolar tissue.

There are some important structures on the mediastinal surfaces of each lung.

Bronchial Tree

The trachea divides at the level of the upper border of the 5th thoracic vertebra, into right and left principal bronchi. The right principal bronchi is approximately 2.5 cm long, wider and more in line with the trachea. The left principal bronchus is longer, narrower (5cm) and more oblique than the right bronchus.

The trachea divides at the level of the upper border of the 5th thoracic vertebra, into right and left principal bronchi

Each principal bronchi enters the lung through the hilum and divides into lobar bronchi. (3 for the right and 2 for the left lung). Each lobar bronchus divides into segmental bronchus. One for each broncho-pulmonary segment. Total 10 for each. Each bronchopulmonary segment is roughly pyramidal in shape. The apex of it is toward the hilum of the lung and the base toward the surface of the lung.

Arterial Supply of Lungs

Bronchial artery supply gives nutrition to the bronchial tree and pulmonary tissue.

On the left side there are two bronchial arteries which are branches of descending thoracic aorta.

On the right side, there is one bronchial artery, which is branch of either 3rd posterior intercostal artery, or upper left bronchial artery.

Deoxygenated blood is brought to the lungs by pulmonary arteries and oxygenated blood is returned to the body.

Venous Drainage

Bronchial veins carry the venous blood from first one of two divisions of bronchi. Rest of the venous blood is drained by pulmonary vein. There are two bronchial veins on each side of the chest. On the right side they drain into the azygos vein. On the left side they drain into the left superior intercostal or into the hemiazygos vein.

Lymphatic Drainage

Lungs are drained by both superficial and deep sets of lymphatics. Both sets drain into bronchopulmonary lymphatic nodes.



3.3. Exercise

3.3.1. Multiple choice the question

Tick (✓) the correct answer

1. Roots of lungs contains
 - a. one pulmonary artery
 - b. two pulmonary artery
 - c. three pulmonary artery.
2. The pleura is lined by
 - a. squamous epithelium
 - b. columnar epithelium
 - c. transitional epithelium.
3. The right lung is divided into
 - a. three lobes
 - b. two lobes
 - c. four lobes.
4. The left lung is divided into
 - a. two lobes
 - b. three lobes
 - c. four lobes.

3.3.2. Short Questions

1. What are pleura?
2. What are the layers of pleura?
3. What is lung?

3.3.3. Analytical Questions

1. What are the contents of roots of lungs?
2. Write the bronchopulmonary segment of right and left lung.
3. Write the arterial supply, lymphatic and venous drainage of lung.

Lesson 4: The Pectoral Region, Axilla, Back and Scapular Region

4.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ describe the boundary of these areas
- ◆ describe the important structure of the area.
- ◆ know contents of the axilla
- ◆ know boundary of the brachial plexus
- ◆ understand the muscles of scapular region.



4.2. The Pectoral Region

Between the upper part of chest and inner side of the arm there is a space called the axilla. The pectoral group of muscles forms the anterior wall of this space. These muscles and the overlying skin and fascias are called the pectoral region. There are three muscles in this area-

Between the upper part of chest and inner side of the arm there is a space called the axilla

- ◆ Pectoralis major
- ◆ Pectoralis minor
- ◆ Subclavius.

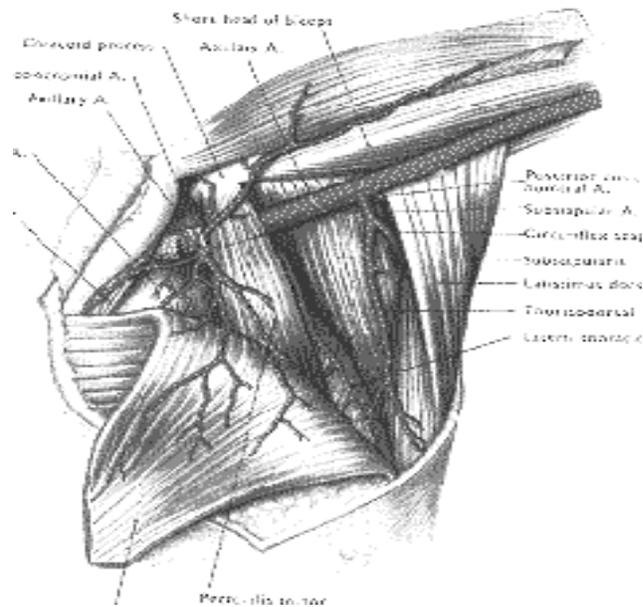


Fig.: Muscle and blood supply of the axilla.

Thorax (External)

The Breast

The breast or mammary gland is the most important structure of the pectoral region. It is rudimentary in males and well developed in female. It is situated in the superficial fascia of the pectoral region.

Extent: Vertically- it extends from the second to the sixth rib.

Horizontally: It extends from the lateral border of the sternum to the mid axillary line.

Deep relation: It situated on the three muscles, namely pectoralis major, serratus anterior and the external oblique muscles of the abdomen.

The breast or mammary gland is the most important structure of the pectoral region

Structure of breast: Breast consists of skin, parenchyma and stroma. Skin covers the gland. There is a conical projection just below the centre of breast called a nipple. The nipple is pierced by 15-20 lactiferous duct. The skin surrounding the base of nipple is pigmented and forms a circular area called areola.

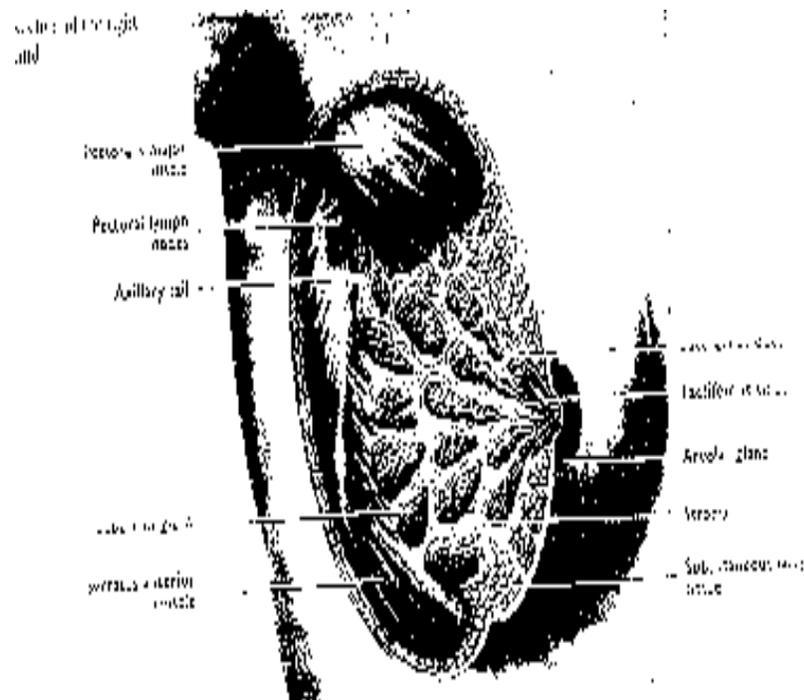


Fig.: The Structure of breast.

Parenchyma: is made of glandular tissue. The gland is arranged in 15-20 lobes. Each lobe is a collection of alveoli and drained a lactiferous duct.

Lactiferous ducts converge towards the nipple and open on it.

