

**VidyaSiri College of  
Pharmacy  
#67/4, Off Sarjapur Road,  
Bangalore East  
Taluk, Chikkakannalli,  
Bangaluru-560035**



**VIDYA SIRI**  
COLLEGE OF PHARMACY  
**HUMAN ANATOMY AND  
PHYSIOLOGY**

**LABORATORY RECORD**

Name of the Student : .....

Reg.No. : .....

Class : .....

Batch : .....

**VidyaSiri College of Pharmacy**  
**#67/4,Off SarjapurRoad,**  
**BangaloreEast Taluk,**  
**Chikkakannalli,**  
**Bengaluru-560035**



## **CERTIFICATE**

*This is to certify that Mr./Ms.*

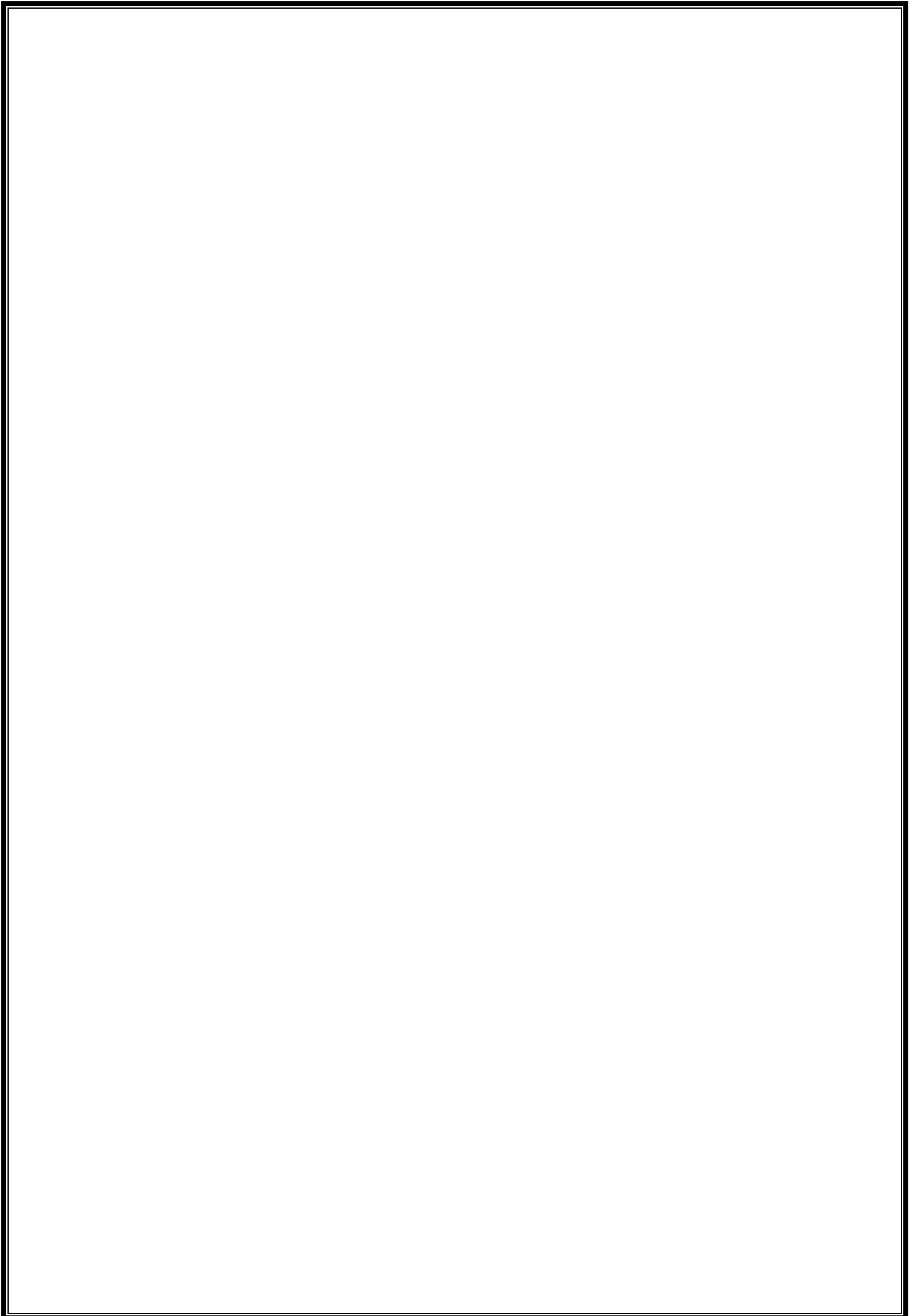
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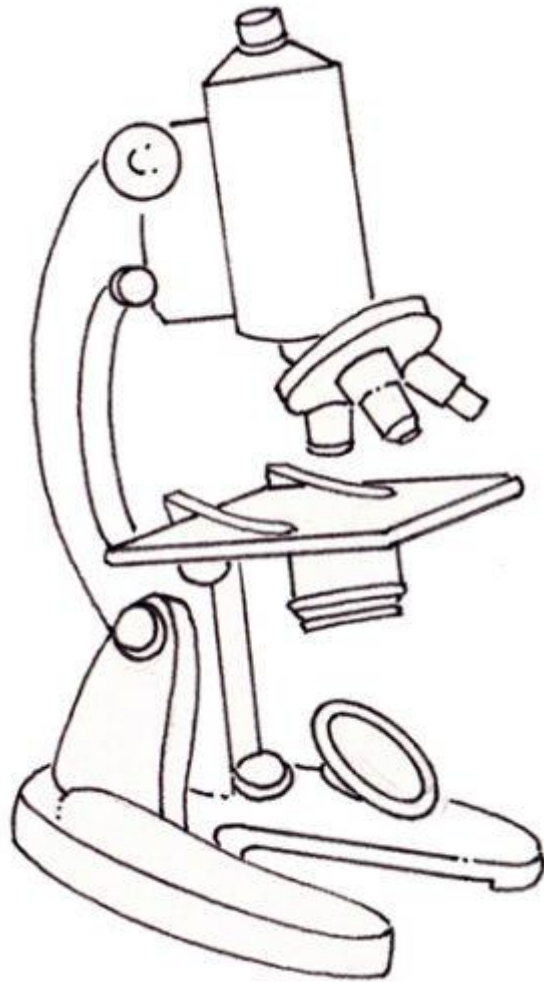
*is a student of **D.Pharm PART-I (ER 2020)** and has satisfactorily completed the Practical prescribed by Board of Examination Authority, Bangalore in **HUMAN ANATOMY AND PHYSIOLOGY** during the academic year.....*

*Reg.No.\_\_\_\_\_*

*Signature of the Subject  
Teacher*

S.NO	DATE	EXPERIMENTS	PAGE.NO
1		Study of compound microscope.	
2		General techniques for collection of blood.	
3		Microscopic examination of Epithelial tissue.	
4		Microscopic examination of cardiac tissue	
5		Microscopic examination of Smooth muscle tissue	
6		Microscopic examination of Skeletal tissue	
7		Microscopic examination of Connective tissue	
8		Microscopic examination of Nervous tissue	
9		Study of human skeletal system- Axial	
10		Study of human skeletal system- Appendicular	
11		Determination of blood group.	
12		Determination of ESR.	
13		Determination of Hemoglobin content of blood.	
14		Determination of bleeding time.	
15		Determination of clotting time.	
16		Determination of WBC count of blood.	
17		Determination of RBC count of blood	
18		Determination Of Differential count of blood.	
19		Recording of blood pressure.	
20		Recording of Body temperature.	
21		Determination of Pulse rate.	
22		Recording Pulse oxygen.	
23		Recording force of air expelled using Peak flow meter.	
24		Determination of BMI.	
25		Study of various systems and organs.	
		A. Respiratory system B. Urinary system C. Endocrine system D. Reproductive system E. Nervous system F. Cardiovascular system G. Skin H. Eye I. Ear	





**TO STUDY THE COMPOUND MICROSCOPE**

**Aim:** To study the compound microscope.

**Requirement:** Microscope.

**Theory:** A compound microscope is an intricate gathering of a combination of lenses that renders a highly maximized and magnified image of microscopic living entities and other complex details or tissues and cells.

**Parts of Compound Microscope:**

**The parts of the compound microscope can be categorized into:**

I Mechanical parts

II. Optical parts

**Mechanical Parts of a Compound Microscope:**

- 1. Foot or base:** It is a U-shaped structure and supports the entire weight of the compound microscope.
- 2. Inclination joint:** It is a joint, wherein the arm is fastened to the compound microscope's pillar. The microscope can be tilted using the inclination joint.
- 3. Nose piece:** The nose piece is circular and a rotating metal part that is connected to the body tube's lower end. The nose piece has three holes wherein the objective lenses are embedded.
- 4. Body tube:** The upper part of the arm of the microscope comprises a hollow and tubular structure known as the body tube. The body tube can be shifted down and up using the adjustment knobs.
- 5. Fine adjustment knob:** It is the smaller knob, which is used for sharp and fine focusing of the object. For accurate and sharp focusing, this knob can be used.
- 6. Coarse adjustment knob:** It is a large knob that is used for moving the body tube down and up for bringing the object to be examined under exact focus.

**II Optical Parts of Compound Microscope:**

- 1. Eyepiece lens or Ocular:** At the top of the body tube, a lens is planted which is known as the eyepiece. On the rim of the eyepiece, there are certain markings such as; SX, 10X, 15X, etc.

These indicate the magnification power. The object's magnified image can be observed with the help of an eyepiece.

**2. Mirror:** A mirror is found attached wither to the pillar or the lower end of the arm. It consists of a concave mirror on one side and a plain mirror on the other side. It can be used for reflection of light rays into the microscope

**3. Objective lenses:** At the bottom of the body tube, there are two objective lenses, which are connected to the revolving nose piece. The three objective lenses are as follows: Oil immersion objective - 100X High power objective - 45X Low power objective 10X Low power objective

#### **Working of a compound microscope:**

- View into the eyepiece. Rearrange the mirror such that, adequate light passes into the microscope.
- The mirror, lenses, stage, and slides should be cleared of dust and be clean..
- Place the slide in the middle of the stage..
- Firmly secure the slide with clips at two edges of the slide to ensure that the slide cannot move. The nose piece is adjusted in such a way that, the low power objective is aligned with the object of focus placed on the slide.
- The coarse adjustment knob can be shifted upwards or downwards such that, the slide is well under focus.
- Turn the fine adjustment knob by moving upwards or downwards to get a clear and sharp image of the object under focus.
- All minute details of the object are observed under low power objective. Necessary diagrams are sketched.
- The nose piece is now turned to bring the high power objective aligning with the object. The fine adjustment knob is tuned as much as possible to get a bright and precise view of the object.
- In high power, the details of the object are observed. Draw the necessary diagrams. The coarse adjustment knob should not be used when the object is being examined in high power as it can crush the slide.

**Result:** The study of compound microscope is done.



**Arterial Sampling**

## **Methods of Blood Collection**



**Venipuncture/  
Venepuncture Sampling**



**Fingerstick Sampling  
Skin puncture**

**GENERAL TECHNIQUES FOR COLLECTION OF BLOOD.**

**Aim:** General techniques for collection of blood.

**Theory:**

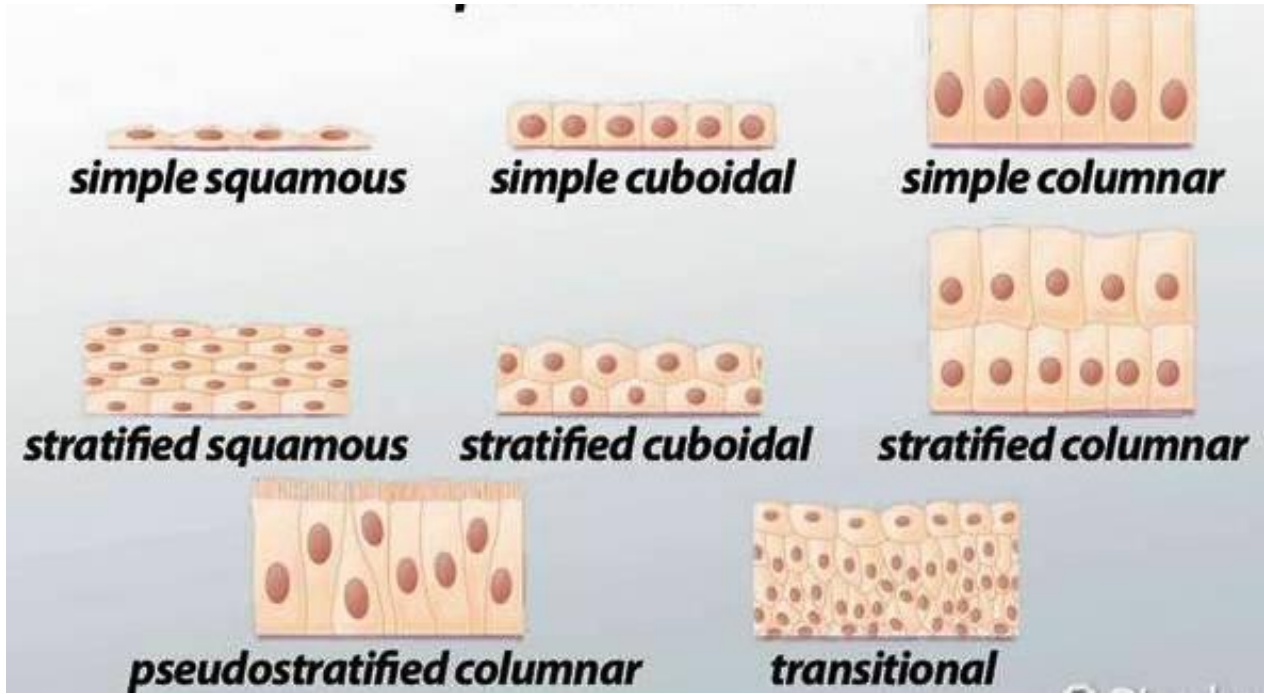
Blood is the important component of human body. It delivers necessary substances such as nutrients and oxygen to the cells and transports metabolic waste products away from those same cells. Blood generally withdrawn and collected to perform a variety of laboratory tests.

Techniques for collection of blood:

1. Arterial Sampling
2. Venipuncture Sampling
3. Fingerstick Sampling

- Arterial blood sample is a blood sample collected from the peripheral artery. The arterial blood sample is mainly collected to analyze the concentration of certain gases dissolved in the blood. This procedure is called an arterial blood gas analysis (ABG).
- Venipuncture is the most common way to collect blood from adult patients. Collection takes place from a superficial vein in the upper limb.
- Fingerstick or fingerpick sampling involves taking a very small amount of blood from the patient, usually from the end of a finger.

**Result:** Study of techniques for collection of blood is done.



## EXPERIMENT NO. 3

DATE:

### MICROSCOPIC STUDY OF EPITHELIAL TISSUE.

**Aim:** Microscopic study of epithelial tissue.

**Requirements:** Microscope, slide.

**Theory:** Epithelial Tissue: (Epithel-Covering, lay on). Epithelial tissue consists of cells arranged in continuous sheets in single or multiple layers. It is lining, covering and glandular tissue of body. Epithelial tissue play different roles in body like, protection, filtration, secretion, absorption and excretion.

There are the following three types of epithelial tissues:

**1. Simple Epithelium:** It contains single layer of cells and is of four types:

**(a) Simple squamous epithelium:** This tissue consists of a single layer of fat cells that resembles a tiled floor when viewed from the apical surface. Simple squamous epithelium is present at sites where the processes of filtration or diffusion occur.

**(b) Simple cuboidal epithelium:** It consists of single layer of cube shaped cells having round and centrally located nucleus. This epithelium is found in organs such as the thyroid gland and kidneys. It performs the functions of secretion and absorption.

**(c) Simple columnar epithelium:** The cell of simple columnar epithelium appears like columns, with oval nuclei near the base. These play a role in absorption and secretion. Simple columnar epithelium cells can be ciliated (containing hair on surface).

**(d) Pseudo-stratified columnar epithelium:** Pseudo-stratified columnar epithelium appears to have several layers because the nuclei of the cells are at various depths. Even though all the cells are attached to the basement membrane in a single layer, some cells do not extend to the upper surface. In pseudo-stratified ciliated columnar epithelium, the cells secrete mucous or bear cilia. Pseudo stratified non-ciliated columnar epithelium contains cells without cilia and lacks mucous cells.

**2. Stratified Epithelium:** It contains multiple layers of cells. It is more durable and can better protect underlying tissues and is of four types:

**(a) Stratified squamous epithelium:** Upper layers of this epithelium are squamous, deep are cuboidal and deeper may be columnar. This type of epithelium is found at sites which receive good deal of abrasion, wear and tear. Its major functions are protection, prevention of water loss and foreign invasion. This type of epithelium is generally present in skin, wet lining of mouth, oesophagus and tongue. upper layer are cuboidal. Stratified cuboidal epithelium serves a role in protection, secretion and absorption.

**(c) Stratified columnar epithelium:** It is also uncommon type of epithelium. The basal layers consist of shortened, irregularly shaped cells; only the upper layer has cells are columnar in shape. This type of epithelium functions in protection and secretion. Present in ducts of glands and conjunctiva of eye.

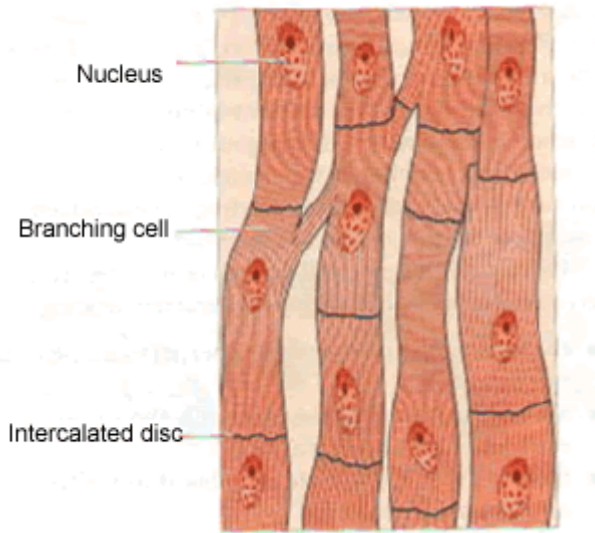
**d) Transitional epithelium:** Transitional epithelium is present only in the urinary system. In its relaxed or up-stretched state, transitional epithelium looks like stratified cuboidal epithelium. As the tissue is stretched, its cells become flatter, giving the appearance of stratified squamous epithelium. It allows the urinary bladder to stretch to hold a variable amount of fluid without rupturing.

**(e) Glandular epithelium:** The function of glandular epithelium is secretion. Glandular cells often lie in clusters deep to the covering and lining epithelium. A gland consists of a single cell or a group of cells that secrete substances into ducts (tubes), on a surface, or into the blood. All glands of the body are classified as either endocrine or exocrine.

**Endocrine glands:** (endo-inside; crine-secretion). These are the glands whose secretions (hormones) enter the interstitial fluid and then diffuse directly into the blood stream without flowing through a duct. The pituitary, thyroid, and adrenal glands are examples of endocrine glands.

**Exocrine glands:** (Exo-outside; crine-secretion). These glands secrete their products into ducts that empty onto the skin surface or the lumen of a hollow organ. The secretions of exocrine glands includes mucous, sweat, oil, ear wax, saliva and digestive enzymes. Examples of exocrine glands include sudoriferous (sweat) glands, which produce sweat to help lower body temperature and salivary glands, which secrete saliva.

