| Class Notes | |
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| **Class: XI** | **Topic: Animal Tissues** |
| **Subject: Biology** | |

## Animal Tissues

The structures of the cells vary according to their function. Therefore, the tissues are different and are broadly classified into four types:

**(i) Epithelial,**
**(ii) Connective,**
**(iii) Muscular and**
**(iv) Neural**

### Kinds of Tissues

On the basis of function and location the tissues are of four types:

### (1) Epithelial Tissue

- Tissue has a free surface, which faces either a body fluid or the outside environment and thus provides a covering or a lining for some part of the body. The cells are compactly packed with little intercellular matrix.
- There are two types of epithelial tissues namely simple epithelium and compound epithelium, Simple epithelium is composed of a single layer of cells and functions as a lining for body cavities, ducts, and tubes. The compound epithelium consists of two or more cell layers and has protective function as it does in our skin.
- On the basis of structural modification of the cells, simple epithelium is further divided into three types. These are

(i) Squamous, (ii) Cuboidal, (iii) Columnar.

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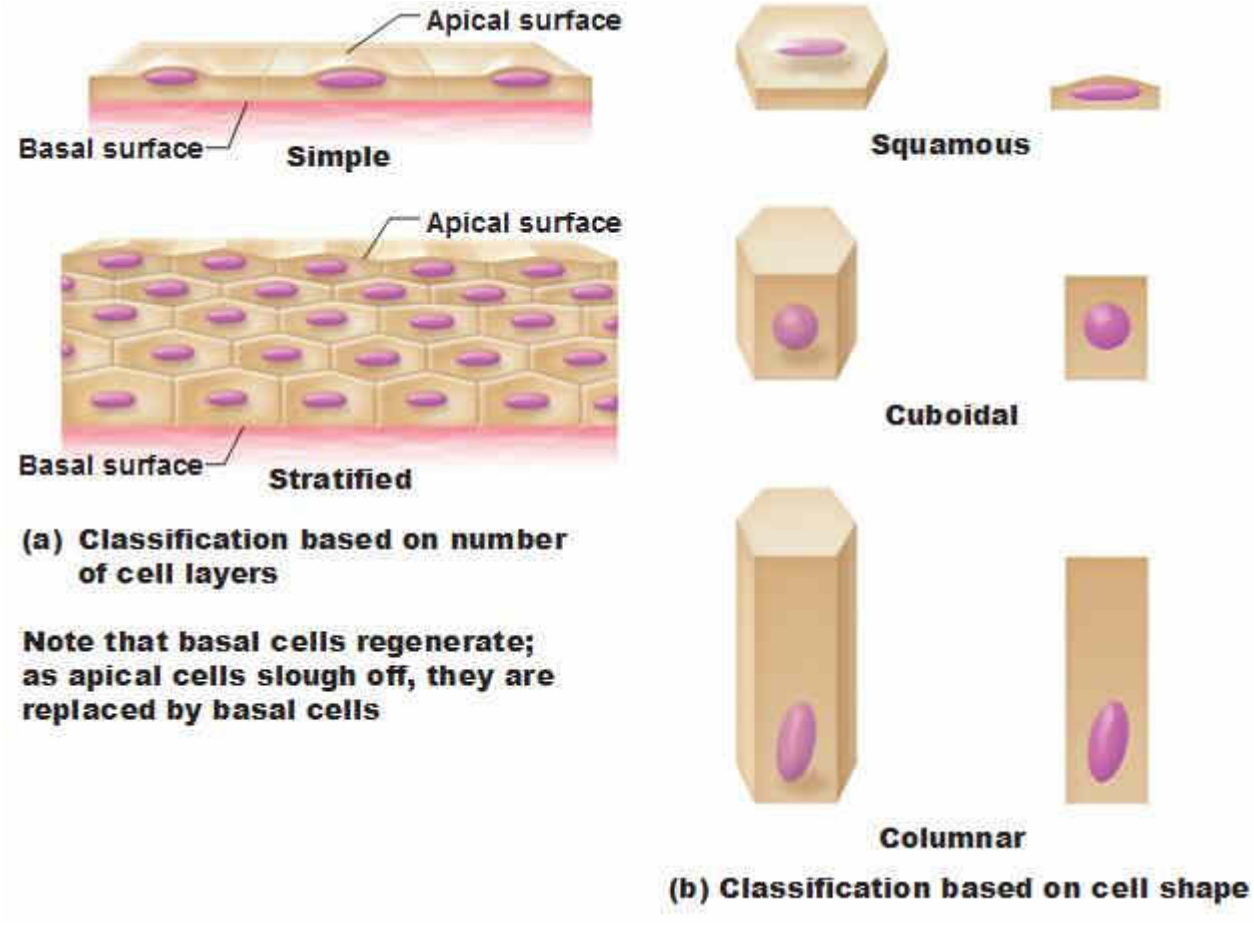