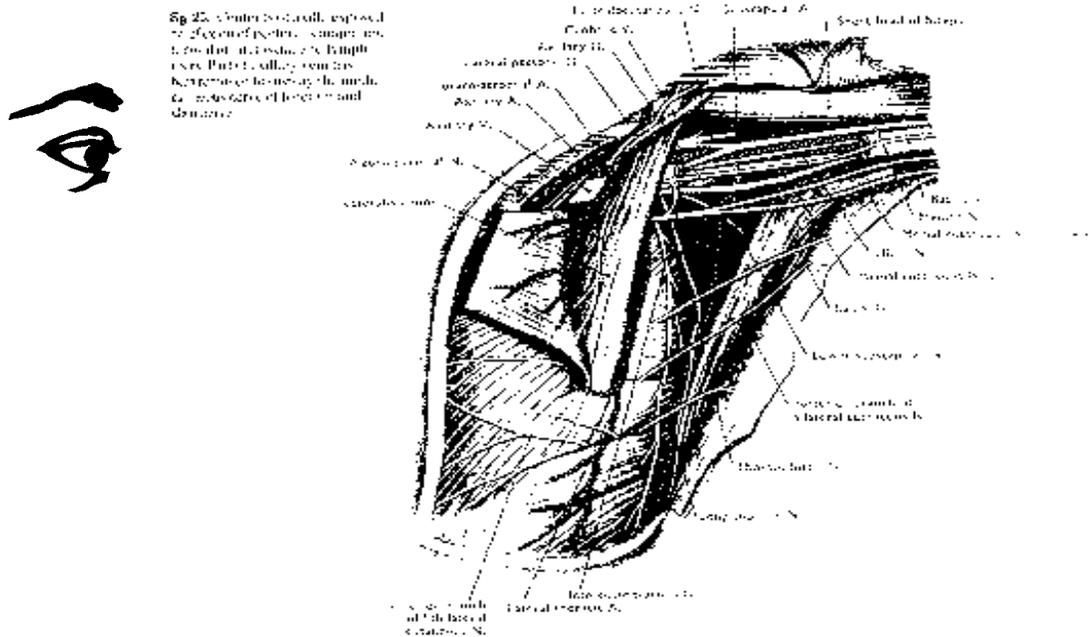


Fig.: Axillary Region

Stroma: is made of fibrous and fatty tissue. It forms the supporting framework of breast.

The axilla or armpit is a pyramidal space situated between the upper part of arm and the chest wall. It is like a four-sided pyramid. It has a base, an apex and four walls.

The apex is formed anteriorly by the clavicle, posteriorly by the upper scapula and medially by the outer border of first rib.

The pectoralis major, pectoralis minor and subclavius muscles form the anterior wall. The subscapularis, teres major and latissimus dorsi muscles form the posterior wall.

The upper four ribs with their intercostal muscles and the upper part of serratus anterior form the medial wall.

The lateral wall is formed by the upper part of the shaft of the humerus, coracobrachialis and short head of the biceps.

Contents of the Axilla

- ◆ Axillary artery and its branches
- ◆ Axillary vein and its tributaries

Thorax (External)

- ◆ Part of brachial plexus
- ◆ Axillary lymph nodes
- ◆ Long thoracic nerve and the inter-costobrachial nerve
- ◆ Axillary fat and areolar tissue.

Brachial Plexus

This plexus produces nerve supply to the upper limb. This plexus consists of root, trunk, division and spinal cord.

Roots: These are formed by the anterior primary of the cervical spinal nerve c-5, 6, 7, 8 and T-1

Trunks

Roots C5 and C6 form upper trunk.

Root C7 form middle trunk.

Roots C8 and T1 form the lower trunk.

Division: Each trunk divides into ventral and dorsal divisions.

Cords: The union of the ventral division of the upper and middle trunk forms the lateral cord.

The Ventral division of the lower trunk forms the medial cord.

The Union of the dorsal divisions of all the trunks forms the posterior cord.

Axillary Artery

It is the continuation of the subclavian artery.

It extends from the outer border of the first rib to the lower border of the trees major muscle.

It has Six Branches

- ◆ Superior thoracic artery
- ◆ Acromiothoracic artery
- ◆ Lateral thoracic artery
- ◆ Subscapular artery

- ◆ Anterior circumflex humeral artery
- ◆ Posterior circumflex humeral artery.

Axillary Lymph Nodes

Axillary lymph nodes are arranged in five groups

- ◆ The anterior group runs along the lateral thoracic artery.
- ◆ The posterior group then along the subscapular vessels.
- ◆ The lateral group runs along the upper part of humerus.
- ◆ The central group runs in the fibro fatty tissue of axilla.
- ◆ The apical group lies deep in the clavico-pectoral fascia.

Back

The muscles connecting the upper limb to vertebral columns are the -

- i. Trapezius
- ii. Latissimus dorsi
- iii. Levator scapulae
- iv. Rhomboideus minor
- v. Rhomboideus major.

Scapular Region

Muscles of Scapular Region

- ◆ Deltoid
- ◆ Supra spinatus
- ◆ Infra spinatus
- ◆ Subscapularis
- ◆ Teres major
- ◆ Teres minor.

Musculotendinous Cuff of the Shoulder (Rotator Cuff)

Four flattened tendons blend with the capsule of shoulder joint and form a fibrous sheath. This is called Rotator cuff of shoulder joint.

Thorax (External)

These muscles are subscapularis, infraspinatus and teres minor.

This cuff gives strength to the capsule of the shoulder joint.

Subacromial Bursa

This is the largest bursa of the body. This is situated below the coracoacromial arch and deltoid muscle.



4.3. Exercise

4.3.1. Multiple Choice Questions

Tick (✓) the correct answer

- a. axillary artery gives 6/9/8 branches.
- b. axillary lymph node arranged in 4/5/6 groups.
- c. the ventral division of the lower trunk forms the medial cord/ lateral cord/lower cord.
- d. rotator cuff gives strength to the capsule of the shoulder joint/ ankle joint.

4.3.2. Short Questions

1. What is pectoral region?
2. What are the muscles of pectoral region?
3. What is Rotator cuff?

4.3.3. Analytical Questions

1. Describe structure of Breast.
2. Describe the boundaries of Axilla.
3. What are the contents of Axilla?
4. Draw and describe Brachial plexus.
5. What are the muscles of Scapular region?

Unit 5: Thorax (Internal Organ)

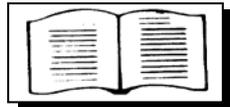
Lesson 1: The Mediastinum, Pericardium and Heart



1.1. Learning Objectives

At the end of this lesson you will be able to-

- ◆ describe the boundary and contents of mediastinum
- ◆ know the structure and functions of pericardium and heart.



1.2. The Mediastinum

The mediastinum is the midline partition of the thorax between the two lungs.

Boundaries

Anterior	—————→	Sternum
Posterior	—————→	Vertebral Column
Superior	—————→	Thoracic inlet
Inferior	—————→	Diaphragm
On each side	—————→	Mediastinal pleura

Divisions of the Mediastinum

The mediastinum is divided into superior and inferior mediastinum by an imaginary line. This imaginary line passes through the sternal angle (anteriorly) and lower borders of 4th thoracic vertebra. The inferior mediastinum is divided into anterior, middle and posterior parts.

The mediastinum is divided into superior and inferior mediastinum by an imaginary line. This imaginary line passes through the sternal angle (anteriorly) and lower borders of 4th thoracic vertebra

Contents of Superior Mediastinum

- i. Trachea and oesophagus
- ii. Arteries: The Arch of the aorta and its branches
- iii. Upper half of the superior vena cava and its tributaries
- iv. Nerves: Vagus, phrenic and cardiac nerves
- v. Thymus
- vi. Thoracic duct
- vii. Lymph nodes.