**Result:** The human epithelial cells are studied.



**MICROSCOPIC EXAMINATION OF CARDIAC MUSCLE.**

**Aim:** Microscopic examination of cardiac muscle.

**Requirements:** Microscope, slide.

**Theory:** Cardiac muscle (also called heart muscle or myocardium) is one of three types of vertebrate muscle tissue, with the other two being skeletal muscle and smooth muscle. It is involuntary, striated muscle that constitutes the main tissue of the wall of the heart. Cardiac muscle is highly organized and contains many types of cell, including fibroblasts, smooth muscle cells, and cardiomyocytes. Cardiac muscle only exists in the heart. It contains cardiac muscle cells, which perform highly coordinated actions that keep the heart pumping and blood circulating throughout the body.

Cardiac muscle cells or cardiomyocytes are the contracting cells that allow the heart to pump. Cardiac muscle tissue gets its strength and flexibility from its interconnected cardiac muscle cells, or fibres. Most cardiac muscle cells contain one nucleus, but some have two. The nucleus houses all of the cell's genetic material.

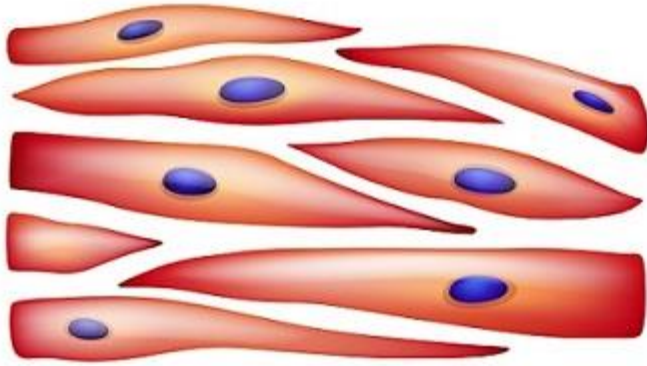
**Four characteristics define cardiac muscle tissue cells:** They are involuntary and intrinsically controlled, striated, branched, and single nucleated. Cardiac muscle is considered to be an involuntary tissue because it is controlled unconsciously by regions of the brain stem and hypothalamus.

**Observations:**

- Faint cross-striations, present both longitudinally and transversely.
- Cardiac muscle fibres are branched, uninucleate and much shorter than the striated muscles
- Presence of junctional complexes is characteristic of cardiac muscles.
- Cardiac muscles are present in the walls of the heart. They are myogenic but are also controlled by autonomic nervous system. They are involuntary in nature and contract rhythmically throughout life without getting fatigued.

**Result:** The cardiac muscles are examined under a microscope

# Smooth Muscle Quiz



**EXPERIMENT NO. 5****DATE:****MICROSCOPIC EXAMINATION OF SMOOTH MUSCLE.**

**Aim:** Microscopic examination of smooth muscle.

**Requirements:** Microscope, slide.

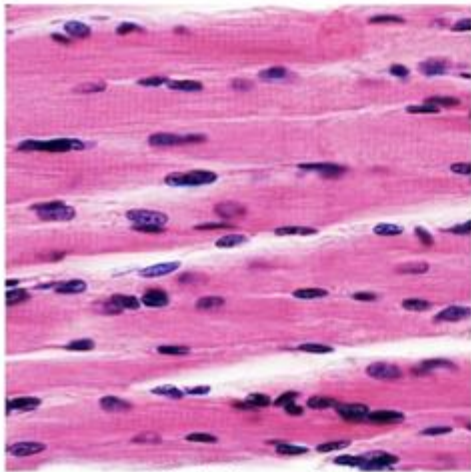
**Theory:** Smooth muscle is a type of muscle tissue which is used by various systems to apply pressure to vessels and organs. Smooth muscle is composed of sheets or strands of smooth muscle cells. These cells have fibers of actin and myosin which run through the cell and are supported by a framework of other proteins. They are also called involuntary muscle.

Smooth muscle fibers are spindle-shaped (wide in the middle and tapered at both ends, somewhat like a football) and have a single nucleus; they range from about 30 to 200  $\mu\text{m}$  (thousands of times shorter than skeletal muscle fibers), and they produce their own connective tissue, endomysium. Smooth muscles have a much stronger ability to contract than skeletal muscles, and are able to maintain contraction longer. Smooth muscle fibers are located in walls of hollow visceral organs, except the heart, appear spindle-shaped, and are also under involuntary control.

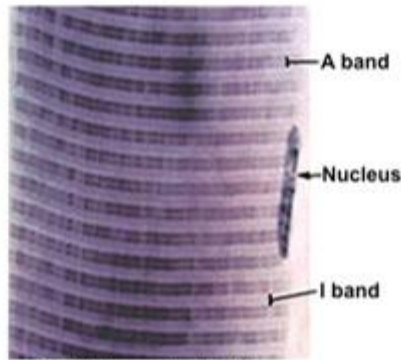
**Observation:**

- The following features in the muscle fibre appears: Smooth muscle cells are extremely long and spindle shaped. They have an oval nucleus located centrally in the cytoplasm.
- Sarcolemma is absent.
- Since these fibres do not show dark and light bands, they are called unstriated muscles.
- Smooth or unstriated muscles are present in the dermis of skin and in the wall of various hollow visceral organs like alimentary canal, urinary bladder, etc. They are usually controlled by autonomic nervous system. Their contraction process is slow and not under voluntary control and therefore they are also called involuntary muscles.

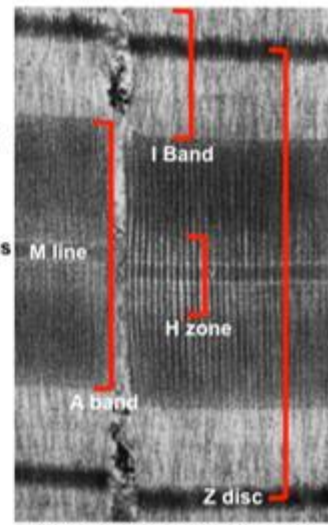
**Result:** The smooth muscles are studied under the microscope.



Skeletal muscle



Skeletal muscle striations



Sarcomere = Z disc to Z disc

**MICROSCOPIC EXAMINATION OF SKELETAL MUSCLE.**

**Aim:** Microscopic examination of skeletal muscle.

**Requirements:** Microscope, slide.

**Theory:** Skeletal muscles are voluntary muscles under the control of the somatic nervous system. Skeletal muscle is found between bones, and uses tendons to connect the epimysium to the periosteum, or outer covering, of bone. Skeletal muscle is adapted and shaped in many different ways, which give rise to complex movements. Skeletal muscles enable humans to move and perform daily activities. They play an essential role in respiratory mechanics and help in maintaining posture and balance. They also protect the vital organs in the body.

A skeletal muscle contains multiple bundles of muscle fascicles of muscle fibers. The individual fibers and each muscle are surrounded by connective tissue layers of fasciae. Muscle fibers are formed from the fusion of developmental myoblasts in a process known as myogenesis. Muscle fibers are cylindrical and have more than one nucleus. They also have multiple mitochondria to meet energy needs. Skeletal muscle cells are long, cylindrical, and striated. They are multinucleated meaning that they have more than one nucleus. This is because they are formed from the fusion of embryonic myoblasts. Each nucleus regulates the metabolic requirements of the sarcoplasm around it. bole

**Observations:**

- Muscle fibres are elongated, cylindrical and multinucleated (syncytium).
- These fibres are enclosed in a membrane called sarcolemma.
- Several dark and light bands are alternately arranged perpendicularly to the long axis of the fibre. Presence of these bands alternately produce striations, hence these muscles are called striated muscles.

**Result:** The skeletal muscles are observed under the microscope.

## TYPES OF CONNECTIVE TISSUE



BLOOD



LOOSE  
CONNECTIVE



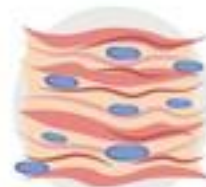
ADIPOSE



CARTILAGE



BONE



DENSE

**MICROSCOPIC STUDY OF CONNECTIVE TISSUES**

**Aim:** Microscopic study of connective tissues

**Requirements:** Microscope, slide.

**Theory:** Connective tissue is one of the most abundant and widely distributed tissues in the body. It binds together, supports and strengthens other body tissues, protects and insulates internal organs, serves as the major transport system within the body (blood, a fluid connective tissue). It is the primary location of stored energy reserves (adipose or fat tissue) and is the main source of immune responses.

**Classification of connective tissues:** Connective tissues can be divided as

**1) Loose connective tissue:** In loose connective tissue, fibres present between cells are loosely arranged. Loose connective tissue contains more cells and fewer fibres

**(a) Areolar connective tissue:** (Areola-space). This is one of the most widely distributed connective tissues in body. It contains several types of cells and all the three types of fibres embedded in ground substance. Due to areolar nature, it acts as reservoir for water, salts and nutrient. It is also called packing material as it is present in almost every body structure, eg skin, mucous membrane. Its function is to provide strength, elasticity and support.

**(b) Adipose connective tissue:** (Adipo-fat). This tissue is made up of specific cells called Adipocytes. These adipocytes are specialized to store fat and triglycerides. Adipose tissue forms layer beneath skin which insulates the body from heat and cold, protects the kidney by capsule of fat and Cushion's eye ball socket. It also serves as energy reserve, supports and protects several organs.

**(c) Reticular connective tissue:** It is delicate network of reticular fibres and reticular cells which forms internal frame work of certain soft organs like liver and spleen. It functions to filter and remove worn out blood cells and microbes in lymph nodes.

**2) Dense connective tissue:** Dense connective tissue contains more numerous, thicker and denser fibres which are packed more closely and fewer cells than loose connective tissue. Cells present mainly in dense connective tissue are fibroblast. There are three types: dense regular connective tissue, dense irregular connective tissue and elastic connective tissue

**(a) Dense regular connective tissue:** It contains mainly collagen fibres regularly arranged in bundles and few fibroblasts are present which are arranged in rows in between the bundle

fibres. It forms tendons (attaches bone to muscle) and ligaments (attaches bone to bone). It also provides strong attachments between various structures.

**Dense irregular connective tissue:** It contains collagen fibers which are irregularly arranged with few fibroblast present between them. It is present in sheets beneath skin and around muscles, joint capsules, etc. It provide pulling strength in many directions

**(c) Elastic connective tissue:** It is made up of branched elastic fibers and fibroblasts. It is present in lungs, elastic arteries, trachea, etc. Due to its elastic fibers, it allows stretching of various organs and recoils after stretching.

**3) Cartilage:** It consists of dense network of collagen and elastic fibers. It can bear more stress than loose and dense connective tissue. It contains few cells (chondrocytes) and large amount of extracellular material. It lacks blood supply. It is of three types: hyaline cartilage, elastic cartilage, and fibrocartilage.

**(a) Hyaline cartilage:** Hyaline cartilage is the most abundant cartilage in the body. It consists of chondrocytes embedded in fine collagen fibers. Extracellular matrix appears glassy, bluish white and shiny substance. It provides flexibility and support and at joints, reduces friction and absorbs shock. Hyaline cartilage is the weakest of the three types of cartilage.

**(b) Fibro-cartilage:** Chondrocytes are scattered among clearly visible, thick bundles of collagen fibres within the extracellular matrix of fibro-cartilage. With a combination of strength and rigidity, this tissue is the strongest of the three types of cartilage. One location of fibro-cartilage is the intervertebral discs, the discs between the vertebrae (backbones). Its main function is to support and join structures.

**(c) Elastic cartilage:** It consists of the chondrocytes located within a thread-like network of elastic fibres within the extracellular matrix. Elastic cartilage provides strength and elasticity and maintains the shape of certain structures, such as the external ear.

**4) Bone Tissue:** The bone supports soft tissues, protects delicate structures and works with skeletal muscles to generate movement. Bones store calcium and phosphorus, house red bone marrow, which produces blood cells; and contains yellow bone marrow, a storage site for triglycerides. The basic unit of compact bone is an osteon or haversian system. Each osteon has four parts: lamellae, lacunae, canaliculi and central (haversian) canal.

**5) Liquid connective tissue:** Liquid connective tissue is of two types:

**(a) Blood tissue (or simply blood):** It is a connective tissue with a liquid extracellular matrix. The liquid extracellular matrix is called blood plasma which is a pale yellow fluid that consists

mostly of water with a wide variety of dissolved substances like nutrients, wastes, enzymes, plasma proteins, hormones, respiratory gases and ions. Cells are suspended in the blood plasma which includes red blood cells (erythrocytes), white blood cells (leukocytes) and platelets (thrombocytes).

**(b) Lymph:** It is the extracellular fluid that flows in lymphatic vessels. It is a connective tissue that consists of several types of cells in a clear liquid extracellular matrix that is similar to blood plasma but with much less protein.

**Result:** The human connective tissues are studied

**MICROSCOPIC EXAMINATION OF NERVOUS TISSUES**

**Aim:** Microscopic examination of nervous tissues

**Requirements:** Microscope, slide.

**Theory:** Nervous tissue detects changes in conditions inside and outside the body and responds by generating action potentials (nerve impulses) that activate muscular contractions and glandular secretions. Nervous tissue consists of only two types of cells: Neurons and Neuroglia.

1) **Neurons:** Neurons are the cells which are sensitive to various stimuli. These convert various stimuli into electrical signals, called action potentials (nerve impulses) and conduct these action potentials to other neurons, muscle tissue or glands.

Neurons consist of three parts:

(a) **Cell body:** It contains the nucleus and other organelles.

(b) **Dendrites (dendr-tree):** These are tapering, branched and short processes and are the receiving portion of a neuron.

(c) **Axon:** Single, thin, cylindrical and long process. It is the output portion of a neuron which conducts nerve impulses toward another neuron or to some other tissues.

2) **Neuroglia:** These cells do not generate or conduct nerve impulses but provide protection and support to neurons. Neuroglia cells are of six types: astrocytes, oligodendrocytes, microglia, ependymal cells, Schwann cells and satellite cells.

**Result:** The human nervous tissues are studied.

## **EXPERIMENT NO. 9**

**DATE:**

### **TO STUDY THE ANATOMY AND PHYSIOLOGY OF HUMAN SKELETAL.**

**Aim:** To study the anatomy and physiology of human skeletal.

**Theory:** The entire framework of bones and their cartilages, along with ligaments and tendons, constitutes the skeletal system. Supports soft tissues and provides attachment for skeletal muscles. Skeletal system protects internal organs, assists in movement along with skeletal muscles, stores and releases minerals, contains red bone marrow which produces blood cells, contains yellow bone marrow (which stores fats). The human skeletal is divided into two divisions: axial skeleton and appendicular skeleton.

**Axial Skeleton:** Axial skeleton is the framework of bones which lies along a vertical axis. It consists of the following bones;

**(a) Skull:** Bony framework of the head is called Skull.

The skull, with its 22 bones, rests on the superior end of the vertebral column (backbone).

The bones of the skull are grouped into two categories:

#### **CRANIAL BONES (8 bones)**

- 1 Frontal bone
- 2 Parietal bones
- 2 Temporal bones
- 1 Occipital bone
- 1 Sphenoid bone
- 1 Ethmoid bone

#### **FACIAL BONES (14 bones)**

- 2 Zygomatic bone

2 Lacrimal bones

2 Palatine bones

2 Nasal bone

2 Maxillae

2 Inferior nasal conchae

1 Mandible

1 Vomer

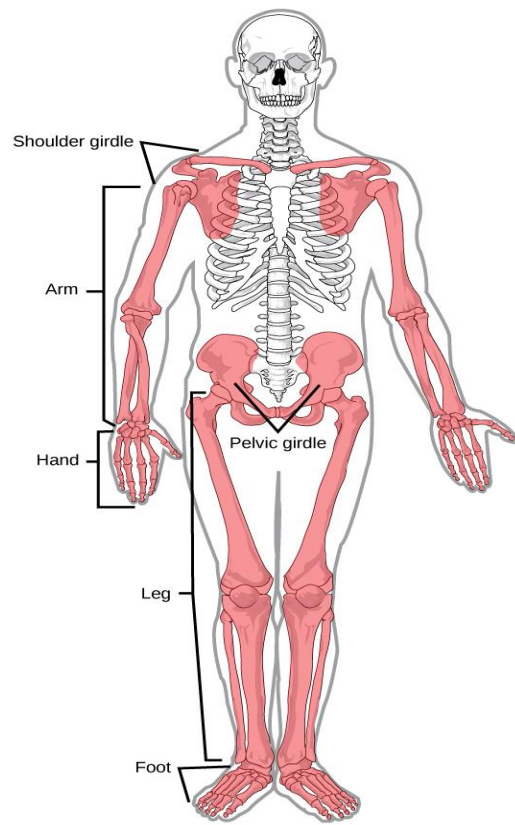
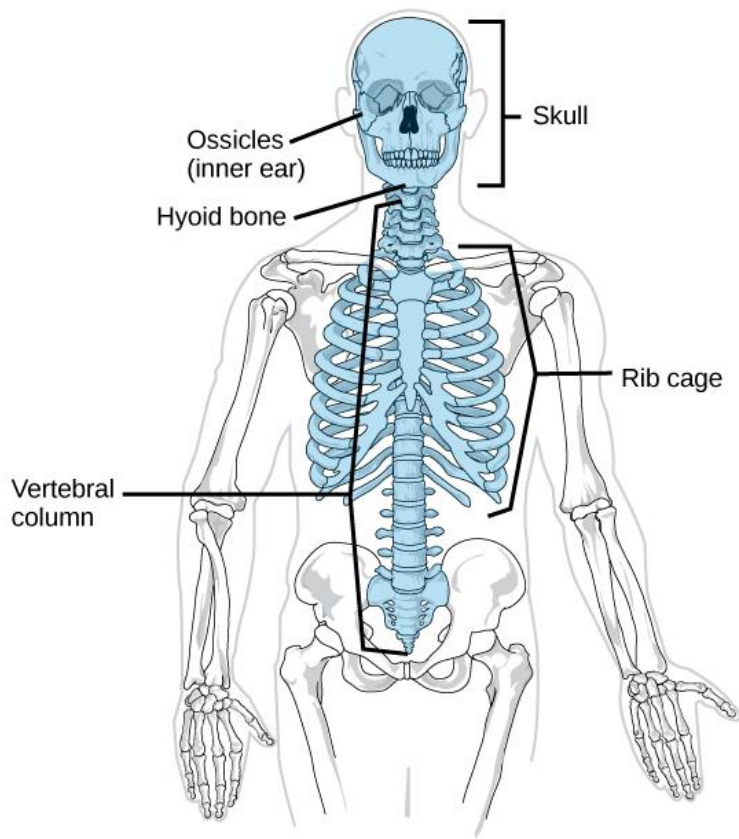
**(b) Vertebral Column:**

Vertebral column is also called spinal column, spine or back bone, composed of a series of 33 bones called vertebrae. Extends from skull to pelvic bones. Functions as strong flexible rod which can move forward, backward, sideways and rotate. It encloses and protects spinal cord, supports the head, and serves as a point of attachment for the ribs, pelvic girdle and muscles of the back and upper limbs. These 33 bones are categorized as first 7 are called cervical vertebrae, next 12 are called thoracic vertebrae, next 5 are called lumbar, next 5 are called sacra vertebrae which gets fused to form one sacrum, and last 4 are called coccyge vertebrae which fused to form coccyx.

**(c) Thorax:**

The term thorax refers to the entire chest. The thoracic cage is a bony enclosure formed by the sternum, ribs and the bodies of the thoracic vertebrae. Also have costal cartilages which attach the ribs to the sternum. It encloses and protects the organs (heart, lungs and blood vessels) in the thoracic cavity and provides support to the bones of the upper limbs. Divided mainly into two parts i.e., Sternum and Ribs.