- The squamous epithelium is made of a single thin layer of flattened cells with irregular boundaries. They are found in the walls of blood vessels and air sacs of lungs and are involved in a functions like forming a diffusion boundary.
- The cuboidal epithelium is composed of a single layer of cube-like cells. This is commonly found in ducts of glands and tubular parts of nephrons in kidneys and its main functions are secretion and absorption. The epithelium of proximal convoluted tubule (PCT) of nephron in the kidney has microvilli.
- The columnar epithelium is composed of a single layer of tall and slender cells. Their nuclei are located at the base. Free surface may have microvilli. They are found in the lining of stomach and intestine and help in secretion and absorption. If the columnar or cuboidal cells bear cilia on their free surface they are called ciliated epithelium. Their function is to move particles or mucus in a specific direction over the epithelium. They are mainly present in the inner surface of hollow organs like bronchioles and fallopian tubes.
- Some of the columnar or cuboidal cells get specialised for secretion and are called glandular' epithelium. They are mainly of two types: unicellular, consisting of isolated glandular cells (goblet cells of the alimentary canal), and multicellular, consisting of cluster of cells (salivary gland).
- Compound epithelium is made of more than one layer (multi-layered) of cells and thus has a limited role in secretion and absorption. Their main function is to provide

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protection against chemical and mechanical stresses. They cover the dry surface of the skin, the moist surface of buccal cavity, pharynx, inner lining of ducts of salivary glands and of pancreatic ducts.

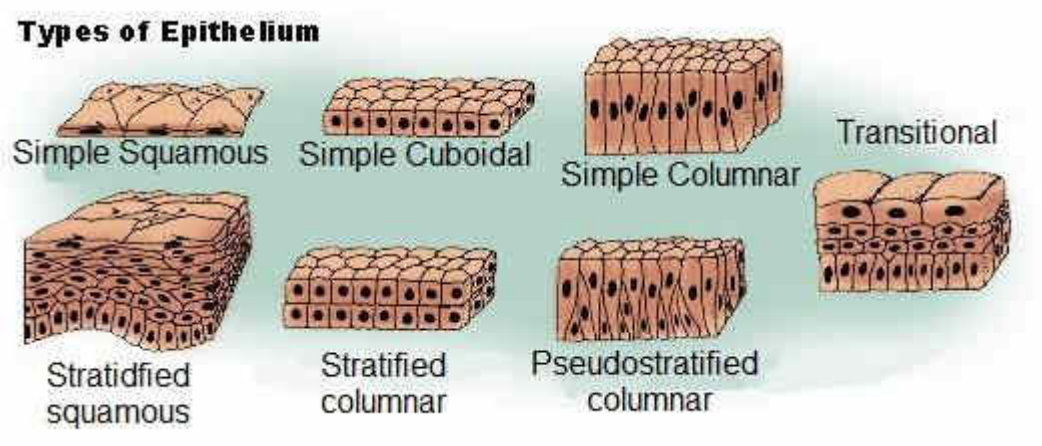
**Epithelial tissues are classified into:**

**(a) Stratified squamous keratinised epithelium:**

Stratified squamous epithelium is characterized by multiple layers of cells with typical flattened squamous cells at the free or outer surface of the sheet. The presence of keratin in these cells contributes to the protective qualities of skin covering the body surface. Keratin is dead and waterproof so it protects the underlying tissues from abrasion and infection e.g. epidermis of the skin of land vertebrates.