Thorax (Internal Organ)

Contents of Anterior Mediastinum

- i. Lymph nodes
- ii. Lowest part of the thymus
- iii. Mediastinal branch of the internal thoracic artery
- iv. Areolar tissue.

Contents of Middle Mediastinum

- i. Heart in the pericardium
- ii. Arteries : ascending aorta, pulmonary artery trunk and two pulmonary arteries
- iii. Veins the lower half of the superior vena cava and the terminal part of azygos vein and two pulmonary veins
- iv. Tracheo-bronchial lymph nodes
- v. Bifurcation of the trachea and two principal bronchi.

Contents of Posterior Mediastinum

- i. Oesophagus
- ii. Arteries: The descending thoracic aorta and its branches
- iii. Veins: The azygos, hemiazygos and accessory hemiazygos vein
- iv. Nerves: The vagus and splanchnic nerves
- v. Lymph nodes.

The Pericardium

The pericardium is the enclosing membrane of the heart and the root of the great vessels. It is in the middle mediastinum. It consists of fibrous pericardium and serous pericardium.

Layers of Pericardium

Fibrous pericardium is made of fibrous tissue. The parietal layer of serous pericardium is attached to deep surface. Serous pericardium is a thin double layered membrane lined by squamous epithelium. The outer parietal layer is fused fibrous pericardium and the inner, visceral pericardium is fused to the heart. The parietal and visceral layers become continuous with each other at the root of the great vessels. The potential space between the visceral and parietal layers of the peritoneum is called pericardial cavity and it contains a thin layer of serous fluid for lubrication.

The potential space between the visceral and parietal layers of the peritoneum is called pericardial cavity

Arterial supply of pericardium: The branches of supply the fibrous and parietal pericardium-

- i. Lateral thoracic artery
- ii. Musculophrenic artery
- iii. Descending thoracic aorta.

Nerve Supply: The fibrous and parietal pericardium is supplied by phrenic nerve and they are pain sensitive.

Applied anatomy: Collection of fluid in the pericardial cavity is called pericardial effusion.



1.3. Exercise

1.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. Content of superior medistinum is
 - a. heart
 - b. trachea and esophagus
 - c. lower part of the thymus.

2. Pericardial effusion is condition - collection of fluid in
 - a. pleural sac
 - b. pericardial cavity
 - c. peritoneal cavity.

3. Content of posteria medistinum is
 - a. heart
 - b. trachea
 - c. oesophagles.

4. Content of anterior medistinum
 - a. heart
 - b. lung
 - c. lower port of the thymus.

1.3.2. Short Questions

1. What is pericardium?
2. What are the layers of pericardium?
3. What is the arterial supply of pericardium?

1.3.3. Analytical Questions

1. What are the types of medistinum?
2. What are the contents of superior medistinum?
3. What are the contents of inferior medistinum?

Lesson 2: The Heart

2.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ identify the heart
- ◆ say external features of the heart
- ◆ describe internal feature of the heart
- ◆ understand the circulation of the heart.



2.2. Heart

The heart is a hollow, conical-shaped muscular organ situated in the middle mediastinum. It pumps blood to different parts of the body. It weighs about 300 gram in male and about 250 grams in females.

External Features of the Heart



The human heart has four chambers. These are right and left atria and right and left ventricles. On the surface, the atria are separated from ventricles by an atrioventricular groove. The atria are separated from each other by an intratrial groove. The ventricles are separated by the interventricular groove.

The heart has an apex (top) and a base (bottom) three surface and four borders. The surfaces are anterior, inferior and left. The borders are upper, lower, right and left.

Apex of the heart: The left ventricle forms the apex. It is situated in the left 5th intercostal space, $3\frac{1}{2}$ inches lateral to the midsternal line, just medial to the line.

Base of the heart: This mainly formed by the left atrium and a small part by the right atrium. In erect posture, it is opposite to the 6th to 9th thoracic. In a lying position, it is related next to the 5th to 8th thoracic vertebrae.

Borders of the heart: The upper border is formed by the atria, the right border is formed by the right atrium. Mainly the right ventricle forms the inferior border and mainly the left ventricle forms the left border.

Thorax (Internal Organ)

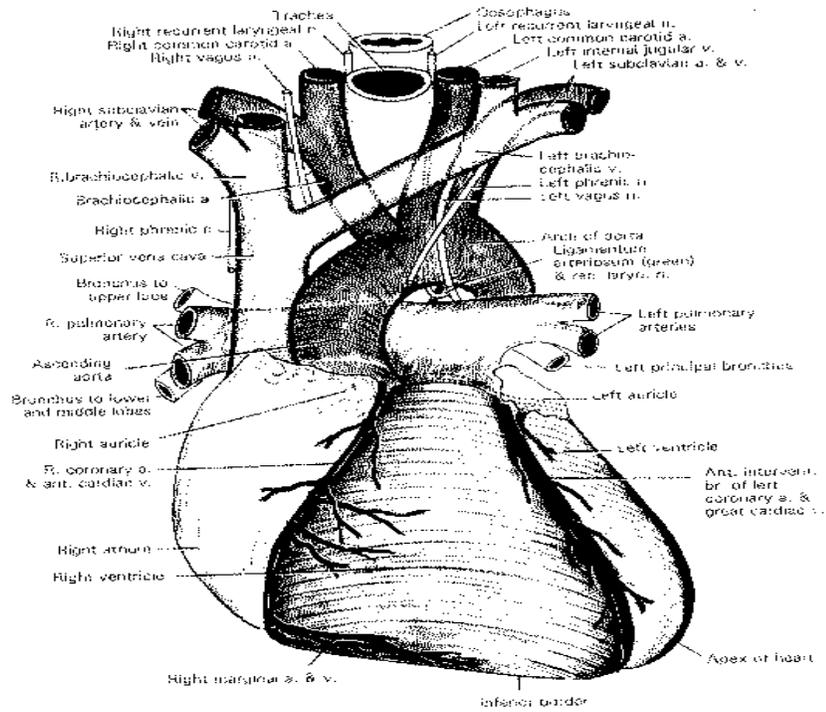


Fig.: Showing external feature of the heart.

Surfaces of the Heart

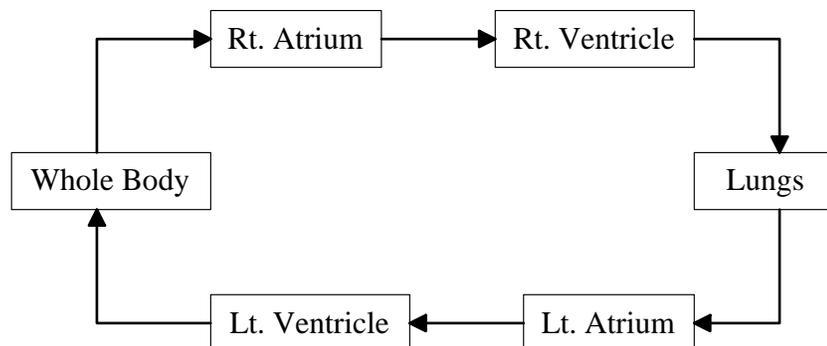
Mainly the right atrium and right ventricle form the anterior or sternocostal surface of the heart. Most of the surface covered by lungs.

The inferior surface is formed on the left -2/3 by the left ventricle and on the right 1/3 by the right ventricle.