**Result:** The human axial skeletal system is studied.



**EXPERIMENT NO. 10****DATE:****TO STUDY HUMAN SKELETAL-APPENDICULAR SKELETAL**

**Aim:** To study Human skeletal-Appendicular skeletal.

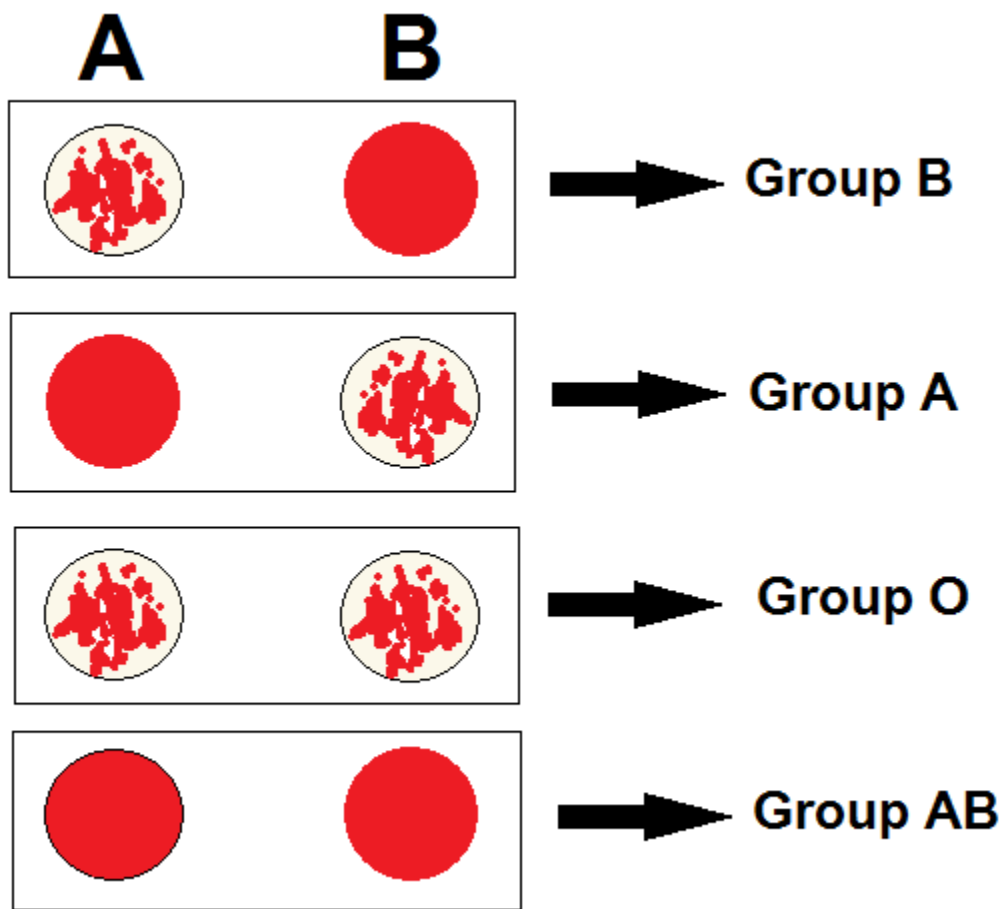
**Theory:** The appendicular skeleton includes the bones that make up the upper and lower limbs as well as the bones of the two girdles that attach the limbs to the axial skeleton. It consists of the following bones: (a) Pectoral girdle: The human body has two pectoral or shoulder girdles that attach the bones of the upper limbs to the axial skeleton. Each pectoral girdle consists of a clavicle and a scapula.

(b) Upper limbs: Each upper limb has 30 bones in three locations: Humerus in the arm, Ulna and radius in the forearm, 8 carpals in the carpus (wrist), 5 metacarpals in the metacarpus (palm), 14 phalanges (bones of the digits) in the hand.

(c) Pelvic or Hip girdle: Consist of two bones called coxal bones or hip bones. The hip bones unite anteriorly at a joint called the pubic symphysis. They unite posteriorly with the sacrum at the sacroiliac joints. Complete ring composed of hip bones, pubic symphysis and sacrum forms a deep, basin like structure called the bony pelvis.

(d) Lower limbs: Each lower limb has 30 bones in four locations. Femur in the thigh, The Patella (knee cap), The Tibia and Fibula in the leg, 7 Tarsals in the tarsus (ankle), 5 Metatarsals in the metatarsus, 14 Phalanges (bones of the digits) in the foot.

**Result:** The human skeleton and bones are studied.



**EXPERIMENT NO. 11****DATE:****TO DETERMINE BLOOD GROUP OF GIVEN SAMPLE****Aim:** To determine blood group of given sample**Requirements:** Porcelain tile, blood, Antisera A, Antisera B, Anti-D sera.

**Theory:** The surfaces of erythrocytes contain a genetically determined assortment of antigens composed of glycoproteins and glycolipids. These antigens, called agglutinogens, occur in characteristic combinations. Based on the presence or absence of various antigens, blood is categorized into different blood groups. Within a given blood group, there may be two or more different blood types. There are at least 24 blood groups and more than 100 antigens that can be detected on the surface of red blood cells. Two major blood groups are ABO and Rh

**Blood Group:** The ABO blood group is based on two glycolipid antigens called A and B. A person whose RBCs display only antigen A has type A blood. Those who have only antigen B are type B. Individuals who have both A and B antigens are type AB, those who have neither antigen A nor B are type O. Blood plasma usually contains antibodies called agglutinins that react with the A or B antigens if the two are mixed. These are the anti-A antibody, which reacts with ABO antigen A, and the anti-B antibody, which reacts with antigen B.

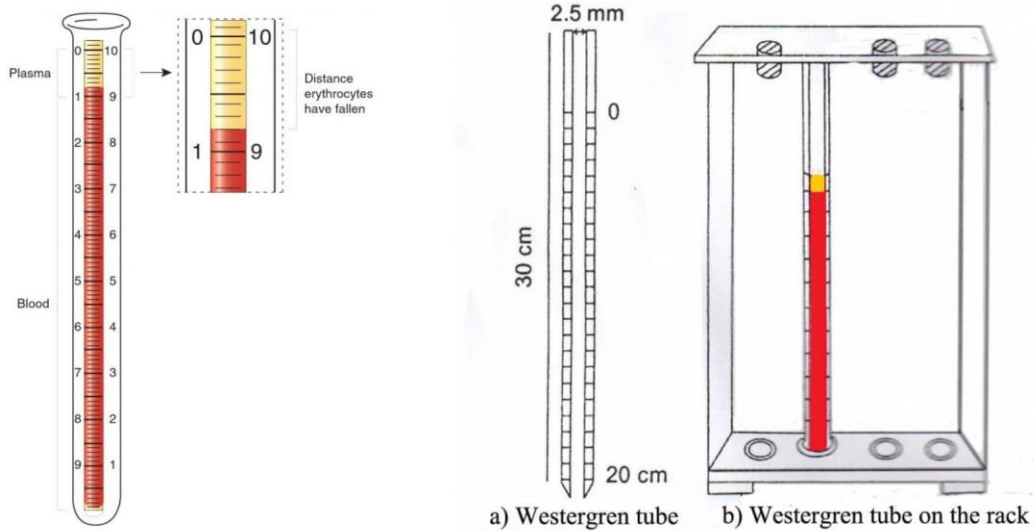
**Procedure:**

1. Take a clean and dry porcelain tile and put a drop of Antisera A, Antisera B and Anti-D sera respectively.
2. Add one drop of blood to each and mix well. Wait for a minute and observe agglutination.
3. If there is agglutination, it is confirmed under microscope.
4. If agglutination is present in anti-A, then blood belongs to group A.
5. If agglutination is present in anti-B, then blood belongs to B blood group.
6. If agglutination is present in both, then blood belongs to AB blood group.
7. If agglutination is absent in both, then blood belongs to O blood group.

8. If agglutination is presented in anti-D, then blood is Rh +ve, otherwise Rh-ve.

**Result:** The blood group of given sample is found to be .....

## Erythrocyte Sedimentation Rate (ESR)



**DETERMINATION OF ERYTHROCYTE SEDIMENTATION RATE**

**Aim :** Determination Of Erythrocyte Sedimentation Rate

**Requirements :** Anticoagulated blood (EDTA, double oxalate), Pauster pipette, timer, Wintrobe's tube, Wintrobe's stand.

**Theory:** The erythrocyte sedimentation rate (ESR) is a common haematological test for non-specific detection of inflammation that may be caused by infection, some cancers and certain autoimmune diseases. ESR is defined as the rate at which RBCS sediment in a period of one hour.

**Principle:** When anticoagulated blood is allowed to stand in a narrow vertical glass tube, undisturbed for a period of time, the RBCS—due to the gravitational force, settled in the bottom of tube from the plasma. The rate at which they settle is measured as the number of millimetres of clear plasma present at the top of the column after one hour (mm/hr).

**Procedure:**

1. Mix the blood with an anticoagulant.
2. By using Pauster pipette blood is transferred in to Wintrobe's tube. The tube is kept in Wintrobe's stand undisturbed for a period of one hour. The ESR is determined after one hour.

Westergren's method: It is better than Wintrobe's method. The reading obtained is magnified as the column is lengthier. The Westergren's tube is open at both ends. It is 30 cm in length and 2.5 mm in diameter. The lower cm is marked with 0 at the top and 200 at the bottom. It contains about 2 ml of blood. Normal Value: Males: 0-10 mm/hr, females: 0-15mm/hr.

**Clinical significance of ESR:**

ESR increases in all types of anaemia except sickle cell anaemia.

ESR increases in HIV, tuberculosis (TB), arthritis.

ESR decreases in polycythemia, dehydration, Dengue fever.

**Result:** Erythrocyte Sedimentation Rate (ESR) of given sample is found



**TO DETERMINE HAEMOGLOBIN CONTENT**

**Aim:** To determine haemoglobin content.

**Requirements:** Sahli's haematometer, N/10 HCl, blood sample, distilled water.

**Principle:** Haemoglobin is converted into acid haematin by the addition of N/10 HCl. Brown colour appears, this brown colour is compared with the standard brown glass reference blocks. Acid haematin formation depends upon the amount of haemoglobin present in blood sample.

**Theory:** Each RBC contains about 280 million haemoglobin molecules. A haemoglobin molecule consists of a protein called globin, composed of four polypeptide chains (two alpha and two beta chains) and a ring like non-protein pigment called a heme is bound to each of the four chains. At the centre of each heme ring is an iron ion (Fe) that can combine reversibly with one oxygen molecule, allowing each haemoglobin molecule to bind four oxygen molecules. Each oxygen molecule picked up from the lungs is bound to an iron ion. As blood flows through tissue capillaries, the iron-oxygen reaction reverses. Haemoglobin releases oxygen, which diffuses first into the interstitial fluid and then into cells.

**Procedure:**

1. Place N/10 hydrochloric acid in graduated tube up to lowest marking.
2. Clean the tip of finger with cotton soaked in spirit. Take a sterile lancet and make a sharp prick. Wait for some time until a full drop is formed.
3. Draw blood in Sahli's pipette up to 20  $\mu$ l mark. Care must be taken to avoid air bubbles.
4. Then pour the blood into Hb tube, wait for some time for acid to react with Hb and change into acid haematin. Brown colour is formed.
5. Then add distilled water drop by drop. Mix well until the colour matches with
6. The level of liquid is noted at its lowest meniscus and the reading corresponding to its level of scale is read in gm/100 ml or in gram percentage.

Normal Values: Males = 14 to 18 gm%

Females = 13 to 14 gm% Children = 10 to 13 gm%

**Result:** The Hb content of given sample is      gm %.

**NORMAL VALUE: 2 – 8 MINUTES**

FIBRIN THREAD →



**CLOTTING TIME OF BLOOD**

**Aim:** To determine the clotting time of blood.

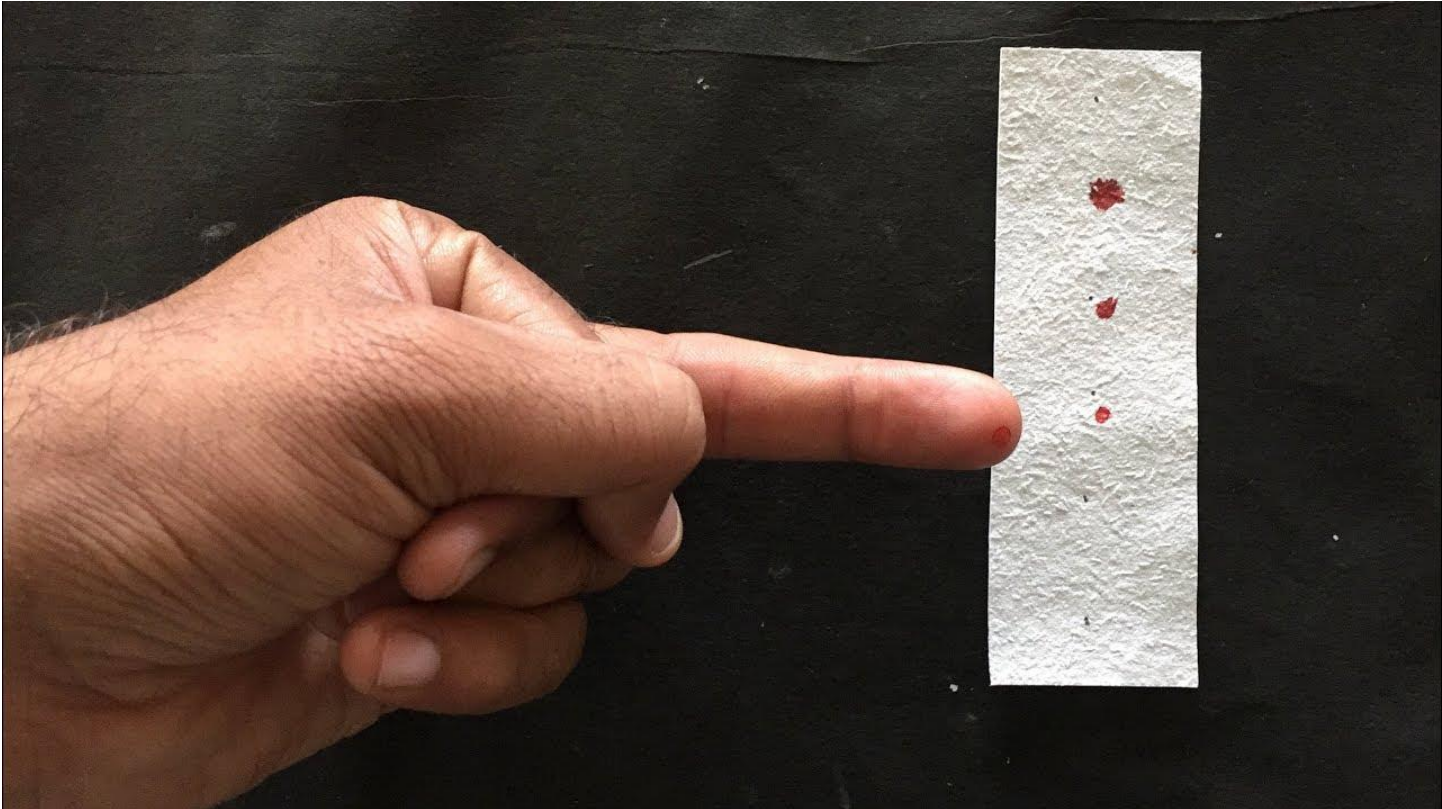
**Requirements:** Needle, capillary tube..

**Theory:** Normally, blood remains in its liquid form as long as it stays within its vessels. When blood is shed it loses its fluidity in a few minutes and sets into a semi solid jelly. This phenomenon is called coagulation or clotting. The normal clotting time is 3-8 min. The clotting involves series of chemical reactions that results in formation of fibrin threads. Clotting involves several substances known as clotting factors. Generally clotting time determine by capillary method

**Procedure:**

1. Prick the finger and note the time.
2. Draw a small amount of blood in the capillary tube.
3. Stop watch is started. Break the tube at the end of every 30 seconds.
4. Note the time when a clot is seen between the two ends of time.
5. Normal value is 4-8 minutes.

**Result:** The clotting time is .....minutes.



**BLEEDING TIME OF BLOOD**

**Aim:** To determine the bleeding time of blood. Requirements: Needle, capillary tube.

**Theory:** The time required for complete stopping of blood flow from the punctured blood vessels called the bleeding time. Normally it is 1-4 minutes for a normal human's blood. Normal clotting time and bleeding time values differ because bleeding time is the time for stopping bleeding by the formation of fibrin network on the surface of punctured skin; that is it is the surface phenomenon. Generally bleeding time determine by Duke's method.

Haemostasis is a sequence of responses that stops bleeding. When blood vessels are damaged or ruptured, the haemostatic response must be quick, localized to the region of damage, and carefully controlled in order to be effective. Three mechanisms reduce blood loss:

- (1) Vascular spasm
- (2) Platelet plug formation
- (3) Blood clotting (coagulation)

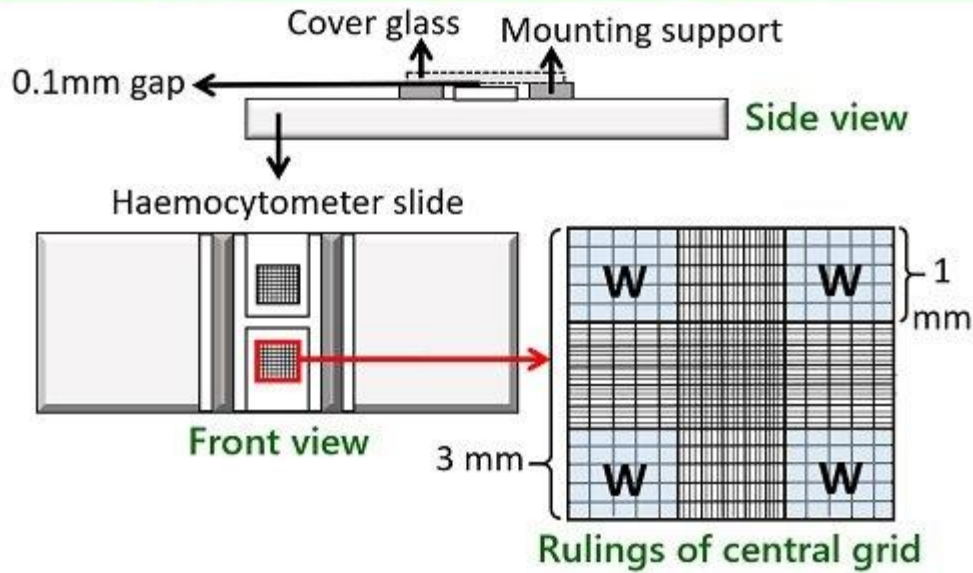
When successful, haemostasis prevents haemorrhage, the loss of a large amount of blood from the vessels.

**Procedure:****For bleeding time:**

- 1 Prick the finger with the needle.
2. Note the time.
3. Wipe the blood from bleeding point with filter paper every 30 seconds until bleeding stops.
4. Note the time taken to stop bleeding.
5. Normal value is 2-4 minutes.