**(b) Stratified squamous non keratinised epithelium:**

Its free surface is moist, and the outer epithelial cells, unlike those found in the skin, do not contain keratin. This type of epithelium serves a protective function. It is found lining the oral cavity (buccal cavity), pharynx, oesophagus, anal canal, lower part of urethra, vocal cords, vagina, cervix (lower part of uterus) and cornea of eyes.




**(c) Stratified columnar epithelium:**

It is protective epithelium has multiple layers of columnar cells, only the most superficial cells are truly columnar in appearance. Epithelium of this type is rare. It is found in male urethra and in the mucous layer near the anus. It also lines mammary gland ducts and epiglottis.

**(d) Transitional epithelium (Urothelium):**

It is often consists fen or more layers thick. It lacks germinative layer, basement membrane. Stratified transitional epithelium is typically found in the body areas such as the wall of urinary bladder, ureter and renal pelvis. It is located in all the hollow viscera subjected to stress and protects organ wall from tearing.

**(e) Neurosensory epithelium:**

Olfactory mucosa, called Schneiderian membrane, lining of internal nares, retina of eyes and epithelial covering of tongue containing taste buds are examples of neurosensory epithelia. The sensory cells bear, at their free ends, slender "sensory hairs" to receive specific stimuli. Basely, these cells are connected, by means of synapses, with fine fibrils of sensory nerves.

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**(f) Pigmented epithelium:**

The epithelial cells of the basal layer of retina contain pigment. Hence, this layer is often referred to as a pigmented epithelium. For e.g. - Pigmented layer of retina, iris and skin.

**(g) Germinal epithelium:**

- Specialized cuboidal cells capable of producing gametes as found in gonads. Germinal epithelium produces gametes e.g., ova (Female gametes) and sperms (Male gametes)
- All cells in epithelium are held together with little intercellular material. In nearly all animal tissues, specialised junctions provide both structural and functional links between its individual cells.
- Three types of cell junctions are found in the epithelium and other tissues. These are called as tight, adhering and gap junctions.
- Tight junctions help to stop substances from leaking across a tissue.
- Adhering junctions perform cementing to keep neighbouring cells together.
- Gap junctions facilitate the cells to communicate with each other by connecting the cytoplasm of adjoining cells, fat rapid transfer of ions, small molecules and sometimes big molecules.

## (2) Connective Tissue

- Connective tissues are most abundant and widely distributed in the body of complex animals.
- They are named connective tissues because of their special function of linking and supporting other tissues / organs of the body.
- They range from soft connective tissues to specialised types, which include cartilage, bone, adipose, and blood.
- In all connective tissues except blood, the cells secrete fibres of structural proteins called collagen or elastin.
- The fibres provide strength, elasticity and flexibility to the tissue.
- These cells also secrete modified polysaccharides, which accumulate between cells and fibres and act as matrix (ground substance).
- Connective tissues are classified into three types:

(i) Loose connective tissue,

(ii) Dense connective tissue and

(iii) Specialised connective tissue.