Mostly the left ventricle forms the left surface.

Circulation of Blood

The circulation of blood is shown in diagrammatic chart.



Valves of the Heart

There are two pairs of valves in the heart, one pair of atrio-ventricular valve and one pair of semilunar valves. The valves maintain blood flow in one direction.

The atrio-ventricular valves are situated between atrium and ventricle. The right atrio-ventricular valve is called the tricuspid valve. It has three cusps. The left atrio-ventricular valve has two cusps and is called the mitral valve.

Structure of Heart

The wall of the heart consists of three layers. From inside to outside they are endocardium, myocardium and epicardium. The endocardium is made up of a single layer of squamous endothelium resting on a thin layer of loose connective tissue.

The myocardium consists of cardiac muscle cells. These muscles are arranged in a spiral manner around the heart.

The epicardium is the visceral layer of serous pericardium.

The semilunar valves are the aortic and pulmonary valves. Each of them has three cusps.

Sino-Atrial node (S. A Node) -This is called the pacemaker of the heart

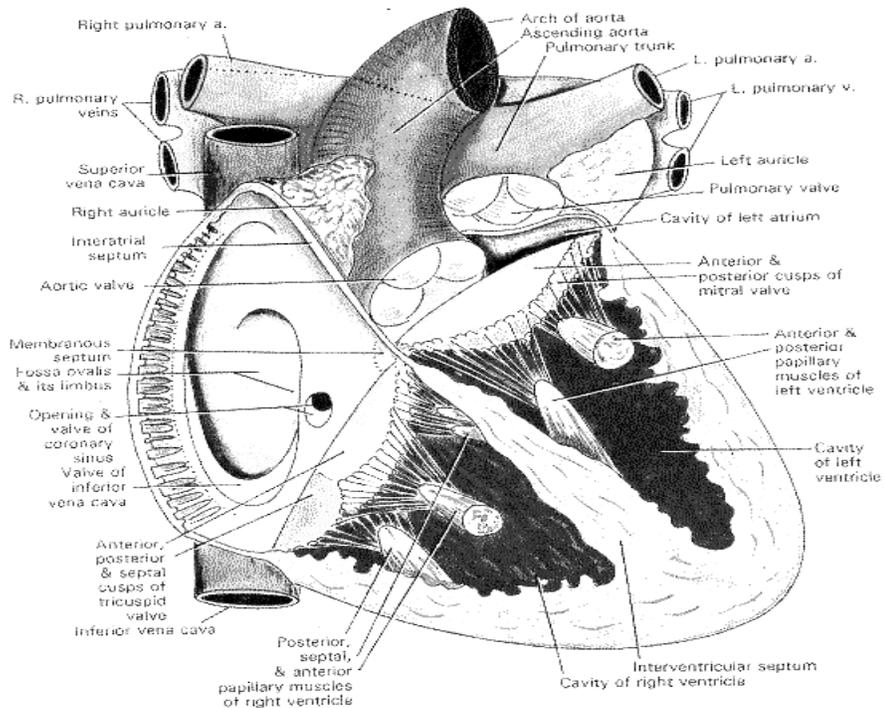


Fig.: Internal feature of the heart.

Thorax (Internal Organ)

The Conducting System of Heart

The conducting system of heart initiates and conducts the cardiac impulse. It is made of specialized myocardium. It consists of the following parts -

- i. Sino-Atrial node (S. A Node) -This is called the pacemaker of the heart
- ii. Atrio-ventricular nodes (A-V node)
- iii. Atrio-ventricular bundle (A-V bundle)
- iv. Right branch of A-V bundle
- v. Left branch of A-V bundle
- vi. The purkinjee fibres.

Arterial Supply: The heart is supplied by two coronary arteries. The coronary arteries are branches of the ascending aorta.

The Veins of the Heart

The coronary sinus is the largest vein of the heart. It opens in to the right atrium. It receives the following tributaries -

- i. The great cardiac vein
- ii. The middle cardiac vein
- iii. The small cardiac vein
- iv. The posterior vein of the left ventricle
- v. The oblique vein of the left atrium
- vi. The marginal vein.

Nerve Supply of the Heart

Parasympathetic from the vague nerve and sympathetic stimulus comes from the 3rd to 5th segments of the thoracic nerve.

Applied Anatomy

- ◆ Incomplete obstruction of the coronary artery causes angina pectoris, occurs- agonizing chest pain.
- ◆ Thrombosis of the coronary artery results in sudden death due to myocardial infarction.



2.3. Exercise

2.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. Human heart has
 - a. three chamber
 - b. four chamber
 - c. five chamber.

2. The semilunar valves are the
 - a. atrium and ventricle
 - b. aortic and pulmonary
 - c. right atrium and left atrium.

3. The pacemaker of the heart is
 - a. A-V node
 - b. left atrium
 - c. S-A node.

4. Apex of the heart is formed by the
 - a. right ventricle
 - b. left ventricle
 - c. right atrium.

1.3.2. Short Questions

1. Draw and label the blood circulation of the heart.
2. What are the valves of the heart?
3. What do you mean conducting system of heart?

2.3.3. Analytical Questions

1. What is heart? Describe the external features of heart.
2. Draw and level the internal structural of the heart.
3. Describe the internal structural of the heart.
4. Give the diagrammatic chart in the blood circulation of the heart.

Lesson 3: The Superior Vena Cava, Aorta, Trachea, Oesophagus and Thoracic Duct



3.1. Learning Objectives

At the end of this lesson you will be able to-

- ◆ describe superior vena cava
- ◆ parts of aorta
- ◆ length of oesophagus and its constriction
- ◆ description of trachea.



3.2. Superior Vena Cava

The superior vena cava is a large blood vessel, which collects blood from the upper half of the body. It is formed by the union of the right and left brachiocephalic veins. It is approximately seven centimeters in length.

It begins at the lower border of the right second costal cartilage.

Termination

In the right atrium at the level of Rt 3rd costal cartilage and terminates in the right atrium at the level of the right 3rd costal

Tributaries of the Superior Vena Cava

- i. Azygos vein
- ii. Several small mediastinal and pericardial veins.

The Aorta

The aorta is the great arterial trunk for distributing oxygenated blood to all parts of the body. It is divided into three parts

- i. Ascending aorta
- ii. Arch of Aorta
- iii. Descending aorta.

Ascending Aorta

Origin: From the upper part of left ventricle at the level of the lower border of the right second costal cartilage.

Termination: It becomes continuous with the arch of aorta at the upper border of second right costal cartilage.

Branches: Right and left coronary arteries.

Arch of the Aorta

Beginning: The arch of the aorta is the continuation of the ascending aorta. It begins at the upper border of the right second costal cartilage joint.

Termination: The arch of the aorta ends the lower border of the body of the 4th thoracic vertebrae where it becomes continuous with the descending aorta.

Branches

- i. Brachio cephalic artery
- ii. Left common carotid artery
- iii. Left subclavian artery.

Descending Thoracic Aorta

Beginning: At the lower border of thoracic artery as the continuation of the arch of the aorta.

Termination: At the lower border of the 12th thoracic vertebra.

Branches

- i. Nine posterior intercostal arteries on side
- ii. The subcostal artery on each side
- iii. Two left bronchial arteries
- iv. Oesophageal branches
- v. Pericardial arteries
- vi. Mediastinal arteries
- vii. Superior phrenic arteries.

The Trachea

The trachea transmits air through the bronchi to the lungs.

Thorax (Internal Organ)

Beginning: Opposite the 6th cervical vertebrae.