**Result:** The bleeding is.....minutes.

# Improved Neubauer's Chamber



## Calculations:

$$\begin{aligned}
 \text{Number of WBCs in } 0.4 \text{ mm}^3 &= n \\
 \text{Number of WBCs in } 1 \text{ mm}^3 &= \frac{n \times 10}{4} \\
 \text{Dilution factor} &= 20 \\
 \therefore \text{Number of WBCs per mm}^3 (\mu\text{l}) &= \frac{n \times 10}{4} \times 20 \\
 &= n \times 50
 \end{aligned}$$

**DETERMINATION OF WBC COUNT OF BLOOD**

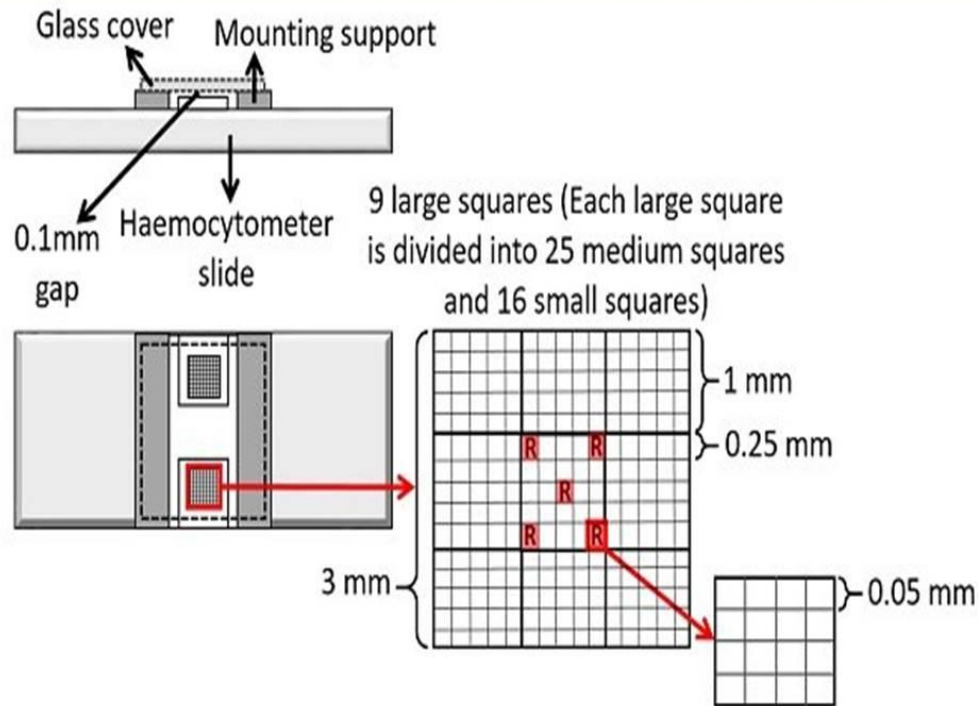
**Aim:** To find out the number of WBCS present in given sample of blood. Requirements: WBCS pipette. Neubauer counting chamber, cover slip, WBC fluid, blood and microscope.

**Theory:** White blood cells or leukocytes (leuko-white, cyte-cell) have nuclei and do not contain haemoglobin, WBCS are classified as either granular or agranular, on whether they contain cytoplasmic granules that are made visible by staining, when viewed through a light microscope. Granular leukocytes include; depending eosinophils, basophils and neutrophils whereas Agranular leukocytes include; lymphocytes and monocytes. There are 5000-10000 WBCs present per jil of blood.

**Procedure:**

1. Sterilize the fingertip with spirit.
2. Make a prick with lancet and suck the blood using WBC pipette up to 0.5 mark.
3. Excess of blood sticking to the tip of the pipette is wipe out immediately.
4. Draw diluted fluid up to 11 mark.
5. Rotate the pipette between thumb and forefinger for one minute.
6. Discard the first few drops.
7. Place the counting chamber on the stage of microscope.
8. Apply the cover slip over the neubauer rulings.
9. Apply a drop of fluid by just touching the edge of chamber.
10. Wait for 5 minutes for the cells to settle down.
11. Count the WBCs over four big cover squares under 10X and calculate the WBCs in 1 ml.

**Result:** The given sample of blood contains.....cells/ul.



## Calculation :

$$\text{RBCs} = \frac{\text{Number of RBCs/cu.mm of whole blood} \times \text{Dilution}}{\text{Area Counted} \times \text{Depth of the Fluid}}$$

Here,

$$\text{Dilution} = 20$$

$$\text{Area Counted} = 5 \times 0.04 \text{ Sq.mm} = 0.2 \text{ Sq.mm}$$

$$\text{Depth of the fluid} = 0.1 \text{ mm (Constant)}$$

Hence,

$$\text{Number of RBCs/cu.mm of whole blood}$$

$$= \frac{\text{Number of RBC Counted} \times 200}{0.2 \text{ Sq.mm} \times 0.01 \text{ mm}}$$

$$= \text{Number of RBC Counted} \times 10000$$

**EXPERIMENT NO. 17**

**DATE:**

**DETERMINATION OF RBC COUNT OF BLOOD**

**Aim:** To find out the number of RBCS present in given sample of blood..

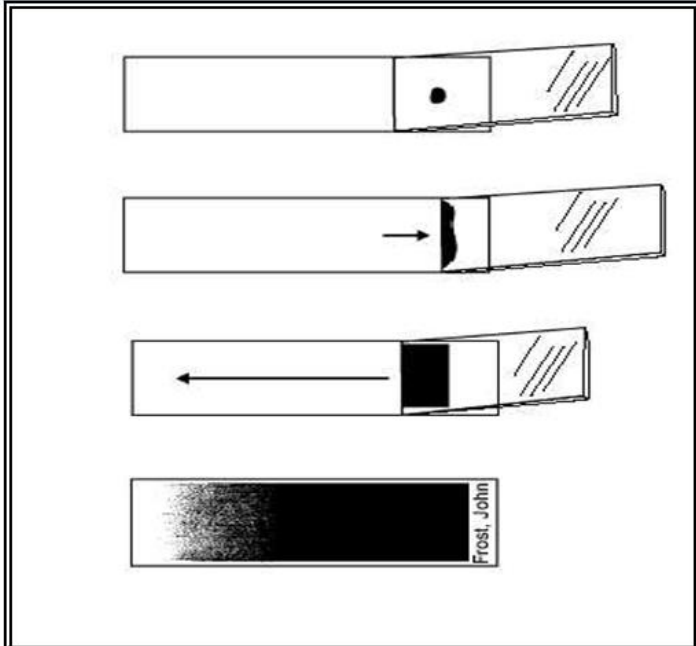
**Requirements:** RBCs pipette, Neubauer counting chamber, cover slip, RBC counting Alm: Raid blood and microscope.

**Theory:** Red blood cells (RBCs) or erythrocytes (erythro-red; cyte-cell) are biconcave discs with a diameter of 7-8 um. These contain the oxygen carrying protein which is a pigment that gives whole blood its red colour. RBCs lack a nucleus and other organelles and can neither reproduce nor carry on extensive metabolic activities. They have strong and flexible plasma membrane, which allows them to deform without rupturing as they squeeze through narrow capillaries. A healthy adult male has about 5.4 million red blood cells per microlitre (ul) of blood and a healthy adult female has about 4.8 million red blood cells.

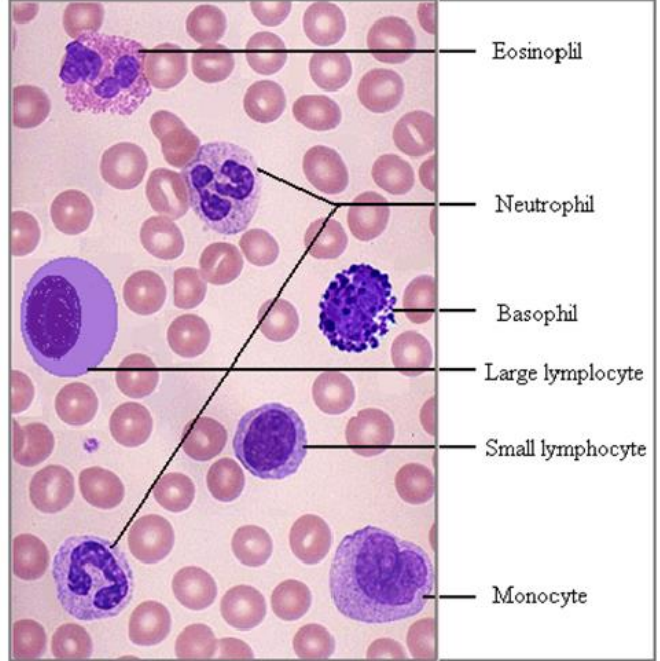
**Procedure:**

1. Sterilize the finger tip with spirit.
2. Make a prick with lancet and suck the blood using WBC pipette up to 0.5 mark.
- 3 Excess of blood sticking to the tip of the pipette is wipe
4. Draw diluted fluid up to 11 mark.
5. Diluted fluid is either formalin citrate or hayems fluid.
6. Rotate the pipette between thumb and forefinger for one minute.
7. Discard the first few drops.
8. Place the counting chamber on the stage of microscope.
9. Apply the cover slip over the neubauer rulings.
10. Place one drop over counting chamber.
- 11 Apply a cover slip over tie without any air bubbles.
12. Place the chamber under the microscope. Count the RBC in 5 small squares of the main central squares which contain 16 smaller squares.
13. The cells touching upper and the left lines alone should be counted to avoid repetition.

**Result:** The given sample contains.....million cells per ml.



**Preparation of blood smear**



**Morphology of several types of leukocytes**

**DIFFERENTIAL COUNT OF BLOOD**

**Aim:** To determine differential count of blood.

**Requirements:** Microscopic slides, 70% alcohol, pricking needle, Leishman's stain, microscope with oil immersion lens and mechanical stage and cedar wood oil.

**Theory:** White blood cells or leukocytes (leuko-white) have nuclei and do not contain haemoglobin. WBCs are classified as either granular or agranular, depending on whether they contain cytoplasmic granules that are made visible by staining, when a light microscope. Granular leukocytes include; eosinophils, basophils and neutrophils whereas Agranular leukocytes include lymphocytes and viewed through monocytes. There are 5000-10000 WBCs present per microliter of blood.

**Granulocytes or Granular Leukocytes:**

**1. Eosinophil:** These produce red-orange stain with acidic dyes. Nucleus of eosinophil has two lobes connected by a thick strand of chromatin. Eosinophils phagocytize antigen-antibody complexes and are effective against certain parasitic worms.

**2. Basophil:** These produce blue-purple stain with basic dyes. The granules obscure the nucleus, which has two lobes. These substances intensify the inflammatory reaction and are involved in hypersensitivity (allergic) reactions.

**3. Neutrophil:** The granules are smaller, evenly distributed and pale lilac in colour. Nucleus has 2-5 lobes which are connected by very thin strands of chromatin. Neutrophils respond most quickly to tissue destruction by bacteria. They are capable to carry out phagocytosis.

**Agranulocytes or Agranular Leukocytes:**

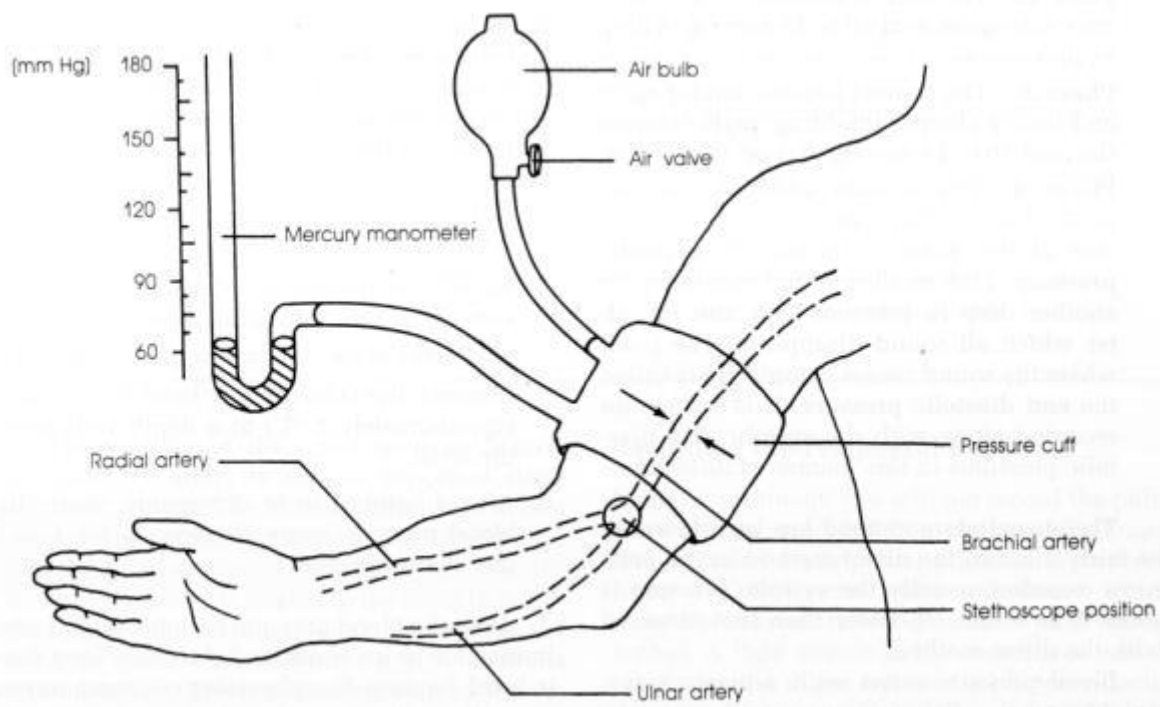
**1. Lymphocytes:** The nucleus is round or slightly indented and stains darkly. The cytoplasm stains sky blue and forms a rim around the nucleus. Diameter of lymphocytes varies from 6-9  $\mu\text{m}$  to 10-14  $\mu\text{m}$ .

**2. Monocytes:** The nucleus of monocyte is kidney shaped or horse shoe shaped. The cytoplasm is blue-grey and has a foamy appearance. Diameter of monocyte is 12-20  $\mu\text{m}$ .

**Procedure:**

1. Keep the microscope ready. Clean two slides properly with xylol.
2. Sterilize the finger tip as usual and give a bold prick to obtain a small drop of blood. Then, touch it to the slide, the slide at one end in the centre at least 1 cm away from the narrow border.
3. Place the slide on the smooth surface of a table such a way that the drop of blood is in the front. Hold the spreader glass slide along its long edge to form an acute angle of 30-40° on the right side.
4. Push the spreader slide ahead towards the left end with quick and uniform motion and a light even pressure. The blood flows along with the spreader slide
5. Dry the film in air, and then pour the Leishman's stain on the film drop wise to cover the film. Allow the stain to act for one minute.
6. Place double the amount of water on this slide with stain on it. Mix the stain thoroughly with the water by blowing. Now allow this to act for three minutes (care should be taken such that the stain is not getting dried up).
7. Wash the stain in running tap water for 5 minutes till the slide gets pinkish to form a film.
8. Drain water out and allow slide to dry.
9. Place a drop of cedar-wood oil on the portion of film which is apparently good. Examine the slide under the oil immersion microscope lens appearance.
10. Prepare an observation chart having 100 squares and after identifying each cell, it is entered by writing letter say N (neutrophil), E (eosinophil), B (basophil), M (monocyte) and L (lymphocyte). Identify all the cells in the view without ignoring any cell. Move the slide in definite direction and identify the cells till it reaches 100.
11. Obtain the differential WBC count directly from the observation chart by summing up total number of differential WBCs.

**Result:** The blood sample is observed for granular leukocytes (neutrophil, eosinophil, basophil monocyte and lymphocyte).



**RECORDING BLOOD PRESSURE**

**Aim:** To record the blood pressure of a subject.

**Requirements:** Stethoscope and a mercury sphygmomanometer

**Theory:** Blood pressure (B.P.) is defined as the lateral pressure exerted on the walls of the vessels by the contained blood. This is due to the muscularity and elasticity of the walls of blood vessels. The blood pressure also depends upon the force exerted by the heart when it pumps the blood. The maximum pressure during systole is defined as systolic blood pressure whereas the minimum pressure during diastole is defined as the diastolic blood pressure. The difference between the systolic and diastolic blood pressure is described as pulse pressure. The average systolic blood pressure in healthy adult is 100-140 mmHg, the average diastolic blood pressure is 80-100 mmHg. The average pulse pressure is about 30-50 mmHg.

There are two methods which are used to measure blood pressure using sphygmomanometer, which are:

- A. Palpatory method (feeling pulse).
- B. Auscultatory method (hearing pulse).

**Procedure:**

1. Ask the subject to sit down or lie down at ease on the couch in the supine position. Remove the garments round the arm, place the arm on a table and adjust position such that it is level of the heart.
2. Tie the cuff of sphygmomanometer around the arm. It should be neither too tight to cause any discomfort to the subject, nor too loose to allow its movement round the arm.
3. Feel the artery and mark its course in the cubital fossa. Also feel and mark the radial pulse at the place where it is feel well.
4. Place the manometer by the side of the subject, between his arm and the body. Tight the screw of the rubber pump and press the pump to inflate the bag. It inflate to raise the mercury to 200 mm level or 20-25 mm Hg higher after the disappearance of pulse.
5. Keep the eyes fixed at mercury level and the finger at the pulse (which is disappeared) slowly release pressure by unscrewing the valve of the rubber pump. The reading of the level of the mercury when the pulse reappears gives the systolic pressure. This is palpatory method. This method does not give any idea about diastolic pressure.

6. In auscultatory method, after inflation as usual, the chest piece of stethoscope is placed over the brachial artery in the cubital fossa and deflation is started by slowly releasing the pressure. The pressure at which sudden tap heard is the systolic pressure. The sound gets muffled and disappears. The level at which the sound gets muffled is the diastolic pressure. The sound heard is called Korotkoff's sound.

**Interpretation of the results:**

- The blood pressure tended to drop in the standing position compared with the sitting, supine and supine with crossed legs.
- It's best to take your blood pressure from your left arm if you are right-handed. However, you can use the other arm if you have been told to do so by your healthcare provider. A large difference in blood pressure measurement between the two arms may be a sign of a health problem, such as; Blocked arteries (peripheral artery disease), Cognitive decline and due to Diabetes mellitus.
- It's normal for systolic blood pressure to rise to between 160 and 220 mmHg during exercise. Unless you've cleared it with your doctor, stop exercising if your systolic blood pressure surpasses 200 mmHg. Beyond 220 mmHg, your risk of a heart problem increases.

**Result:** The blood pressure is found to be.....mmHg Systolic & .....mmHg Diastolic.



**RECORDING BODY TEMPERATURE**

**Aim:** To record the body temperature using thermometer.

**Requirement:** Thermometer.

**Theory:** Humans are homoitherns of warm blooded animals and hence have the ability to regulate own body temperature. Normally, the body temperature is maintained between 97° F to 99° F. Heat is lost from body by various ways of conduction, convection, radiation and evaporation. Heat is lost mainly from skin, lungs and excretions. Thalamus plays an important role in conservation and loss of heat from body, there are shivering and antirise centres are there in brain that cause sweating, vasodilation, etc. to increase heat loss. The rise in body temperature (pyrexia and fever) occurs due to derangement of heat regulating mechanisms. Toxins, infections, dehydration, tissue destruction, etc. also cause rise in body temperature in the form of various activities like: increased metabolism, blood pressure, pulse, cardiac output and rate of respiration.