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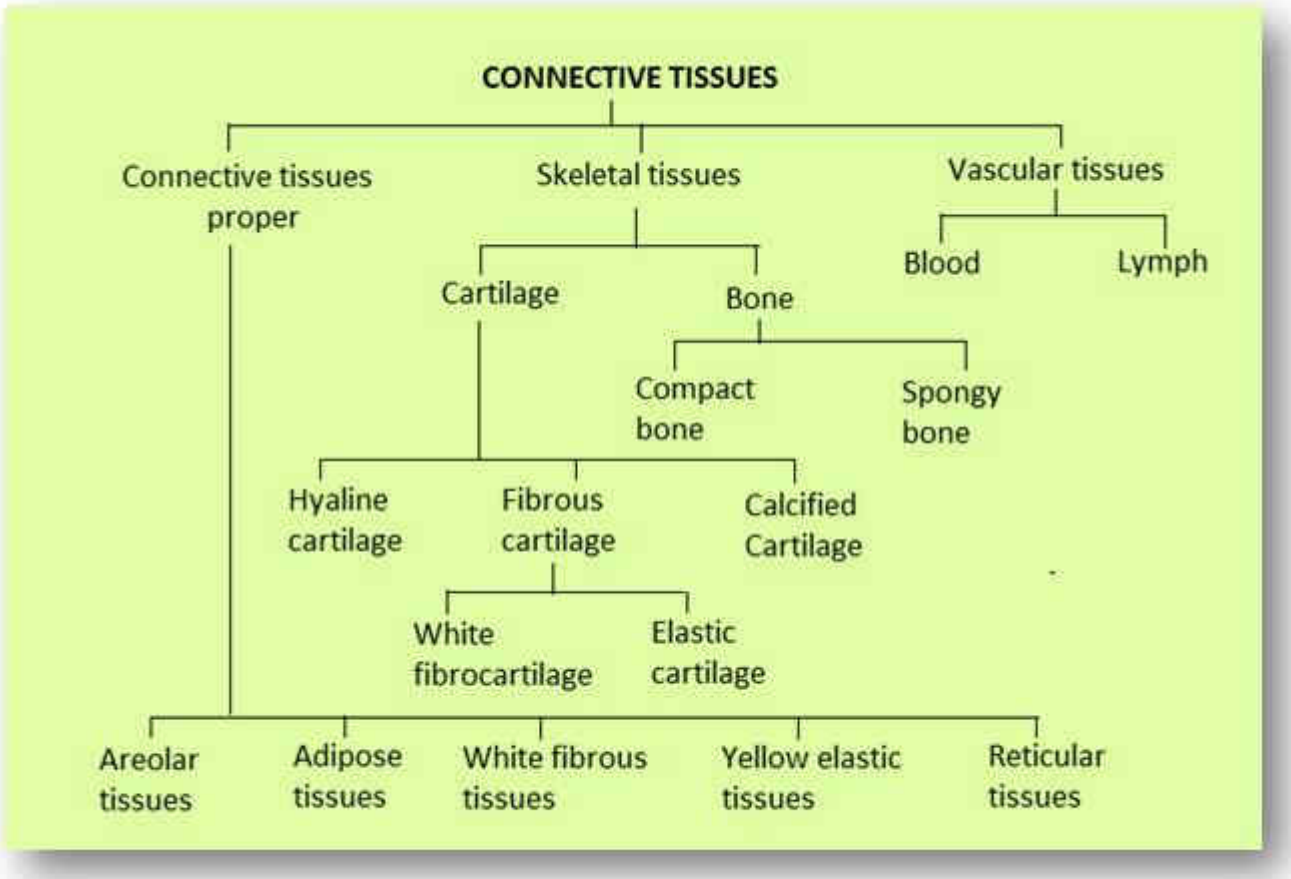


- Loose connective tissue has cells and fibres loosely arranged in a semi-fluid ground substance, for exam pie, areolar tissue present beneath the skin. Often it serves as a support framework for epithelium.
- It contains fibroblasts (cells that produce and secrete fibres), macrophages and mast cells.
- Adipose tissue is another type of loose connective tissue located mainly beneath the skin. The cells of this tissue are specialised to store fats. The excess of nutrients which are not used immediately are converted into fats and are stored in this tissue.
- Fibres and fibroblasts are compactly packed in the dense connective tissues.
- Orientation of fibres shows a regular or irregular pattern and is called dense regular and dense irregular tissues.
- In the dense regular connective tissues, the collagen fibres are present in rows between many parallel bundles of fibres.
- Tendons, which attach skeletal muscles to bones and ligaments which attach one bone to another are examples of this tissue.
- Dense irregular connective tissue has fibroblasts and many fibres (mostly collagen) that are oriented differently. This tissue is present in the skin.