Termination: At the upper border of the 5th thoracic vertebra by divided into right and left principal bronchi.

Structure: The trachea has cartilaginous supported by fibro-elastic tissue the total number of rings is 16-20. It is lined by pseudo-stratified ciliated columnar epithelium.

Oesophagus

The oesophagus is the tube through which food passes from the lower part of pharynx to the upper part of stomach. It extends from the neck to the upper part of the abdomen. Length -25 cm.

Beginning: At the lower border of the 6th cervical vertebra.

Termination: At the level of 11th thoracic vertebra

Constrictions: The oesophagus is not uniform in its width along its length. It has 4 constrictions -

- ◆ At the beginning (15 cm from the incisor teeth).
- ◆ Where it is crossed by aortic arch (22 cm from the incisor teeth).
- ◆ Where it is crossed by the left bronchus (27 cm from the incisor teeth)
- ◆ Where it pierces the diaphragm (40 cm from the incisor teeth)

Blood Supply

- i. The cervical part of the oesophagus is supplied with blood by inferior thyroid artery.
- ii. The oesophageal branches of left gastric artery supply the thoracic part.

Venous Drainage

- ◆ Blood from the upper part of the oesophagus is the brachio cephalic vein
- ◆ The left gastric vein drains blood from the middle part of the esophagus. The lower part is a site of the porto--systemic anastomosis

Applied Anatomy

- i. Oesophageal varices occur in the lower part of the esophagus in portal hypertension. Rupture of the varices causes serious bleeding.
- ii. During esophagoscopy it is essential to know the constriction sites

Thoracic Duct

Thoracic duct is the largest lymphatic vessel in the body. It extends from the upper part of the abdomen to the lower part of neck.

From the upper end of cisterni chyli

Termination: At the junction of left subclavian and the left internal jugular veins.

Length: 45 cm.

Drainage area: The thoracic duct receives lymph from the lower part below diaphragm and the left half above diaphragm.

Thorax (Internal Organ)



3.3. Exercise

3.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. Lengths of thoracic duct is
 - a. 35 cm
 - b. 40 cm
 - c. 45 cm.

2. Termination of the oesophagus
 - a. at the level of 11 thoracic vertebra
 - b. at the level of 12 thoracic vertebra
 - c. at the level of 10 thoracic vertebra.

3. Length of the oesophagus
 - a. 20 cm
 - b. 25 cm
 - c. 30 cm.

3.3.2. Short Questions

1. What is superior vena cava?
2. What is Aorta?
3. What is thoracic duct?

3.3.3. Analytical Questions

1. What is superior vena cava?
2. Describe the parts of the aorta.
3. Write the arterial supply, lymphatic and venous drainage of oesophagus.
4. Describe the different constrictions of the esophagus.

Unit 6: Reproductive System

Lesson 1: Female Reproductive System

1.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ know the name of female organ.
- ◆ identify the position of various organ.

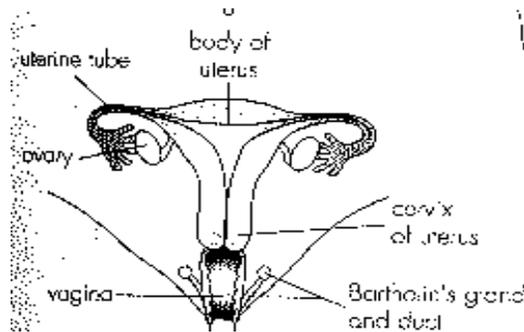
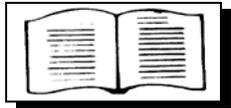


Fig.: Female reproductive system



1.2. Anatomy

Anatomy of the female reproductive system can be described under the heading of the external genitalia and internal genitalia with pelvic floor musculature and fascia.

The external genitalia included under-

- ◆ Mons pubis
- ◆ Labia Majora
- ◆ Labia Minora
- ◆ Clitoris
- ◆ Bulbs of the vestibule
- ◆ Bartholin's gland
- ◆ Vestibule of the vagina
- ◆ Hymen.

Reproductive System

The internal genitalia consists of-

- ◆ Uterus
- ◆ Fallopian tube
- ◆ Ovary.

Ovary secretes female hormones oestrogen and progesterone and during reproductive life it discharges ova.



1.3. Exercise

1.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. Ovary secretes female hormones
 - a. Bartholin's glands
 - b. ovary
 - c. uterus.
2. Hymen
 - a. internal genitalia
 - b. external genitalia
 - c. Bartholin's gland.

1.3.2. Short Questions

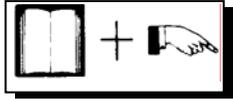
1. Write short notes on-
 - a. Bartholin's glands
 - b. Ovary
 - c. Uterus.

1.3.1. Analytical Questions

1. Draw and label the female internal reproductive system.
2. Name the different parts of female external genitalia.

Lesson 2: Male Reproductive System

2.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ know the name of male organ
- ◆ identify the position of various organ.

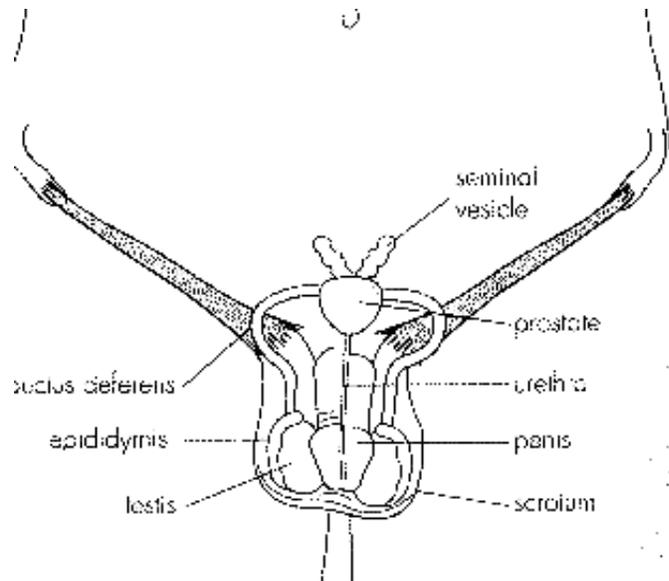
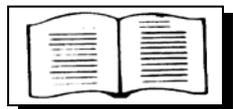


Fig.: Male reproductive system.



2.2. Anatomy

The male reproductive organs consists of the-

- ◆ Testis
- ◆ Epididymis
- ◆ Ductus deferens (vas deferus)
- ◆ Seminal vesicles
- ◆ Ejaculatory duct
- ◆ Prostate gland
- ◆ Bulbo urethral gland.

Reproductive System

The testis produces spermatozoa and male sex hormones testosterone

The testes are covered with in the serotum, a wrinkled sac of skin and smooth muscle. It is situated below the pubic symphysis together with the penis. They form the external reproductive organs -external genitalia.

The internal reproductive system of male which are within the pelvis.

The testis produces spermatozoa and male sex hormones testosterone.



2.3. Exercise

2.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. The testis produces
 - a. ova
 - b. spermatozoa
 - c. hormone.

2. Male sex hormones is
 - a. oestrogen
 - b. progesterone
 - c. testosterone.

3. Bulbo urethral gland is a
 - a. male reproductive organ
 - b. female reproductive organ
 - c. oesophagus.

2.3.2. Short Questions

1. Write short notes on
 - a. Vas deferens
 - b. Prostate gland.

2.3.3. Analytical Questions

1. Draw and label the male internal reproductive system.
2. Name the different parts of male external genitalia.

Unit 7: Brain

Lesson 1: Component of Brain



1.1. Learning Objectives

At the end of this lesson you will be able to-

- ◆ identify the brain
- ◆ describe the location of the brain
- ◆ describe the covering of brain
- ◆ mention the components of brain.