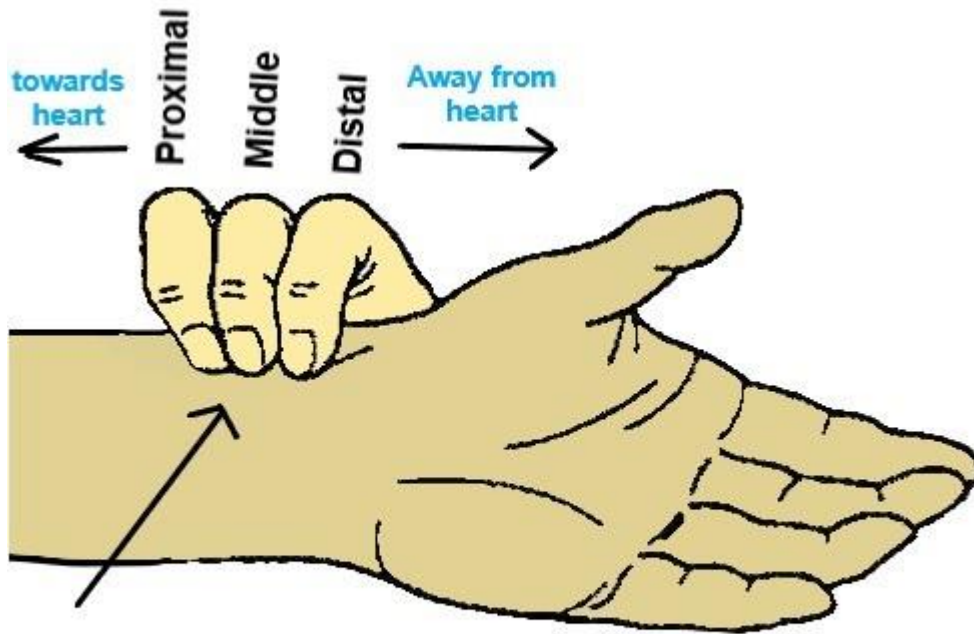
A clinical thermometer is used to measure the body temperature. It differs from other thermometers by presence of a constricted twist near the junction of main bulb and the capillary limb. Because of this device small portions of mercury rises above the twist and separate itself from the main bulk in the bulb. It remains there until shaken down. Usually, the clinical thermometer contains a flattened back with white coating that helps in reading the index it also lessens the danger of breakage from rolling. The other two surfaces are curved and serve as a lens and magnify the width of the mercury. They contain the scale or the index of temperature in Centigrade as well as in Fahrenheit.

**Procedure:**

1. Bring the mercury down to about 95° F by quick motion downwards.
2. Place it in such a position that tissues of the body completely surround the bulb. Such positions are available at armpits or axilla, mouth, vagina and rectum. Usually, the thermometers are placed into the mouth under the tongue in adults and in armpit of children.
3. While taking the temperature under the armpit it should be dry, clean and unexposed to the surrounding. No fold of clothing should interfere the contact of thermometer with skin.
4. While taking the temperature in mouth, it should be noted that the patient has not taken any hot or cold drink prior to the recording. The temperature recorded from mouth is always a half degree higher than axillary temperature

5. Usually, the temperature may be recorded for half minute as specified by the manufacturer, however, it is safe to put the thermometer in position for the maximum time (2 min.).
6. Read thermometer immediately.
7. After use it should be cleaned with cold water under the tap and wiped with a clean napkin.

**Result:** The body temperature is found to be.....



keep fingers in a line  
against each other  
without gap.

**RECORDING PULSE RATE/HEART RATE**

**Aim:** To examine the radial pulse.

**Requirement:** A stopwatch.

**Theory:** The arterial pulse is a wave of increased pressure propagated centrifugally with each ventricular ejection at an increasing velocity (4-10 m/sec.). The arterial pulse does not synchronized in all arteries. The extent of rise at pressure is not the same everywhere, examination of radial pulse is one of the important steps in clinical examination. Much information can be gained from the rate and quality of the pulse regarding cardiovascular diseases. The normal values of radial pulse for an infant is 130 beats/min., for a normal adult will be around 70-75 beats/min.

**Procedure:**

1. Ask the individual to sit comfortably and fully relaxed.
2. Hold the right forearm of the subject in semi-prone position upwards and little finger touching the table).
3. Feel the radial pulse with the middle three fingers of right hand.

**Result:** The radial pulse is observed.....per minute.





**RECORDING PULSE OXYGEN**

**Aim:** To record Pulse oxygen (before and after exertion).

**Requirement:** Pulse oximeter.

**Theory:** A pulse represents the tactile arterial palpation of the cardiac cycle by trained fingertips. The pulse may be palpated in any place that allows an artery to be compressed near the surface of the body, such as at the neck, wrist, at the groin, behind the knee, near the ankle joint, and on foot.

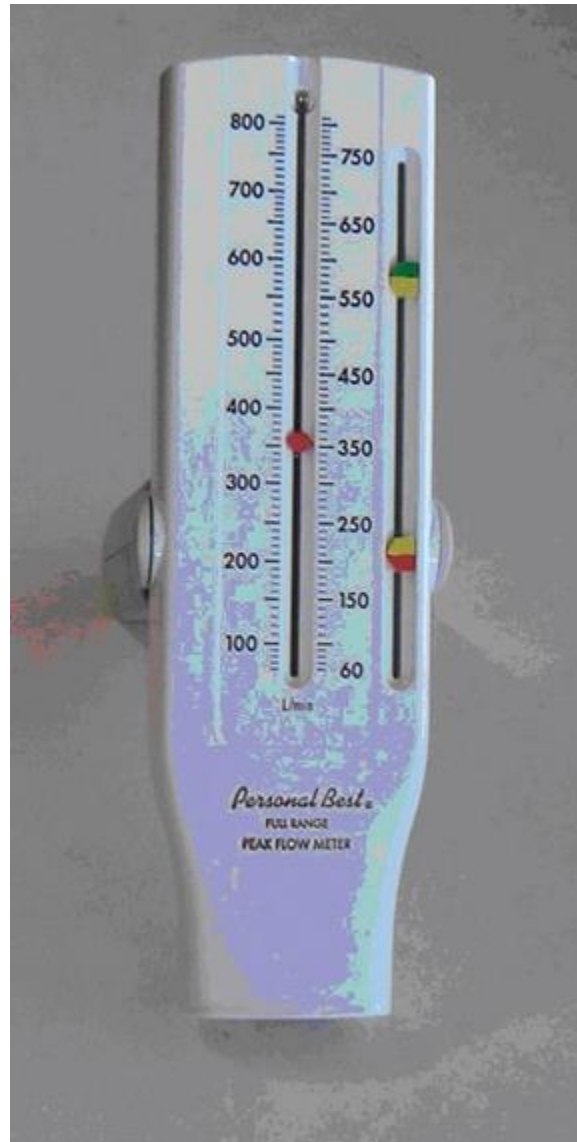
Pulse oximetry is a test used to measure the oxygen level (oxygen saturation) of the blood. It is an easy, painless measure of how well oxygen is being sent to parts of your body furthest from your heart, such as the arms and legs.

**Procedure:**

1. Make sure that your hands are at normal temperature, warm them a film if you feel they're cold.
2. Rest and make your body relaxed before putting on the pulse oximeter.
3. Place the pulse oximeter on your index or middle finger.
4. Place your hand on your chest near your heart and try reducing hand movement
5. Keep the pulse oximeter on your finger for at least a minute, till the reading stabilises 6. Record the highest reading that flashes on the oximeter after it has established after 5 seconds.

**Interpretation of results:** A normal pulse oximeter readings usually range from 95 to 100 percent. A normal resting heart rate should be between 60 to 100 beats per minute. The oxygen saturation level falls between 95% and 99%. But after exertion, the level drops to 92%.

**Results:** The pulse oxygen is.....%.



**PEAK FLOW METER**

**Aim:** Recording force of air expelled using peak flow meter.

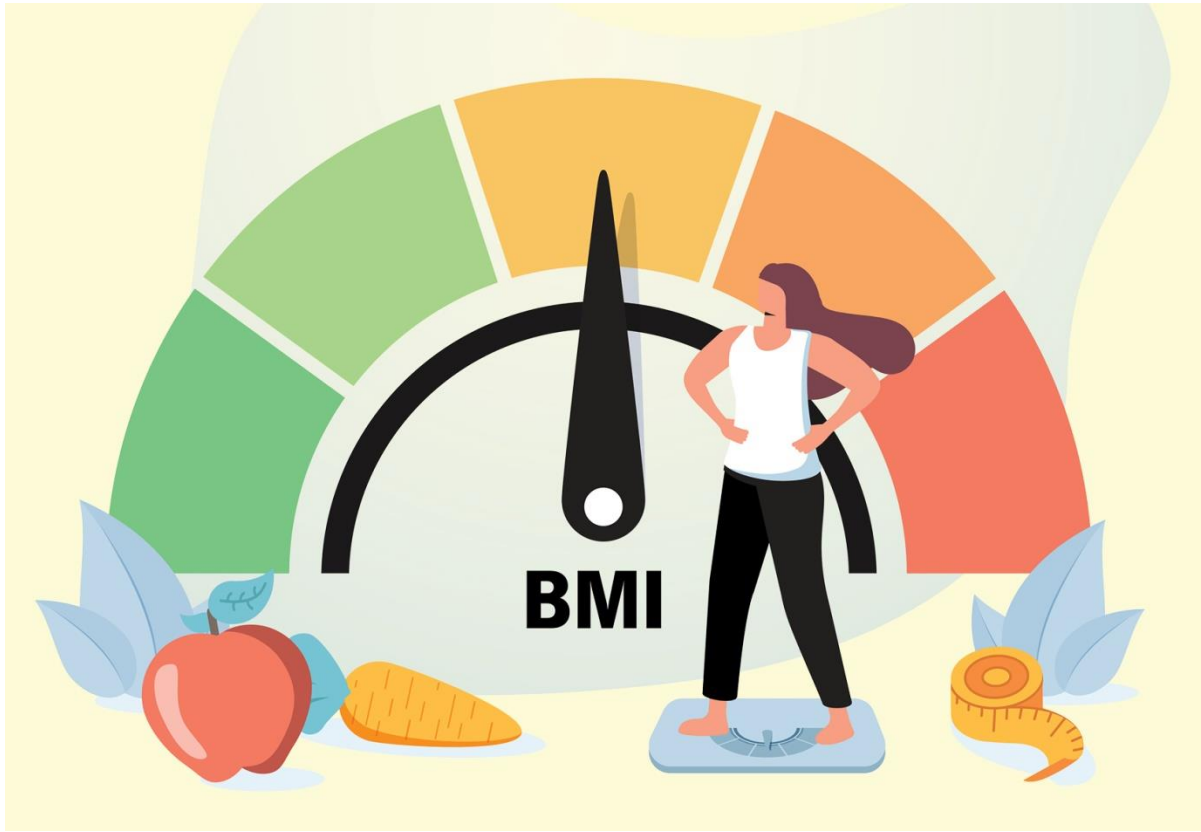
**Requirement:** Peak flow meter apparatus.

**Theory:** Peak expiratory flow rate (PEFR) is the volume of air forcefully expelled from the lungs in one quick exhalation, and is a reliable indicator of ventilation adequacy as well as airflow obstruction. The normal peak flow value can range from person to person and is dependent upon factors such as sex, age and height. PEFR is typically higher in males than females and higher in taller patients. After expected increases through childhood and adolescence, PEFR decreases with age from 30-40 years onwards.

Procedure:

1. Slide the marker down as far as it will go. This sets the meter at zero
2. Stand up , Breathe out fully
3. Take a deep breath in with their mouth open.
4. Place the meter in their mouth with their lips forming a tight seal around the mouthpiece
5. Keep their fingers away from the markings
6. Blow out once as hard and fast as they can
7. Repeat two more times (resetting the marker to zero each time)
8. Their peak flow is the HIGHEST of these 3 readings

**Result:** Force of air expelled out is found to be .....%



**MEASUREMENT OF BMI**

**Aim:** To record body mass index.

**Requirements:** Tape measure, weighing machine, scale, pen  
**Theory:** Body Mass Index or Quetelet index is a simple calculation using a person's weight in kilograms and m<sup>2</sup> is their height in metres squared. BMI is a useful indicator of = health at the population level. However, the distribution of fat on body is more important than the amount, when assessing your disease risk.

**Procedure:**

1. Measure and record height in inches. Convert it to meters.
2. Measure and record weight by using scale in kilogram (kg).
3. Calculate BMI by using formula:  $BMI = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$

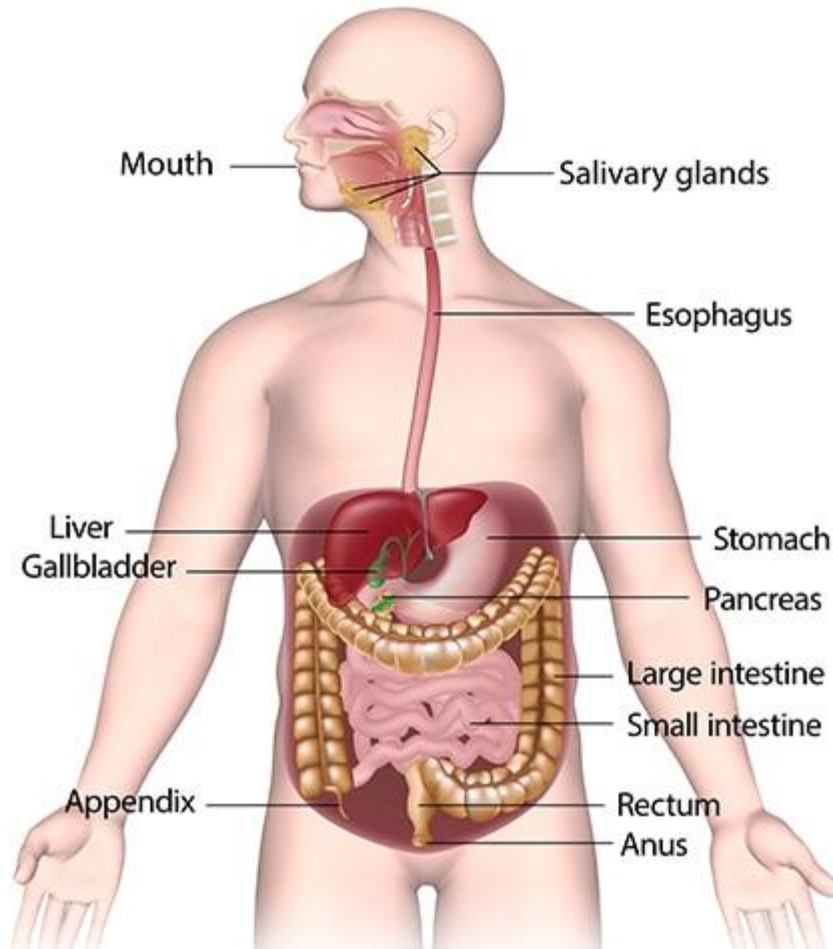
**Result:** The BMI is found.....kg/m<sup>2</sup>.

**STUDY OF VARIOUS SYSTEMS AND ORGANS**

- A. DIGESTIVE SYSTEM
- B. RESPIRATORY SYSTEM
- C. URINARY SYSTEM
- D. ENDOCRINE SYSTEM
- E. REPRODUCTIVE SYSTEM
- F. NERVOUS SYSTEM
- G. CARDIOVASCULAR SYSTEM
- H. SKIN
- I. EYE
- J. EAR



# The Digestive System



## A.DIGESTIVE SYSTEM

**Aim:** To study digestive system using specimen, models and charts.

**Theory:** The digestive system is a system of body which breakdown food into forms that can be absorbed and used by body cells. It also absorbs water vitamins and minerals, and eliminates wastes from the body. It breakdowns the larger molecules present in food into molecules that are small enough to enter body cells by a process known as Digestion. The organs which are involved in the breakdown of food are collectively called the Digestive system. The digestive system is a tubular system A which extends from the mouth to the anus.

### **Digestive system:**

**(a) Lips:** They are partly surrounded by skin and consists of striated muscles and mucous glands. The main function of lips is to provide a gateway to the digestive system.

**(b) Teeth:** There are total 32 teeth in a normal adult. They are further classified as: incisors (2), canine (1), premolar (2) and molars (3) on the each side of jaw, and same number of teeth are there in lower jaw. Major functions of teeth are cutting, gripping and tearing, crushing and grinding.

**(c) Salivary glands:** Salivary glands are present in our mouth which secretes saliva to moisten, lubricate and digest the food, we engulf. They are of three types: parotid, sublingual, and submandibular gland.

**(d) Tongue:** Tongue is an accessory digestive organ composed of skeletal muscle covered with mucous membrane. It helps to taste the food, swallow food and to speak. Tongue and its associated muscles form floor of mouth.

**(e) Pharynx:** It is the junction between the oral and nasal cavity and inferiorly, it is attached to larynx and oesophagus. The larynx gets it connected with wind pipe and oesophagus provides its attachment with digestive system. The major functions of pharynx are to transport air to the respiratory system and food to the digestive system.

**(f) Oesophagus:** It is about 25 cm long tube, which extend from the pharynx to the stomach and lies in the thoracic cavity. The major function performed by oesophagus is transport of food from pharynx to stomach with the help of a process called peristalsis.

**(g) Stomach:** Stomach is a 'J' shaped enlargement of GI Tract which lies directly inferior to diaphragm. It connects oesophagus to duodenum (first part of small intestine). Stomach serves

as mixing chamber and holding reservoir for food.

When food is ingested, stomach pushes a small quantity of food into duodenum periodically. As the size of stomach can vary, it can store large amount of food. It is divided into four parts: Cardia, Fundus, Body and Pylorus. The pylorus communicates with the duodenum of the small intestine via smooth muscle sphincter called the pyloric sphincter. In stomach, semi-solid bolus is converted into liquid, digestion of starch continues, digestion of triglycerides and protein starts, and absorption of several substances takes place.

**(h) Small Intestine:** Small intestine starts from pyloric sphincter of stomach, coils through central and inferior part of abdominal cavity and ends at large intestine. It has major role in digestion and absorption of nutrients.

**Anatomy:** It has three major parts:

**(i) Duodenum:** This is first part of small intestine. It starts from pyloric sphincter, extends up to 25 cm and merges into jejunum. It secretes proteolytic enzymes (trypsinogen, chymotrypsin, procarboxy peptidase, nuclease, collagenase and elastinase to digest proteins. It also secretes amylase which digests carbohydrates and lipase for digestion of lipids. **(ii) Jejunum:** It is middle part and extends up to ileum. It secretes intestinal juice which consists of various proteolytic enzymes like, erepsin, arginase, nuclease etc., carbohydrate splitting enzymes like amylase, maltase, lactase etc, and lipid digesting enzymes like lipase.

**(ii) Ileum:** It is last part of small intestine and ends at ileocecal junction of large intestine. It involves in absorption of digested food material.

**Large intestine:** The large intestine is the terminal portion of the GI tract. The overall functions of the large intestine are the completion of absorption, the production of certain vitamins, the formation of feces and the expulsion of feces from the body. Large intestine is about 1.5 m long and extends from ileum to anus. The joining of small and large intestine occurs at ileocecal sphincter which controls movement of material from small intestine to large intestine. Large intestine consists of four major regions cecum, colon, rectum and anal canal.

**(a) Cecum** is a small pouch like organ which is present next to ileocecal sphincter. Attached to cecum is a coiled and twisted tube called appendix or vermiform appendix

**(b) Colon** is a long tube which is present next to cecum. The open end of cecum attaches with colon. Colon is divided into four portions i.e. ascending colon, transverse colon, descending colon and sigmoid colon.

**(c) Rectum** is approximately last 20 cm of GI tract. Terminal 2-3 cm of rectum is called anal canal. Opening of anal canal to exterior is called anus which is guarded by internal sphincter of

smooth muscles and external sphincter of skeletal muscles.

**The Accessory Digestive Organs:** These are the organs which assist in digestion of food. These include the teeth, tongue, salivary glands, liver, gall bladder and pancreas.

**(a) Pancreas** (Pan-all, creas- flesh) is a retroperitoneal (behind peritoneum) gland, which lies posterior to greater curvature of stomach. It is 12-15 cm long and 2-3 cm thick. Anatomically, it is divided into three parts:

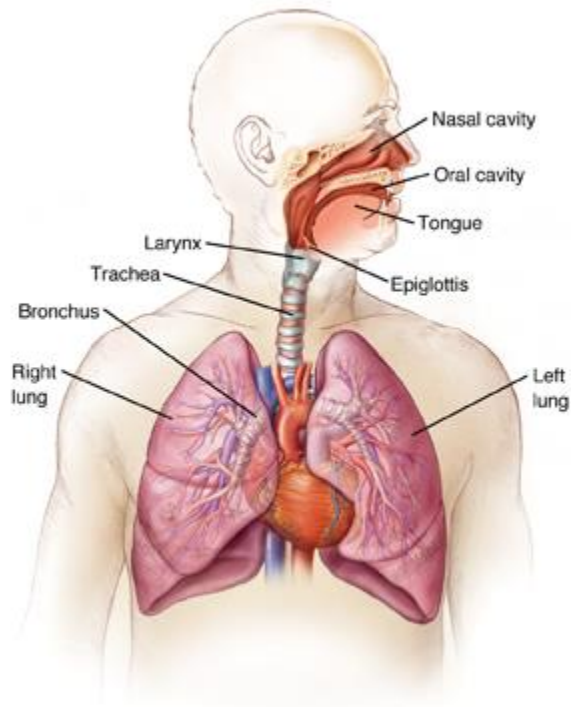
- 1. Head:** It is expanded portion and lies near to curve of duodenum.
- 2. Body:** It is central part and is left and superior to head.
- 3. Tail:** It is last tapering portion of pancreas.

These pancreatic islets secrete four types of hormones:

- 1. Glucagon:** It increases blood sugar level.
- 2. Insulin:** It decreases blood sugar level.
- 3. Somatostatin:** It maintains Glucagon and Insulin level in body.
- 4. Pancreatic polypeptide:** It controls somatostatin secretion.

**(b) Liver and gall bladder:** Liver is the second largest organ in body, located inferior to diaphragm. Gall bladder is pear shaped sac located inferiorly and posteriorly to liver. Liver is divided into two lobes, Right lobe (larger) and left lobe (smaller). The inferior broad portion is called fundus, the middle portion is called body and the upper taper portion is called neck. Liver produces the bile and the gall bladder stores the bile secreted by liver and send it to the small intestine where it aids in the digestive process.

**Result:** The human digestive system is studied.



## B. RESPIRATORY SYSTEM

**Aim:** To study of respiratory system using specimen, models and charts

**Theory:** The respiratory system plays a role in exchange of oxygen and carbon dioxide between the atmospheric air, blood and tissue cells. Metabolic reactions in human body use/oxygen (O<sub>2</sub>) to produce energy from nutrients in form of ATP. At the same time, these reactions release carbon dioxide (CO<sub>2</sub>) which must be eliminated quickly to prevent acidity due to CO<sub>2</sub>. The respiratory and cardiovascular systems co-operate to supply O<sub>2</sub> and eliminate CO<sub>2</sub>. The respiratory system provides for gas exchange i.e., intake of O<sub>2</sub> and elimination of CO<sub>2</sub>. The cardiovascular system transports these gases through blood between the lungs and body cells.

**1. Nose:** It is only externally visible organ of respiratory system. Nose can be divided into two parts:

**(a) External nose:** The external nose consists of a framework of bones and hyaline cartilage covered with muscle and skin and lined by a mucous membrane. On the under surface of the external nose are two openings called the external nares or nostrils.

**(b) Internal nose:** Internal nose is larger, cavity and is present inferior to nasal bone and superior to mouth. Anteriorly, it merges with external nose and posteriorly joins with pharynx through two openings called internal nares. Space within internal nose is called nasal cavity. A vertical partition called the nasal septum divides the nasal cavity into right and left sides.

**2. Pharynx:** It is the junction between the oral and nasal cavity and inferiorly, it is attached to larynx and oesophagus. The larynx gets it connected with wind pipe and oesophagus provides its attachment with digestive system. The major functions of pharynx are to transport air to respiratory system and food to the digestive system.

**3. Larynx:** The larynx or voice box is a short passageway that connects the laryngopharynx with the trachea. It lies in the midline of the neck anterior to the oesophagus. It is made up of nine cartilages. One of the cartilages, called epiglottis extends superiorly and forms a lid over trachea during swallowing so that liquid and food do not enter into wind pipe. Larynx acts as a passageway and produces sound by modifying air vibrations.

**4. Trachea:** The trachea or wind pipe is a tubular passageway for air that is about 12 cm (5 in.) long and 2.5 cm (1 in.) in diameter. It is located anterior to the oesophagus and extends from the larynx to the superior border of the fifth thoracic vertebra (T5), where it divides into right and left primary bronchi.

**5. Bronchi:** At the superior border of the fifth thoracic vertebra, the trachea divides into a right primary bronchus which goes into the right lung and a left primary bronchus which goes into the left lung. On entering the lungs, the primary bronchi divide to form smaller bronchi, the secondary (lobar) bronchi, one for each lobe of the lung (The right lung has three lobes; the left lung has two.). The secondary bronchi continue to branch, forming still smaller bronchi, called tertiary (segmental) bronchi, that divide into bronchioles, Bronchioles in turn branch repeatedly, and the smallest ones branch into even smaller tubes called terminal bronchioles. This extensive branching from the trachea resembles an inverted tree and is commonly referred to as the bronchial tree. Terminal bronchioles subdivide into microscopic branches called respiratory bronchioles. Respiratory bronchioles in turn subdivide into several alveolar ducts. Around the alveolar ducts are numerous alveoli and alveolar sacs. On the outer surface of the alveoli, there is a network of blood capillaries called pulmonary capillaries. The exchange of O<sub>2</sub> and CO<sub>2</sub> between the air spaces in the lungs and the blood takes place by diffusion across the alveolar and capillary walls.

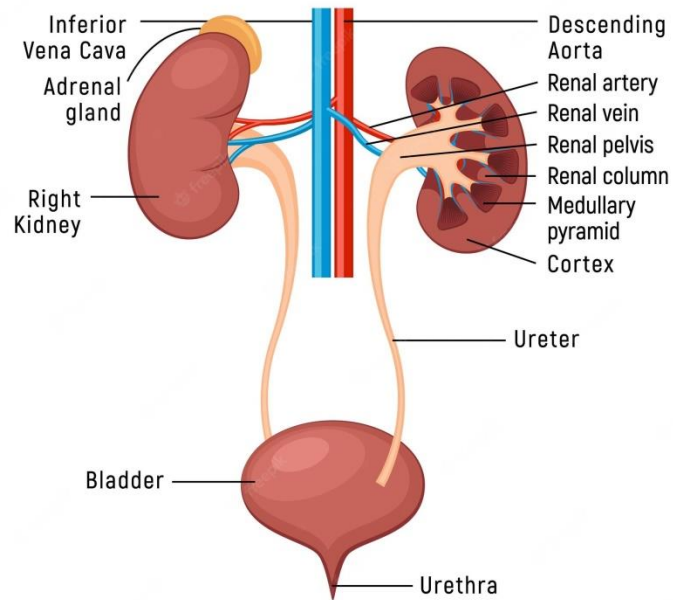
**6. Lungs:** The lungs are paired cone-shaped organs in the thoracic cavity. They are separated from each other by the heart and other structures in the mediastinum. Each lung is enclosed and protected by a double-layered membrane called the pleural membrane. Between the both layers of pleural membrane, a small space is present which is called the pleural cavity.

The broad inferior portion of the lung is called the base and is present over the diaphragm. The narrow superior portion of the lung is called apex. The medial surface of each lung contains a region called the hilum through which bronchi, pulmonary blood vessels, lymphatic vessels, and nerves enter and exit. Medially, the left lung also contains a concavity called the cardiac notch in which the heart lies.

Each lung is divided further into lobes by the fissures. Right lung is divided into three lobes (Superior lobe, Middle lobe and Inferior lobe) by horizontal and oblique fissure. The left lung is divided into two lobes (Superior lobe and Inferior lobe) by oblique fissure. Each lobe is further divided into number of small lobules.

**Result:** The human respiratory system is studied.

## Anatomy of the Urinary System



## C. URINARY SYSTEM

**Aim:** To study the anatomy and physiology of urinary system.

**Theory:** The urinary system consists of two kidneys, two ureters, one urinary bladder and one urethra. Kidneys filter blood plasma to remove waste materials, solutes and water. They return most of the water and solutes to the blood stream. The remaining water constitutes urine, which passes through the ureters and is stored in the urinary bladder until it is excreted from the body through the urethra.

**Kidney:** The kidneys are two reddish, bean-shaped, retroperitoneal organs located just above the waist. The kidneys are located between the levels of the last thoracic and third lumbar vertebrae. A typical adult kidney is 10-12 cm long, 5-7 cm wide and 3 cm in thickness. Near the centre of the concave border, an indentation is present called the renal hilum. Through renal hilum, the ureter, blood vessels, lymphatic vessels and nerves enter and exit the kidney .

Three layers of tissue surround each kidney.

- 1 Renal capsule,
- 2 Adipose capsule,
3. Renal fascia.

A kidney is divided into two distinct regions:

(a) **Renal medulla:** It is inner region of kidney which appears dark reddish-brown in colour. It consists of several cone-shaped regions called renal pyramids. The broad side of each pyramid (called base) faces the renal cortex and its apex (called renal papilla) points toward the renal hilum,

(b) **Renal cortex:** It is outer region which is light red in colour. The renal cortex is the smooth textured area extending from the renal capsule to the bases of the renal pyramids and into the spaces between them. It is further divided into an outer cortical zone and an inner juxtamedullary zone. The portions of the renal cortex present between renal pyramids are called renal columns.

**Major functions performed by kidney are:** Regulation of ionic concentration, pH, pressure, osmolarity and volume of blood. It also produce some hormones like renin, calcitriol, erythropoietin, etc. and it also excrete waste of body and foreign particles: **Nephrons:** Nephrons are the functional units of the kidneys. Each kidney contains approximately 1 million nephrons. Each nephron consists of two parts:

**Renal corpuscle:** This is the part where blood plasma is filtered. It is further divided into two components: The glomerulus which is a network of blood capillaries and the glomerular (Bowman's) capsule which is a double-walled epithelial cup that surrounds the glomerular capillaries:

**Renal tubule:** This is the part into which the filtered fluid passes. It has three main sections:

- (i) Proximal convoluted tubule
- (i) Loop of Henle (nephron loop)
- (ii) Distal convoluted tubule

**The ureters** are two 25-30 cm long, thick walled, retroperitoneal narrow tubes that vary in diameter from 1 mm to 10 mm. They extend from kidney to urinary bladder. The ureters transport urine from the kidneys to the urinary bladder.

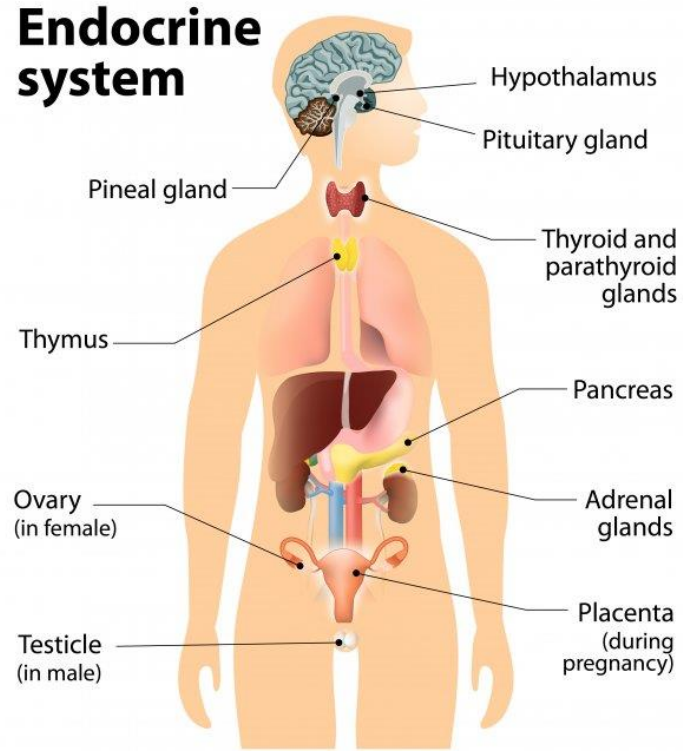
**Urinary Bladder:** The urinary bladder is a hollow, distensible muscular organ situated in the pelvic cavity posterior to the pubic symphysis. In males, it is directly anterior to the rectum and in females, it is anterior to the vagina and inferior to the uterus. Its shape depends upon quantity of urine present. It is collapsed when empty and pear shaped when filled. Urinary bladder capacity averages 700-800 ml. In the floor of the urinary bladder, a small triangular area is present called the trigone. The two posterior corners of the trigone contain the two ureteral openings and the opening into the urethra forms anterior corner.

**Urethra:** The urethra is a small tube leading from the internal urethral orifice in the floor of the urinary bladder to the exterior of the body. In both males and females, the urethra is the terminal portion of the urinary system. In females, the urethra lies directly posterior to the pubic symphysis and has length of 4 cm. The opening of the urethra to the exterior is called the external urethral orifice and is located above vaginal opening. In males, the urethra is 15-20 cm long. It extends from the internal urethral orifice to the exterior. The male urethra is subdivided into three anatomical regions

- (1) The prostatic urethra passes through the prostate.
- (2) The membranous (intermediate) urethra passes through the deep muscles of the perineum.
- (3) The spongy urethra, the longest portion, passes through the penis.

**Result:** The human urinary system is studied.

# Endocrine system



## D. ENDOCRINE SYSTEM

**Aim:** To study endocrine system using charts, model

**Theory:** The endocrine system is a complex network of glands and organs. It uses hormones to control and coordinate your body's metabolism, energy level, reproduction, growth and development, and response to injury, stress, and mood

The major glands that make up the endocrine system are the:

1. Hypothalamus
2. Pituitary
3. Thyroid
4. Parathyroid
5. Adrenal
6. Pancreas
7. Pineal Body
8. Sex Glands

**1. Hypothalamus:** The hypothalamus is a small region of the brain. It's located at the base of the brain, near the pituitary gland. The hypothalamus plays a crucial role in many important functions, including:

- Releasing hormones.
- Regulating body temperature.
- Maintaining daily physiological cycles.
- Controlling appetite
- Managing of sexual behaviour.
- Regulating emotional responses.

**2. Pituitary Gland:** The pituitary gland is a small pea-sized gland that plays a major role

in regulating vital body functions and general wellbeing. It is referred to as the body's 'master gland' because it controls the activity of most other hormone secreting glands. The pituitary has two lobes, the anterior and the posterior lobe. Each of the two lobes of the pituitary gland contains different types of cells and produces different types of hormones.

**The anterior pituitary gland produces six major hormones:** (1) Prolactin (PRL), (2) Growth hormone (GH), (3) Adrenocorticotrophic hormone (ACTH), (4) Luteinizing hormone (LH). (5) Follicle-stimulating hormone (FSH), and (6) Thyroid-stimulating hormone (TSH)

**The posterior lobe produces** two hormones, vasopressin and oxytocin. These hormones are released when the hypothalamus sends messages to the pituitary gland through nerve cells. Vasopressin is also known as anti-diuretic hormone (ADH which is a hormone that plays a key role in maintaining osmolality (the concentration of dissolved particles, such as salts and glucose, in the serum) and therefore in maintaining the volume of water in the extracellular fluid (the fluid space that surrounds cells).

**3. Thyroid Gland:** The thyroid, or thyroid gland, is an endocrine gland in vertebrates. In humans, it is in the neck and consists of two connected lobes. The lower two thirds of the lobes are connected by a thin band of tissue called the thyroid isthmus. The thyroid is located at the front of the neck, below the Adam's apple. It secretes two hormones: Thyroxine and Calcitonin. Thyroxine regulates basal metabolism i.e. the rate of cellular oxidation resulting in heat production at rate. An increase in the secretion increases metabolism and a decrease in the secretion lowers it. Calcitonin is involved in helping to regulate levels of calcium and phosphate in the blood, opposing the action of parathyroid hormone. This means that it acts to reduce calcium levels in the blood.

Under secretion of Thyroxine causes

- (a) Simple goitre
- (b) Cretinism
- (c) Myxoedema

Over secretion of thyroxine may cause a kind of goitre called exophthalmic goitre

**4. Parathyroid glands:** The parathyroid glands are two pairs of glands usually positioned behind the left and right lobes of the thyroid. Parathyroid glands control the calcium levels in our blood, in our bones, and throughout our body. Parathyroid glands regulate the calcium by

producing a hormone called Parathyroid Hormone (PTH) Calcium is the most important element in our bodies (we use it to control many organ systems), so calcium is regulated more carefully than any other element. 5. Adrenal Gland: The adrenal glands are like caps above the kidneys. Each adrenal gland consists of two parts: (i) a central medulla and (ii) a peripheral cortex

**(i) Adrenal medulla:** It secretes adrenaline which prepares the body to meet any emergency situation for flight or to face danger or for "Flight", to run away from

**Adrenal cortex:** It secretes many hormones but best known hormone is cortisone (which suppresses inflammation). Hyposecretion from adrenal cortex causes Addison's disease while Hypersecretion of adrenal cortex causes Cushing's syndrome. 6. Pancreas: Pancreas is both duct gland as well as a ductless gland. As a ductless gland, it has special group of hormone secreting cells called islets of Langerhans. This produces three hormones insulin, glucagon and somatostatin.

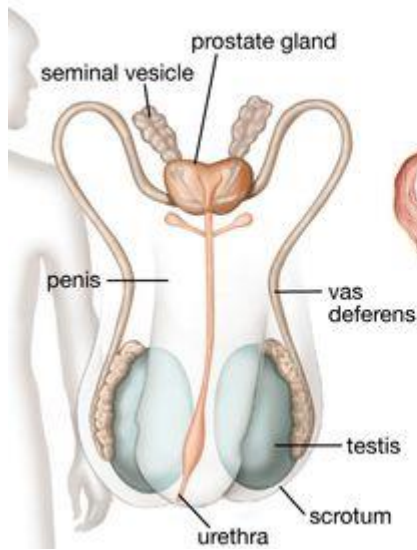
- (1) Insulin checks rise of sugar level in blood. It promotes glucose utilisation by the beta cells.
- (2) Glucagon is secreted from alpha cells. It stimulates the breakdown of glycogen in the liver to glucose, thus it raises sugar level in the blood.
- (3) Somatostatin inhibits secretion of insulin and glucagon.

**7. Pineal Gland:** The pineal gland produces melatonin, a serotonin-derived hormone which modulates sleep patterns in both circadian and seasonal cycles.