1.2. Brain

The brain is part of central nervous system. It is large soft mass of nervous tissue. It lies within the cranial cavity and composed skull bones. It is very delicate, soft but provides most of the control functions for the body.

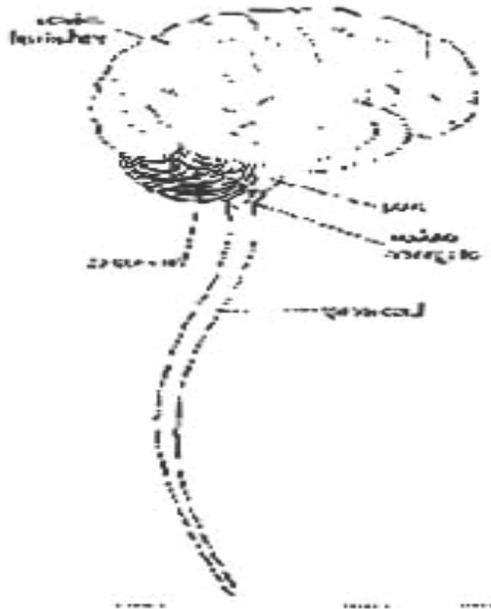


Fig.: Various parts of brain

It is covered by the membranes, which are called meninges. There are three membranes covering the brain and run the continuous as the covering of spinal medulla. Names of the membranes are – i). Dura mater ii). arachnoid and iii). Pia Mater.

Brain

Components of Brain

- | | | |
|----------------|--------------------|------------------|
| 1. Fore brain | 1. Cerebrum | a. Thalamus |
| | 2. Diencephalon- | b. Hypothalamus. |
| 2. Mid brain | 3. Pons | |
| 3. Hind brain- | Medulla oblongata. | Brain Stem. |
| | Cerebellum | |

Each parts of the fore brain is called cerebral hemisphere

Fore Brain: The fore brain is called the cerebrum, which is divided into two hemispheres. Each cerebral hemisphere with a cavity that is called the lateral ventricle. Its have a deeper central portion, the diencephalon has divided into two main parts-thalamus superiorly and hypothalamus inferiorly and a cavity the third ventricle.

Each parts of the fore brain is called cerebral hemisphere.

The diencephalon is almost hidden by the cerebral hemisphere.

1. **Mid Brain:** It is a small region and its cavity is aqueduct and which connects the fore brain with the hind brain. The third cranial nerve (Oculomotor) emerges from the anterior surface of the mid brain. It lies between the lower part of the cerebral hemispheres and the upper part of the pons.
2. **Hind brain:** Hind brain consists of pons, Medulla oblongata and cerebellum. Its cavity the fourth ventricle.
3. **Pons:** It is a white bulging bridge which passes the anterior aspect of the hind brain between the right and left cerebellum. The only nerves, which emerge the pons, are fifth cranial nerves.
4. **Medulla oblongata:** It is a conical white body extends from the pons to join the spinal medulla at the foramen magnum. 6th to 12th cranial nerves attached to medulla oblongata. It has a cavity fourth ventricle and central canal.
5. **Cerebellum:** It is situated in the posterior cranial fossa and it is the second largest mass of nervous tissue. It is easily identified by its large number of closely self-transverse tissues, which cross its surface.
6. **Brain Stem:** Usually applied to the mid brain, pons and medulla oblongata.



1.3. Exercise

1.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. Hind brain consist, of
 - a. medulla oblongata's
 - b. brain steam
 - c. pons.

2. The third cranial nerves emerge from the
 - a. hind brain
 - b. pons
 - c. mid brain.

1.3.2. Short Note

1. Pons
2. Medulla oblongata
3. Cerebellum.

1.3.3. Analytical Questions

1. What is brain?
2. What are the components of brain?
3. What are the coverings of brain?
4. Which are the identifying points of crebellum?

Lesson 2: Functional Areas of Brain

2.1. Learning Objectives



At the end of this lesson you will be able to-

- ♦ describe the functional areas of brain
- ♦ identify the locality of specific functions
- ♦ differentiate motor and sensory area of brain.



2.2. Brain

Each cerebral hemisphere is divided into four lobes and has many different functions.

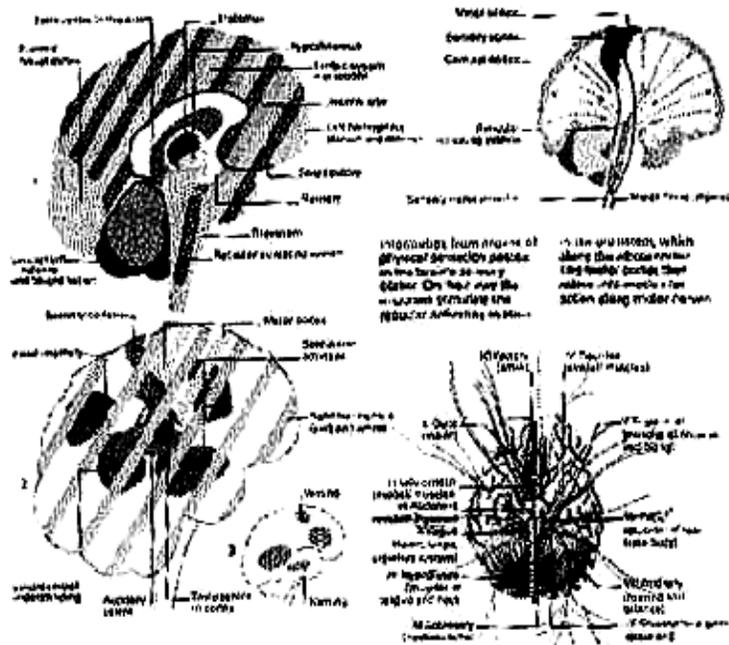


Fig.: Showing different functional areas of brain.

Brain is the controlling area for the entire nervous system. It controls all the actions of the body, voluntary, involuntary and reflex.

The Fore Brain

Cerebrum composed of millions of nerve cells. The never fibre entering and leaving the cerebral hemispheres from all parts of the body, cross over in the brain stem. Therefore the left hemisphere serves the right side of the body and right hemisphere serves in the left side.

There are four lobes in each cerebral hemisphere, largest lobe are frontal lobes. It is responsible for directing voluntary movement's personality development and the ability to form abstract concepts.

Behind the frontal lobes they're called parietal lobes. It is responsible for receiving and sensation of touches and body position.

At the back of the hemisphere the occipital lobe. It is responsible for the receivers and analysers of visual information.

At the side of each hemisphere the temporal lobe which is responsible for the sense of hearing and smell.

The *diencephalon* and also midbrain composing of hypothalamus and thalamus pituitary gland and limbic system.

The *hypothalamus*, which is responsible for controlling the basic, needs of human beings e.g. hunger thirst and sex. It regulates the body temperature and control the activity of pituitary gland the gland produces many hormones.

Thalamus transfer information between sensory-organs and forebrain.

The *hind brain* consists of two parts.

1. **Cerebrum:** Controls the coordination's of body movements, posture and balance, although it has no power to initiate movements.
2. **Brain Stem:** it controls essential life supporting functions e.g., respiration and heart beat.