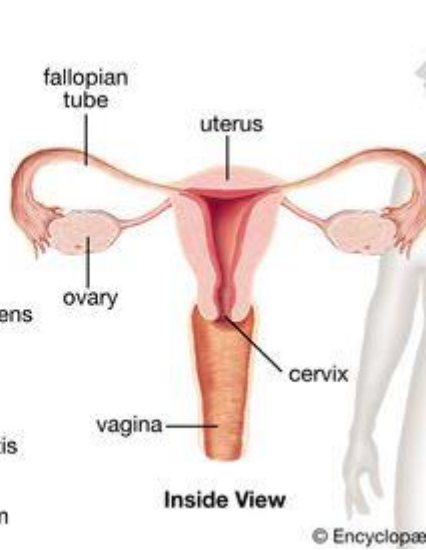
**8. Sex Glands:** A gonad, sex gland, or reproductive gland is a mixed gland that produces the gametes (sex cells) and sex hormones of an organism. In the female of the species the reproductive cells are the egg cells, and in the male the reproductive cells are the sperm. The gonads, the primary reproductive organs, are the testes in the male and the ovaries in the female. The testes are responsible for making testosterone, the primary male sex hormone, and for producing sperm. Within the testes are coiled masses of tubes called seminiferous tubules. These tubules are responsible for producing the sperm cells through a process called spermatogenesis. The ovaries produce the egg cells, called the ova or oocytes. The oocytes are then transported to the fallopian tube where fertilization by a sperm may occur. The fertilized egg then moves to the uterus, where the uterine lining has thickened in response to the normal hormones of the reproductive cycle.

**Result:** The endocrine system and its glands are studied.

**Male Reproductive System**



**Female Reproductive System**



## E. REPRODUCTIVE SYSTEM

**Aim:** To study reproductive system using model.

**Theory:** Reproduction refers to the production of offspring by organized bodies. The offspring is produced as a new individual organism from the parent(s). There are two forms of reproduction. Sexual reproduction is the process in which new organisms are created, by combining the genetic information from two individuals of different sexes. The genetic information is carried on chromosomes within the nucleus of specialized sex cells called gametes. The organs of reproductive system are divided into Primary and Accessory parts: The primary reproductive parts include the gonads which produce the sex cells or gametes the sperm and eggs.

### Male Reproductive System:

The male reproductive system consists of a number of sex organs that play a role in the process of human reproduction. These organs are located on the outside of the body and within the pelvis. The male reproductive system consists of following organs:

- (1) Testes (one pair)
- (2) Scrotum
- (3) Penis
- (4) Seminal vesicles
- (5) Urethra

**1. Testes:** They are the oval bodies, around 1.5 to 3 inches in length. Generally, the left testis hangs slightly lower than the right one. The two primary functions of tests are producing testosterone and producing sperms.

**2. Scrotum:** It is a sac of thick skin that protects and surrounds the testes. It also controls the temperature of the testes since they have to be at a slightly lower temperature than the body temperature for suitable sperm creation. The muscles in the wall allow the testes to hang far from the body or shrink to pull them closer for protection and warmth.

**3. Penis:** It involves three cylindrical spaces of erectile tissue. The two which are larger the corpora cavernosa lie side by side and the third one is sinus, called corpus spongiosum covers the urethra. The penis becomes rigid when these spaces are filled by the blood.

**4. Seminal vesicles:** It is present over the prostate, linked with the vas deferens to create the ejaculatory ducts that travel through the prostate. The seminal vesicles and prostate generate fluid which nourishes the sperm. This fluid provides a maximum volume of the semen, wherein the sperm is ejected during ejaculation.

**5. Urethra:** It is a tube-like structure that connects the urinary bladder to the urinary meatus. In males, the urethra travels through the penis and is mainly involved in two main functions. This region is included in the urinary tract that takes urine from the bladder where semen is ejaculated. The Prostate exists beneath the bladder and covers the urethra.

### **Female Reproductive System:**

The female reproductive system is framed to perform different functions. It creates egg cells that are essential for reproduction known as ova. The system is organized to deliver the ova to the region of fertilization. The egg fertilization takes place in the Fallopian tubes along with the sperm. The implanting in the walls of the uterus and initiating the stages of pregnancy is the next step of fertilized eggs. Apart from the above-mentioned functions, the female reproductive system is also involved in the production of female sex hormones to maintain the reproductive cycle.

The female reproductive system consists of the following parts:

(1) Vagina

(2) Ovaries

(3) Fallopian tubes or Oviducts

(3) Uterus

**1. Vagina:** Vagina is a muscular and elastic tube that connects the cervix to the external body. It functions as the receptacle for the penis in sexual intercourse and delivers sperm to the fallopian tubes and uterus. It also acts as a birth canal by expanding to allow delivery of the foetus during childbirth.

**2. Ovaries:** Ovaries act as the main female sex organs that produce the female gamete and various hormones. These organs are situated one on both the side of the lower abdomen. Each ovary measures about 2 to 4 cm in length which is then connected to the uterus and pelvic wall through ligaments. The ovary is surrounded by a thin covering of epithelium, encloses the ovarian stroma and is divided into two zones outer cortex and the inner medulla. The cortex consists of various ovarian follicles in different stages of development. The ovarian follicle is called the basic unit of the female reproductive system. Each oviduct is divided into three

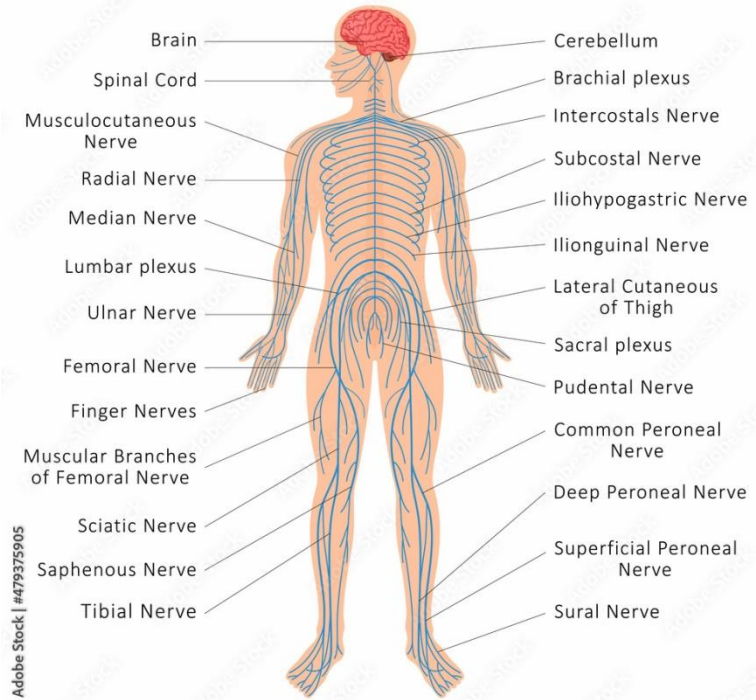
anatomical regions. ampulla, isthmus, and infundibulum.

**3. Fallopian Tubes:** Fallopian tubes are a pair of muscular tubes and funnel-shaped structures extend from the right and left of the superior corners of the uterus to the edge of the ovaries. These tubes are enclosed in small projections called fimbriae that swipe over the ovaries to pick up released ova and deliver them to the infundibulum for supplying the uterus. Each fallopian tube is covered by cilia that functions by carrying the ovum to the uterus.

4. Uterus: Uterus is also called the womb. It is a muscular, inverted pear-shaped organ of the female reproductive system. The walls of the uterus consist of three layers-the inner glandular layer, the middle thick layer, and the outer thin layer.

**Result:** The reproductive system was studied.

# NERVOUS SYSTEM



## F. NERVOUS SYSTEM

**Aim:** To study the Nervous system using model.

**Theory:** The nervous system is a network of neurons whose main feature is to generate, modulate and transmit information between all the different parts of the human body. This property enables many important functions of the nervous system such as: regulation of vital body functions (heartbeat, breathing, and digestion), sensation and body movements. Ultimately, the nervous system structures preside over everything that makes us human; our consciousness, cognition, behaviour and memories. The nervous system is composed of highly specialised cells called neurons which can detect, receive and transmit different kinds of stimuli. The nervous system consists of two divisions;

1. **Central nervous system (CNS)** is the integration and command centre of the body
2. **Peripheral nervous system (PNS)** represents the conduit between the CNS and the body. It is further subdivided into the somatic nervous system (SNS) and the autonomic nervous system (ANS).

**Brain:** Brain is that portion of the central nervous system which is present within the cranium. The brain is the control centre for receiving sensations, correlating them, storing information, making decisions and taking actions. It also is the centre for the intellect, emotions, memory and behaviour. Different parts of the brain also work together to accomplish certain shared functions.

**Cranium and Meninges:** The cranium (skull bones) and the cranial meninges surround and protect the brain. The meninges consists of three layers of connective tissue that cover the spinal cord and brain. The spinal meninges surround the spinal cord and are continuous with the cranial meninges, which encircle the brain. The three layers are: Dura matter. Arachnoid matter and Pia matter.

**Cerebrospinal fluid (CSF):** It is a clear, colourless liquid that protects the brain and spinal cord from chemical and physical injuries. It also carries oxygen, glucose, and other needed chemicals from the blood to neurons and neuroglia. CSF continuously circulates through cavities (called ventricles) in the brain and spinal cord, and around the brain and spinal cord in the subarachnoid space (between the arachnoid matter and pia matter). CSF contains glucose, proteins, lactic acid, urea, cations (Na, K, Ca, Mg), anions (C and HCO) and some white blood cells

### **Parts of Brain:**

1) **Brain stem:** The brain stem is present between the spinal cord and the diencephalon. It consists of three structures: (a) medulla oblongata, (b) pons (c) midbrain. Extending through the brain stem is the reticular formation, a net like region of interspersed grey and white matter.

**2) Cerebellum:** The cerebellum is present posterior to the medulla and pons and inferior to the posterior portion of the cerebrum. A deep groove known as the transverse fissure, separate the cerebellum from the cerebrum. In superior or inferior views, the shape of the cerebellum resembles a butterfly. The central constricted area is called the vermis (worm) and the lateral "wings" or lobes are called the cerebellar hemispheres. Each hemisphere is further divided into anterior, posterior and flocculonodular lobes. The anterior lobe and posterior lobe controls subconscious aspects of skeletal muscle movements. The flocculonodular lobe on the inferior surface contributes to equilibrium and balance. The superficial (outer) layer of the cerebellum is called the cerebellar cortex. It is made up of grey matter. Deep to the grey matter, region of white matter is present which is called arbor vitae (tree of life). Even deeper within the white matter cerebellar nuclei are present that contains axons carrying impulses from the cerebellum to other brain centres.

**3) The diencephalon:** It is middle part of brain and extends from the brain stem to the cerebrum. It includes the thalamus, hypothalamus and epithalamus.

**(a) Thalamus:** The thalamus (inner chamber) consists of paired oval masses of grey matter organized into nuclei with interspersed tracts of white matter. A bridge of grey matter called the intermediate mass joins the right and left halves of the thalamus

The thalamus is the major relay station for most sensory impulses that reach the primary sensory areas of the cerebral cortex from the spinal cord and brain stem. The motor functions of thalamus include transmission of information from the cerebellum and basal ganglia to the primary motor area of the cerebral cortex.

**(b) Hypothalamus:** The hypothalamus (hypo-under) is a small part of the diencephalon located inferior to the thalamus. It consists of number of nuclei which help to control many body activities Hypothalamus monitors osmotic pressure, glucose level, certain hormone concentrations and the temperature of blood.

**(c) Epithalamus:** The epithalamus (epi-above) is a small region superior and posterior to the thalamus. It consists of the pineal gland and habenular nuclei. The pineal gland secretes the hormone melatonin. Melatonin contributes to the setting of the body's biological clock which is controlled by the hypothalamus. The habenular nuclei are involved in olfaction, especially emotional responses to odour.

**4) The cerebrum:** It is the seat of intelligence". It provides us with the ability to read, write, and speak, to make calculations and compose music and to remember the past, plan for the future, and imagine things that have never existed before. The cerebrum is further divided into an outer grey layer of cerebral cortex, an internal region of cerebral white matter, and grey matter nuclei deep within the white matter.

**(a) Cerebral Cortex:** The cerebral cortex is a region of grey matter that forms the outer layer of the cerebrum in the form of folds. The longitudinal fissure separates the cerebrum into right and left halves called cerebral hemispheres. The cerebral hemispheres are connected internally by a broad band of white matter called corpus callosum. Each cerebral hemisphere is subdivided into four lobes named after the bones that cover them. Le. frontal, parietal, temporal and occipital lobes.

**(b) Cerebral White Matter:** The cerebral white matter consists of three types of tracts: Association tracts, Commissural tracts, Projection tracts.

**(c) Basal Ganglia:** It is a group of three nuclei which are present deep within each cerebral hemisphere. These nuclei are named as globus pallidus, putamen and caudate nucleus.

**(d) The Limbic System:** This system is located near brain stem, corpus callosum and diencephalon. The limbic system is also called the "emotional brain" because it plays a primary role in a range of emotions, including pleasure, pain, docility, affection, fear and anger.

**5) Spinal Cord:** Spinal cord is elongated, cylindrical part of CNS which is suspended in vertebral canal. It starts from medulla oblongata and extends up to lower border of first lumbar vertebrae. Spinal cord is a nervous tissue link between brain and rest of the body. Nerves conveying impulses from brain to various organs and tissues pass through spinal cord. Similarly, sensory nerves from organs and tissues enter and pass upward in the spinal cord to brain.

The peripheral nervous system is one of two components that make up the nervous system of bilateral animals, with the other part being the central nervous system. The PNS consists of the nerves and ganglia outside the brain and spinal cord. The peripheral nervous system is divided into the somatic nervous system and the autonomic nervous system. The brain and spinal cord are responsible for processing and integrating the various sources of information to allow us to develop a response. Therefore the main function of the somatic nervous system is to connect the CNS with organs and striated muscle to perform our daily functions. The somatic nervous system provides control of skeletal muscle movement. Conscious control of movement originates in the motor cortex (both premotor and primary motor cortex). The somatic nervous system consists of two parts spinal nerves and cranial nerves.

**1. Spinal nerves:** They are mixed nerves that carry sensory information into and motor commands out of the spinal cord.

**2. Cranial nerves:** They are the nerve fibers that carry information into and out of the brain stem. They include smell, vision, eye, eye muscles, mouth, taste, ear, neck, shoulders, and tongue.

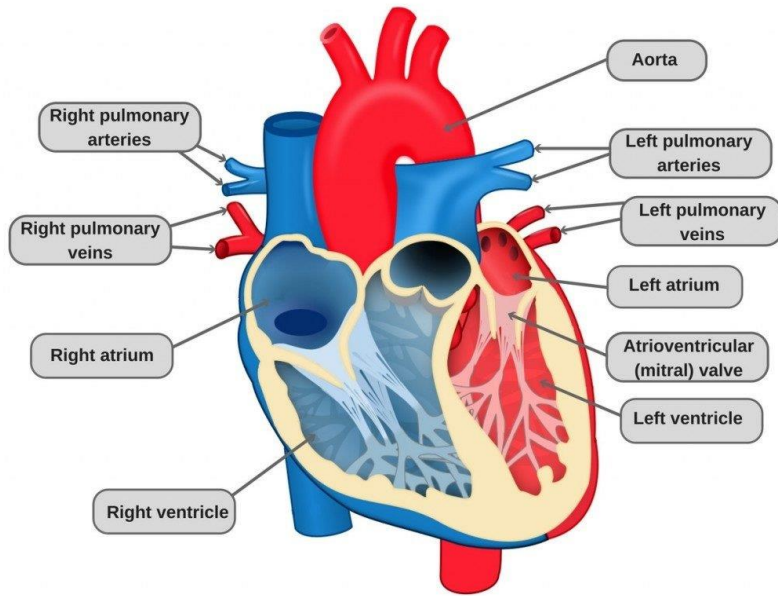
The autonomic nervous system is the part of the nervous system that supplies the internal organs, including the blood vessels, stomach, intestine, liver, kidneys, bladder, genitals, lungs, pupils, heart, and sweat, salivary, and digestive glands. The autonomic nervous system regulates certain body processes, such as blood pressure and the rate of breathing. This system works automatically (autonomously), without a person's conscious effort. Disorders of the autonomic nervous system can affect any body part or process. The autonomic nervous system has two main divisions:

### **1. Sympathetic. 2 Parasympathetic.**

The autonomic nervous system functions to regulate the body's unconscious actions. The sympathetic nervous system's primary process is to stimulate the body's fight or flight response. It is, however, constantly active at a basic level to maintain homeostasis.

The parasympathetic nervous system controls bodily functions when a person is at rest. Some of its activities include stimulating digestion, activating metabolism, and helping the body relax. The parasympathetic system is responsible for stimulation of "rest-and-digest" or "feed and breed" activities that occur when the body is at rest, especially after eating, including sexual arousal, salivation, lacrimation (tears), urination, digestion, and defecation.

**Result:** The human nervous system is studied.



## G. CARDIOVASCULAR SYSTEM

**Aim:** To study cardiovascular system using model.

**Theory:** The cardiovascular system (cardio-heart vascular-blood vessels) consists of three interrelated components: blood, the heart and blood vessels.

**Heart:** The heart rests on the diaphragm, near the midline of the thoracic cavity in the mediastinum. It is about 12 cm long, 9 cm wide at its broadest point, and 6 cm thick, with an average mass of 250 gm in adult females and 300 gm in adult males. About two-thirds of the mass of the heart lies to the left of the body's midline. The pointed apex is formed by the tip of the left ventricle (a lower chamber of the heart) and rests on the diaphragm. The base of the heart is formed by the atria (upper chambers) of the heart, mostly the left atrium.

**Layers of Heart Wall:** The wall of the heart consists of three layers:

(a) **Epicardium:** It is thin, transparent outer layer of the heart wall, also called the visceral layer of the serous pericardium. It is composed of delicate connective tissue that imparts a smooth, slippery texture to the outermost surface of the

(b) **Myocardium:** It is the middle layer made up of cardiac muscle tissue. It makes up heart. about 95% of the heart and is responsible for its pumping action. It is striated and involuntary in nature.

(c) **Endocardium:** It is the innermost thin layer of endothelium. It provides a smooth lining for the chambers of the heart and covers the valves of the heart. It minimizes surface friction as blood passes through the heart and blood vessels.

### • Chambers of the Heart:

(a) **Right Atrium:** It forms the right border of the heart. It receives blood from three

**veins:** the superior vena cava, inferior vena cava, and coronary sinus, and delivers to right ventricle through a valve called tricuspid valve or right atrioventricular valve. Interatrial septum (septum-a dividing wall) divides both atria into right atrium and left atrium.

(b) **Right Ventricle:** It forms most of the anterior surface of the heart. The inside of the right ventricle contains a series of ridges formed by cardiac muscle fibres called trabeculae carneae (trabeculae-little beams; carneae-fleshy). The cusps of the tricuspid valve are connected to tendon like cords, the chordae tendineae, which in turn are connected to cone shaped trabeculae carneae called papillary muscles (papill-nipple). Internally, the right ventricle is separated from the left ventricle by interventricular septum. Right ventricle received blood from

the right atrium and passes it into a large artery called pulmonary trunk through pulmonary valve (pulmonary semilunar valve). Pulmonary trunk divides into right and left pulmonary arteries which deliver blood to right and left lung respectively for removal of CO<sub>2</sub>. Arteries always takes blood away from the heart.

**(c) Left Atrium:** The left atrium is about the same thickness as the right atrium. It forms most of the base of the heart. It receives purified blood from the lungs through four pulmonary veins. Blood passes from the left atrium into the left ventricle through the bicuspid (mitral) valve also called the left atrioventricular valve.