Cerebro Spinal Fluid

Developmentally the central nervous system is hollow and develops from a neural tube and the cavity of the tube is of great importance. In this cavity, cerebro spinal fluid is produced. Ventricles called are those places where the cerebro spinal fluid is produced.

There are main ventricles present in the brain. These are following -

- i. Lateral ventricles (Right and Left)
- ii. Third ventricle
- iii. Cerebral aqueduct
- iv. Fourth ventricle and central canal.

Right and Left Lateral Ventricle

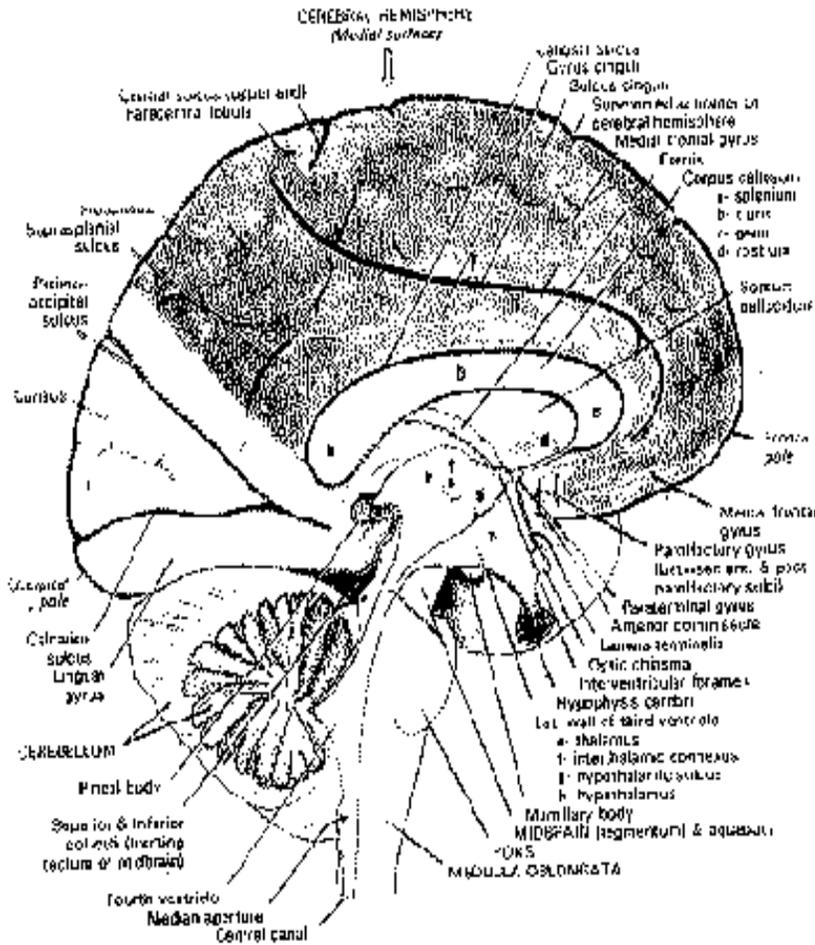


Fig.: Different types of the ventricle.



The lateral ventricle situated in each (Right and Left) cerebral hemisphere. It is a c-shaped cavity lined by ependyma.

Choroid plexus passes in these ventricles along its chorioid fissure. The Choroid plexuses in these ventricles are large and highly vascular, these pair secretes the bulk of the cerebrospinal fluid. Lateral ventricles open into third ventricle by interventricular foramen.

Third Ventricles

Third ventricle lies in between the two halves of the diencephalon. It is narrow slit like cavity and very small amount of choroid plexus in the third ventricles. From the third ventricles the aqueduct opens below in to fourth ventricles.

Cerebral Aqueduct

Cerebral aqueduct situated within the midbrain. It is a narrow tubular cavity, which connects the third ventricle superiorly and fourth ventricle inferiorly. Cerebral aqueduct conveys the CSF from the third to fourth ventricle. Lower part of the cerebral hemisphere and upper part of the pons.

Fourth Ventricle

The fourth ventricle is a diamond-shaped cavity of the hind brain. It extends from the superior border of the pons to the middle of the medulla oblongata. Superiorly it is continuous with the cerebral aqueduct of mid brain and inferiorly it connects with the central canal of the medulla oblongata. CSF passes and small amount produced in the fourth ventricle and then spinal medulla-spinal cord.

Central Canal

It is a diamond shaped cavity, which is situated on the posterior surface of the medulla oblongata and pons. Its spinal medulla consists of H shaped core of gray matter. Which is called gray commissure, this gray commissure is traversed longitudinally by a narrow tunnel and this tunnel is called central canal. It is lined by ependyma and is continuous superiorly with the fourth ventricle and inferiorly the conus medullaris the terminal ventricle. The central canal contains cerebro spinal fluids.

Fluids in the Brain

CSF (Cerebrospinal Fluid)

It is a clear and colourless fluid. It fills the ventricles, subarachnoid space of brain and spinal cord.

CSF is largely produced by the choroid plexuses of the third lateral and fourth ventricles. About 500 ml of CSF produced per day. The total volume of CSF is 130 ml where 130-mm pressure of water 30 ml within the ventricular system and 100 ml in the subarachnoid space. In subarachnoid space where 5 ml in the spinal and 25 ml in the cranial part.

The Main Functions of CSF are as Following-

- i. Product and support the delicate structures of the brain and spinal cord.
- ii. It is an important pathway for the removal of brain metabolic.
- iii. Keep the spinal cord moist.

Brain

- iv. To act as a cushion and shock absorber against.
- v. Act as a reservoir of fluid to regulate the content of the cranium.

Characteristics Features of Normal CSF-

Total volume	150 ml
Sp.gravity	1.000-1.008
Ph	7.31.7.40
Colouer	Colorless
Transparency	clear (fee of clots)
Glucose	50-80mg/100ml
Proteins	20-40 mg/100ml
billirubin	Nil.



2.3. Exercise

2.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. Cerebral aqueduct situated in the
 - a. hind brain
 - b. mid brain
 - c. central canal.

2. The hind brain consist of
 - a. three parts
 - b. two parts
 - c. four parts.

3. The hypothalamus in responsible for
 - a. education
 - b. hunger, thirst, sex
 - c. long life.

2.3.2. Short Questions

1. What are the ventricles of the brain?
2. Where it's situated?
3. What are the fluids presents in the brain?

2.3.3. Analytical Questions

1. Description and function of the CSF.
2. Characteristics of Normal CSF.
3. Describe the functional area of brain.

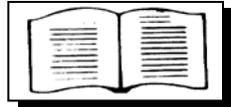
Lesson 3: Circulatory System of Brain

3.1. Learning Objectives



At the end of this lesson you will be able to-

- ◆ describe arterial supply of the brain
- ◆ describe venous drainage of the brain
- ◆ describe cranial nerves in brain.



3.2. The Blood Supply of the Brain

The brain receives its blood from four arteries -

- i. Two internal carotides (right and left)
- ii. Two vertibrals.