**(d) Left Ventricle:** The left ventricle is the thickest chamber of the heart and forms the apex of the heart. Like the right ventricle, the left ventricle also contains trabeculae carneae and has chordae tendineae that anchor the cusps of the bicuspid valve to papillary muscles. Left ventricle receives blood from the left atrium and bicuspid valve and passes it to ascending aorta through the aortic valve (aortic semilunar valve). From ascending aorta some of the blood flows into the coronary arteries, which carry blood to the heart wall. The remainder of the blood passes into the arch of the aorta and descending aorta (thoracic aorta and abdominal aorta) Branches of the arch of the aorta and descending aorta carry blood throughout the body.

**Blood:** Blood is a connective tissue composed of a liquid extracellular matrix called blood plasma that dissolves and suspends various cells and cell fragments. Blood is denser and more viscous (thicker) than water and feels slightly sticky. The temperature of blood is 38°C and it has a slightly alkaline pH ranging from 7.35 to 7.45 The colour of blood is bright red when it has high oxygen content and dark red when it has low oxygen content. The blood volume is 5 to 6 litres in an average sized adult male and 4 to 5 litres in an average sized adult female.

**Components of Blood:** Blood has two components:

(1) **Blood plasma** substances, and contain 99% of red blood cells (RBCs) and 1% of pale, colourless white blood cells (WBCs) and platelets is a watery liquid extracellular matrix that contains dissolved

(2) **Formed elements**, which are cells and cell fragments. Blood is about 45% formed elements and 55% blood plasma: Formed elements

(1) **Blood Plasma:** When the formed elements are removed from blood, a straw colour liquid called blood plasma (or simply plasma) is left. Blood plasma is about 91.5% water, 7% of plasma proteins and 1.5% of other solutes of Plasma proteins are synthesized in liver cells and play a role in maintaining proper blood osmotic pressure, which is an important factor in the exchange of fluids across capillary walls. Major plasma proteins are albumins (54% of plasma proteins), globulins (38%), and fibrinogen (7%). These plasma proteins are also called antibodies or immune-globulins because they are produced during certain immune responses.

Besides proteins, other solutes in plasma include electrolytes, nutrients regulatory substances such as enzymes and hormones, gases and waste products such as urea, uric acid, creatinine, ammonia and bilirubin. (II) Formed Elements: The formed elements of the blood include three principal

### **Components:**

**Red Blood Cells (RBCs):** Red blood cells (RBCs) or erythrocytes (erythro-red; cyte cell) are biconcave discs with a diameter of 7-8  $\mu\text{m}$ . These contain the oxygen carrying protein haemoglobin, which is a pigment that gives whole blood its red colour. RBCs lack a nucleus and other organelles, and can neither reproduce nor carry on extensive metabolic activities. They have strong and flexible plasma membrane, which allows them to deform without rupturing as they squeeze through narrow capillaries. A healthy adult male has about 5.4 million red blood cells per microliter ( $\mu\text{l}$ ) of blood and a healthy adult female has about 4.8 million red blood cells. **White blood cells or leukocytes:** (leuko-white) have nuclei and do not contain haemoglobin. WBCs are classified as either granular or agranular, depending on whether they contain cytoplasmic granules that are made visible by staining, when viewed through a light microscope.

Granular leukocytes include eosinophils, basophils and neutrophils whereas Agranular leukocytes include lymphocytes and monocytes. There are 5000-10000 WBCs present per  $\mu\text{l}$  of blood. **Granulocytes or Granular Leukocytes:**

**Eosinophil:** These produce red-orange stain with acidic dyes. Nucleus of eosinophil has two lobes connected by a thick strand of chromatin. Eosinophils phagocytize antigen-antibody complexes and are effective against certain parasitic worms.

**Basophil:** These produce blue-purple stain with basic dyes. The granules obscure the nucleus, which has two lobes. These substances intensify the inflammatory reaction and are involved in hypersensitivity (allergic) reactions. **Neutrophil:** The granules are smaller, evenly distributed, and pale lilac in colour. Nucleus has 2-5 lobes which are connected by very thin strands of chromatin.

Neutrophils respond most quickly to tissue destruction by bacteria. They are capable to carry out phagocytosis.

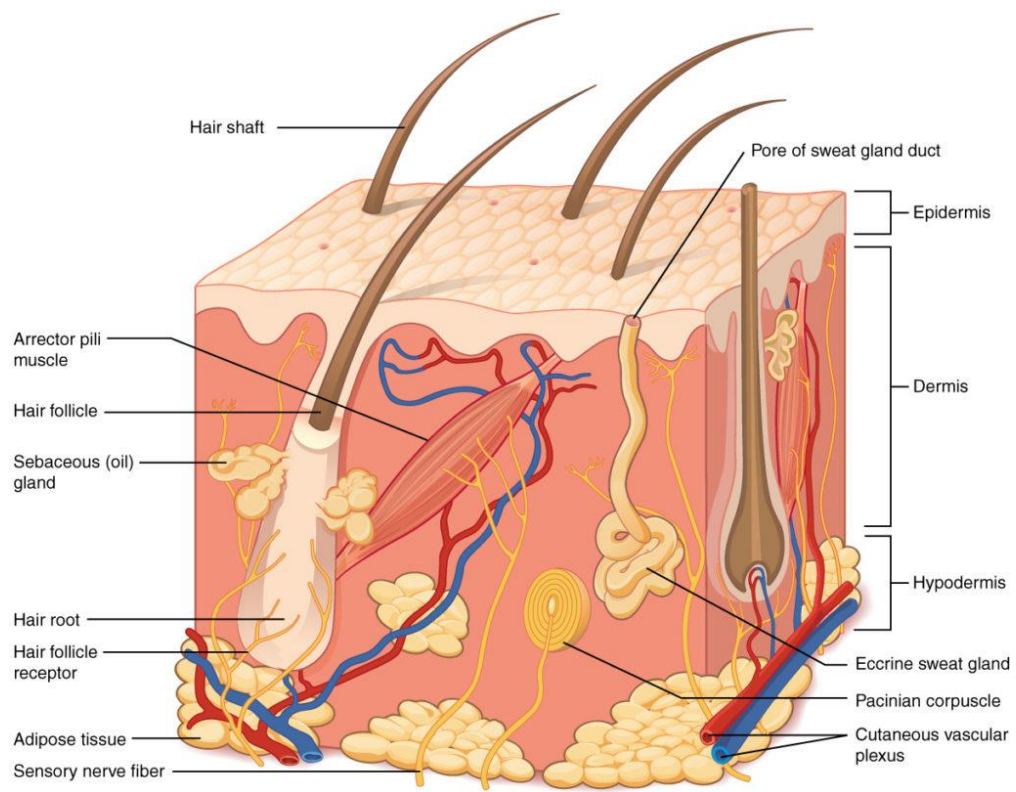
### **Agranulocytes or Agranular Leukocytes:**

**Lymphocytes:** The nucleus is round or slightly indented and stains darkly. The cytoplasm stains sky blue and forms a rim around the nucleus: Diameter of lymphocytes varies from 6-9  $\mu\text{m}$  to 10-14  $\mu\text{m}$ . **Monocytes:** The nucleus of monocyte is kidney shaped or horse shoe shaped.

The cytoplasm is blue-grey and has a foamy appearance. Diameter of monocyte is 12-20  $\mu\text{m}$ .

**Platelets:** Platelets or Thrombocytes consists of cell fragments, enclosed in plasma membrane. 150,000-400,000 platelets are present in each  $\mu\text{l}$  of blood. Each platelet is disc-shaped, 2-4  $\mu\text{m}$  in diameter, and has many vesicles but no nucleus. Platelets help to stop blood loss from damaged blood vessels by forming a platelet plug. Their granules also contain chemicals that, once released, promote blood clotting. Platelets have a short life span, normally just 5 to 9 days. Aged and dead platelets are removed by fixed macrophages in the spleen and liver.

**Result:** The human cardiovascular system is studied.



## H. EYE

**Aim:** To study integumentary (Skin) using model.

**Theory:** The human skin is the outer covering of the body and is the largest organ of the integumentary system. The skin has up to seven layers of ectodermal tissue and guards the underlying muscles, bones, ligaments and internal organs.

**Epidermis:** The epidermis is the outermost of the three layers that make up the skin, the inner layers being the dermis and hypodermis. The epidermis layer provides a barrier to infection from environmental pathogens and regulates the amount of water released from the body into the atmosphere through transepidermal water loss. The epidermis is divided into the following 5 sub layers or strata: (a) Stratum corneum

(b) Stratum lucidum

(c) Stratum granulosum (d) Stratum spinosum

(e) Stratum basale (also called stratum germinativum)

The epidermis contains no blood vessels, and cells in the deepest layers are nourished almost exclusively by diffused oxygen from the surrounding air and to a far lesser degree by blood capillaries extending to the outer layers of the dermis. The main functional cells that make up the epidermis are Merkel cells, keratinocytes, with melanocytes and Langerhans cells also present.

The epidermis can be further subdivided into the following strata (beginning with the outermost layer); corneum, lucidum (only in palms of hands and bottoms of feet), granulosum, spinosum, and basale. The daughter cells (see cell division) move up the strata changing shape and composition as they die due to isolation from their blood source. The cytoplasm is released and the protein keratin is inserted. They eventually reach the corneum and slough off (desquamation). This process is called keratinization. This keratinized layer of skin is responsible for keeping water in the body and keeping other harmful chemicals and pathogens out, making skin a natural barrier to infection.

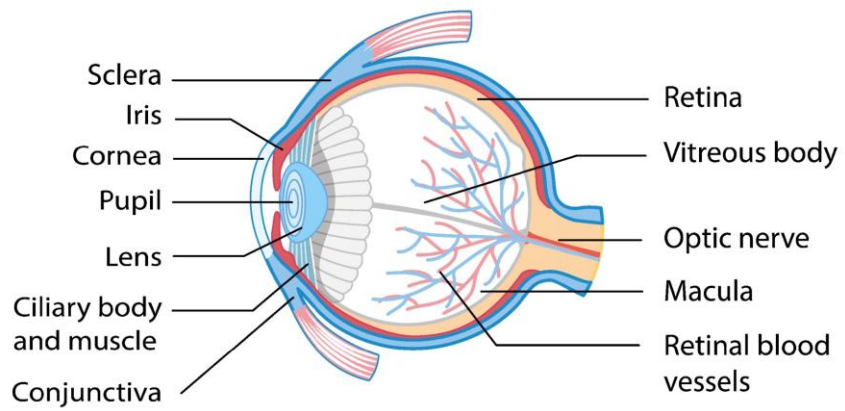
**Dermis:** The dermis is the layer of skin beneath the epidermis that consists of connective tissue and cushions the body from stress and strain. The dermis is tightly connected to the epidermis by a basement membrane. It also harbours many nerve endings that provide the sense of touch and heat. It contains the hair follicles, sweat glands, sebaceous glands, apocrine glands, lymphatic vessels and blood vessels. The blood vessels in the dermis provide nourishment and waste removal from its own cells as well as from the stratum basale of the epidermis. The

dermis is structurally divided into two areas: a superficial area adjacent to the epidermis, called the papillary region, and a deep thicker area known as the reticular region. (a) The papillary dermis is the uppermost layer of the dermis. It intertwines with the rete ridges of the epidermis and is composed of fine and loosely arranged collagen fibers. (b) The reticular dermis is the lower layer of the dermis, found under the papillary dermis, composed of dense irregular connective tissue featuring densely-packed collagen fibers. It is the primary location of dermal elastic fibers.

. **Hypodermis:** The hypodermis lies between the dermis and underlying tissue and organs. It composed of mostly adipose tissue and is the storage site of mostly fat body

**Result:** The Human skin are examined and studied.

# HUMAN EYE ANATOMY



## I) EYE

**Aim:** To study the human eye.

**Theory:** Sight or vision is extremely important to human survival. More than half of the sensory receptors in the human body are located in the eyes, and a large part of the cerebral cortex is devoted to process visual information. In this section, we examine electromagnetic radiation, the accessory structures of the eye, the eyeball itself, the formation of visual images, the physiology of vision, and the visual pathway from the eye to the brain

**Eye:** The adult eyeball measures about 2.5 cm (1 in) in diameter. Of its total surface area, only the anterior one-sixth is exposed; the remainder is recessed and protected by the orbit, into which it fits. Anatomically, the wall of the eyeball consists of three layers:

(1) fibrous tunic (2) vascular tunic, and (3) retina.

**1) Fibrous tunic:** The fibrous tunic is the superficial layer of the eyeball and consists of the anterior cornea and posterior sclera. The cornea is a transparent coat that covers the coloured iris. Because it is curved, the cornea helps to focus light onto the retina. The sclera is the "white" part of the eye. The sclera covers the entire eyeball except the cornea, it gives shape to the eyeball, makes it more rigid and protects its inner parts

**2) Vascular tunic:** The vascular tunic or uvea is the middle layer of the eyeball. It is composed of three parts: choroid, ciliary body and iris. The highly vascularized choroid, which is the posterior portion of the vascular tunic, lines most of the internal surface of the sclera. The choroid also contains melanocytes that produce the pigment melanin, which causes this layer to appear dark brown in colour. Melanin in the choroid absorbs stray light rays, which prevents reflection and scattering of light within the eyeball. As a result, the image cast on the retina by the cornea and lens remains sharp and clear,

(i) In the anterior portion of the vascular tunic, the choroid becomes the ciliary body. It extends from the ora serrata, the jagged anterior margin of the retina, to a point just posterior to the junction of the sclera and cornea. Like the choroid, the ciliary body appears dark brown in colour because it contains melanin producing melanocytes. In addition, the ciliary body consists of ciliary processes and ciliary muscle.

(ii) The iris, the coloured portion of the eyeball, is shaped like a flattened donut. It is suspended between the cornea and the lens and is attached at its outer margin to the ciliary processes. It consists of melanocytes and circular and radial smooth muscle fibres. The amount of melanin in the iris determines the eye colour. A principal function of the iris is to regulate the amount of light entering the eyeball through the pupil, the hole in the centre of the iris

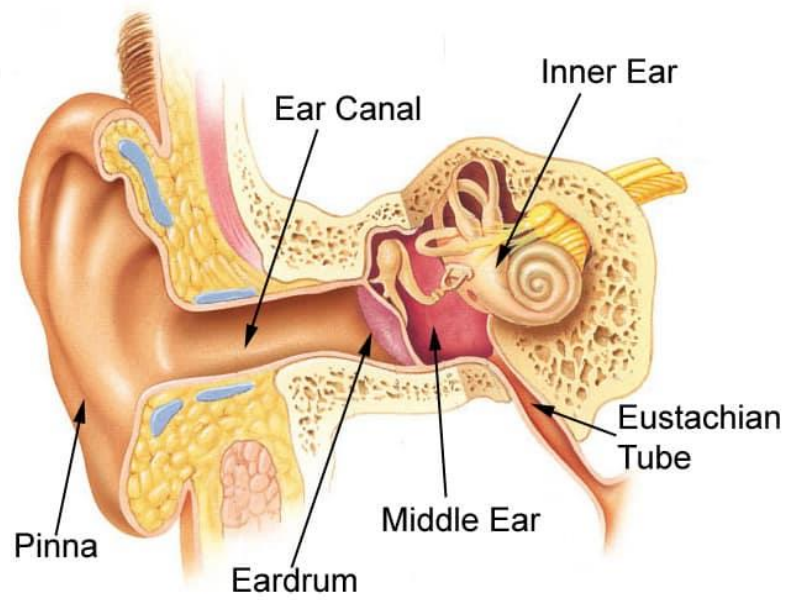
3) The third and inner layer of the eyeball, the retina, lines the posterior three quarters of the

eyeball and is the beginning of the visual pathway. The pigmented layer is a sheet of melanin-containing epithelial cells located between the choroid and the neural part of the retina. The melanin in the pigmented layer of the retina, like in the choroid, also helps to absorb stray light rays. The neural (sensory) layer of the retina is a multi-layered. Three distinct layers of retinal neurons-the photoreceptor layer, the bipolar cell layer and the ganglion cell layer. Photoreceptors are specialized cells that begin the process by which light rays are ultimately converted to nerve impulses. There are two types of photoreceptors rods and cones. Each retina has about 6 million cones and 120 million rods. Rods allow us to see in dim light, such as moonlight Brighter lights stimulate cones, which produce colour vision. Three types of cones are present in the retina:

- (1) Blue cones, which are sensitive to blue light.
  - (2) Green cones, which are sensitive to green light.
  - (3) Red cones, which are sensitive to red light
- From photoreceptors, information flows through the outer synaptic layer to bipolar cells and then from bipolar cells through the inner synaptic layer to ganglion cells. The axons of ganglion cells extend posteriorly to the optic disc and exit the eyeball as the optic (II) nerve.

**Lens:** Behind the pupil and iris, within the cavity of the eyeball, is the lens. Within the cells of the lens, proteins called crystalline, arranged like the layers of an onion, make-up the refractive media of the lens, which normally is perfectly transparent and lacks blood vessels. It is enclosed by a clear connective tissue capsule and held in position by encircling zonular fibres, which attach to the ciliary processes. The lens helps to focus images on the retina to facilitate clear vision.

**Result:** The human eye is studied.



## J) EAR

**Aim:** To study the human ear.

**Theory:** The ear is an engineering marvel because its sensory receptors can transduce sound vibrations with amplitudes as small as the diameter of an atom of gold (0.3 nm), into electrical signals 1000 times faster than photoreceptors can respond to light. Besides receptors for sound waves, the ear also contains receptors for equilibrium.

**Ear:** The ear is divided into three main regions: (1) The external ear, which collects sound waves and channels them inward; (2) The middle ear, which conveys sound vibrations to the oval window; and (3) The internal ear, which houses the receptors for hearing and equilibrium.

**(1) The external (outer) ear** consists of the auricle, external auditory canal and ear drum. The auricle (pinna) is a flap of elastic cartilage shaped like the flared end of a trumpet and covered by skin. The rim of the auricle is the helix the inferior portion is the lobule. The external auditory canal is a curved tube about 2.5 cm (1 in) long that lies in the temporal bone and leads to the ear drum. The tympanic membrane or ear drum is a thin, semi-transparent partition between the external auditory canal and middle ear. Near the exterior opening, the external auditory canal contains a few hairs and specialized sweat glands called ceruminous glands that secrete ear wax or cerumen.

**(2) The middle ear** is a small, air-filled cavity in the petrous portion of the temporal bone that is lined by epithelium. It is separated from the external ear by the tympanic membrane and from the internal ear by a thin bony partition that contains two small membrane covered openings. the oval window and the round window. Extending across the middle ear and attached to it by ligaments are the three smallest bones in the body. The bones, named for their shapes, are the malleus, incus and stapes. The incus is the middle bone in the series, articulates with the head of the stapes. The base or foot plate of the stapes fits into the oval window. Directly below the oval window is another opening, the round window which is enclosed by a membrane, called the secondary tympanic membrane. The anterior wall of the middle ear contains an opening that leads directly into the auditory (pharyngotympanic) tube is commonly known as the eustachian tube.

**(3) The internal (inner) ear** is also called the labyrinth because of its complicated series of canals: Structurally, it consists of two main divisions: an outer bony labyrinth that encloses an inner membranous labyrinth. The bony labyrinth is a series of cavities in the petrous portion of the temporal bone divided into three areas:

The semi-circular canals and

(i) The vestibule, both of which contains receptors for equilibrium, and

(ii) The cochlea, which contains receptors for hearing.

The bony labyrinth is lined with periosteum and contains perilymph. This fluid, which is chemically similar to cerebrospinal fluid, surrounds the membranous labyrinth. Membranous labyrinth is a series of epithelial sacs and tubes inside the bony labyrinth that have the same general form as the bony labyrinth. The epithelial membranous labyrinth contains endolymph.

**Result:** The human ear is studied.