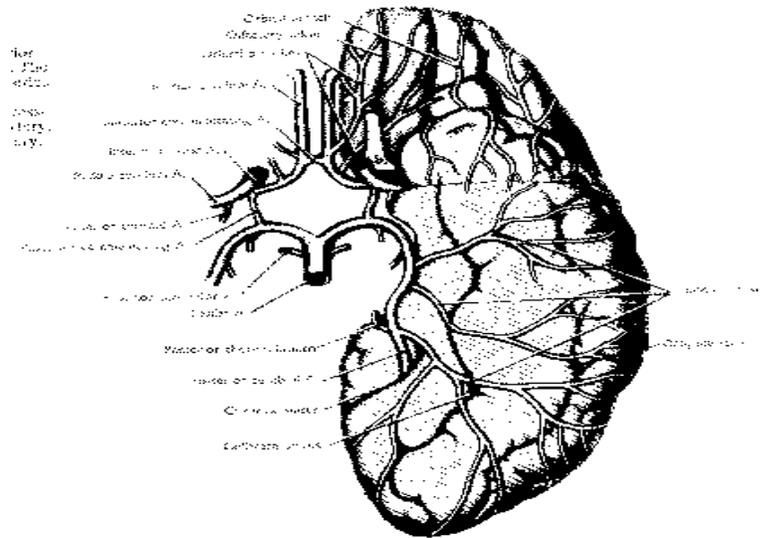


Fig.: Blood supply of the brain.

The course and distribution of the internal carotid artery are shown in the normal angiogram.

The principal branches of the internal carotid artery are -

- i. The ophthalmic artery
- ii. Posterior communicating artery
- iii. Anterior choroidal artery

- iv. Anterior cerebral artery
- v. Middle cerebral artery.

Circle of Willis: The posterior communication artery on each side joins the internal carotid to the posterior cerebral. The circle is completed in front by the internal communicating artery. And units two anterior cerebral.

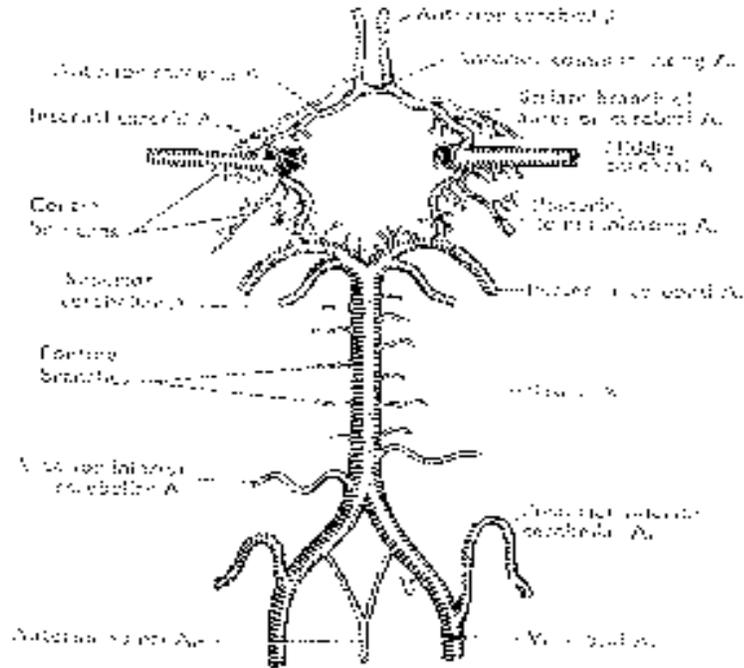


Fig.: Circle of wills

Vertebral Arteries: The vertebral arteries enter the skull through foramen magnum.

Intracranial Branches of the Vertebral Arteries-

- i. Posterior spinal artery
- ii. Posterior or inferior cerebellar artery
- iii. Anterior spinal cerebellar artery.

Basilar Artery: It ends at the upper margin of the pons by dividing into two posterior cerebral arteries.

Branches of basilar arteries.

- i. Anterior inferior cerebellar artery
- ii. The artery of the labyrinth

- ix. Glossopharyngeal
- x. Vagus
- xi. Accessory
- xii. Hypoglossal.



3.3. Exercise

3.3.1. Multiple choice the questions

Tick (✓) the correct answer

1. Cranial nerves are
 - a. eleven pairs
 - b. twelve pairs
 - c. fourteen pairs.
2. Pontine arteries is the branches of
 - a. basilar artery
 - b. spinal artery
 - c. internal carotid.
3. The vertebral arteries enter the skull through
 - a. circle of Willis
 - b. foramen magnum
 - c. basilar arteries.

3.3.2. Short Questions

1. What is circle of Willis?
2. Enumerate name of basilar arteries.
3. Draw and label of "circle of Willis".

3.3.3. Analytical Questions

1. Enumerate arteries supplying the brain.
2. Write on dangerous area of face.
3. What are the cranial nerves are attached to the brain?
4. Write down the name of cranial nerves.

Lesson 4: Bones of the Head and Neck



4.1. Learning Objectives

At the end of this lesson you will be able to-

- ◆ know the general features of the bones of head and neck
- ◆ describe the bones of the head and neck.

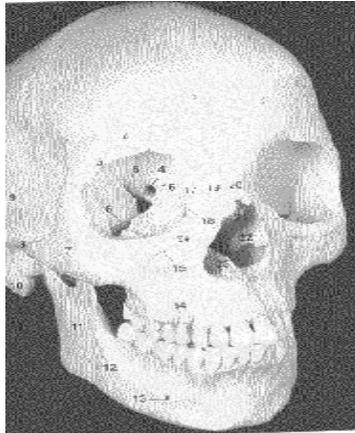
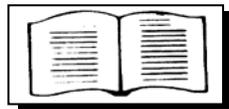


Fig.: Bones of the Skull.



4.2. Bones

The bones of head and neck are-

- i. The bones of skull (22 in number)
- ii. Hyoid bone (one)
- iii. Seven cervical vertebrae.

Bones of the head together are called skull. Skull without mandible (Lower jawbone) is called cranium. Skull has two main parts the calvaria a) the upper part of cranium for enclosing brain and b) the facial skeleton. There are 22 bones in the skull.

a. The calvaria is composed of 8 bones-

Paired bones	Unpaired bone
1. Parietal bone	1. Frontal
2. Temporal bone	2. Occipital
	3. Sphenoid
	4. Ethmoid

b. The facial skeleton has 14 bones in total.

Paired bones	Unpaired bones
1. Maxilla	1. Mandible
2. Zygomatic	2. Vomer
	3. Nasal bone
	4. Lacrimal bone
	5. Palatine bone
	6. Inferior nasal concha.

Skull bones will not be described individually. Skull will be studied as a whole for practical purpose skull can be studied from outside and inside.

The outside study of skull can be done in different views -

- i. Superior view or norma verticalis
- ii. Posterior view or norma occipitalis
- iii. Anterior view or norma frontalis
- iv. Lateral view or norma lateralis
- v. Inferior view or norma basalis.

Sutures Seen Norma Verticalis

- i. Coronal suture
- ii. sagittal suture
- iii. lambdoid suture
- iv. metopic suture.

Some Important Features

Vertex is the highest point on the sagittal suture

Bregma is the meeting point between coronal and sagittal suture.

Lambda is the junction between sagittal and lambdoid suture

Temporal lines: Superior and inferior lines. Two orbital lines across frontal and parietal bone.



4.3. Exercise

Tick (✓) the correct answer

- a. vertex is the highest point on the sagittal suture
- b. the bones of skull is 22/24/26 in number
- c. the calvaria is composed of 6/8/10 bones
- d. lambda is a suture between sagittal and lamboid suture.

4.3.1. Short Questions

- 1. What are the bones of head and neck?
- 2. Enumerate the bones of calvaria.
- 3. What are the bones of facial skeleton?

4.3.2. Analytical Questions

- 1. What is skull? Enumerate the bones of skull.
- 2. Describe the features of norma frontalis.