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**(a) Collagenous fibres**

- These are the most abundant fibrous element of areolar and other connective tissues. There are long, unbranched fibres of a soluble and shining collagen protein (tropo collagen).
- These fibres are of more strength and provide maximum tensile strength. These are colourless and hyaline, yet called white fibres to distinguish them from yellow elastin fibres.
- Collagen protein is the most abundant protein, of the body constitutes 25% the total body protein.
- Collagen fibre can be stained by eosin. When collagen fibres are removed from the areolar tissue they become loose and elastic. e.g. Bone, Cartilage, Ligament and tendon.

**(b) Yellow elastin fibres**

- Formed of elastin protein, these fibres are less numerous, thinner, branched, anastomosing, and of a pale yellow colour.
- These are very elastic and remain stretched due to tension in the areolar tissue, when broken in teased preparations, these coil and cur; like tense wires.
- Elastin is probably the most resistant of all body proteins to chemical changes. Thousands of year's old 'mummies' still have their arteries intact due to, well-preserved elastin fibres. They are the orceinophilicie, stained by orcein.

**(c) Reticulin fibres:**

- These are delicate, freely branching and inelastic fibres of reticulin protein, found interwoven, to form networks.
- These are very abundant in embryos, new born babies and in healing and regenerating wounds.
- In areolar tissues of adults, these are mostly replaced by collagen fibres, but remain abundant in lymphoid and blood forming tissues and in the stroma of pancreas, liver etc.
- They are stained with AgBr and $AgNO_3$ hence are called Argentophillic or Argyrophillic. On boiling collagen and reticular fibres both convert in glue.

**(d) Yellow fibrous tissue:**

- The matrix is with numerous and closely packed yellow or elastin fibres which are similar to but thicker than those of areolar connective tissue.
- It is elastic and flexible. It forms wall of blood vessels, lungs; true vocal chords, trachea, capsule of spleen and bronchioles.
- It also forms sheet in ligaments. Ligament is a modified yellow elastic fibrous tissue and connects bone to bone.

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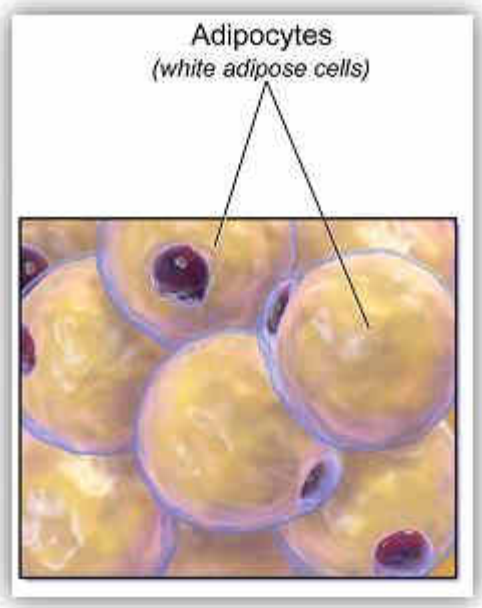
**(e) Adipose tissue:**

- It is modified form of areolar tissue made up of specialized large spherical fat cells




(below the skin) or adipocytes.

- Adipose tissue chiefly acts as "Food reserve" or fat depot for storage and metabolism of lipids. Besides this, they also act as heat insulators and pressure, pull and push absorbers.

**(f) White fibrous tissue:**

- It is modified form of areolar tissue. Only collagen fibres are present in the matrix and cells are mainly fibroblasts, present at the joints between skull bones and makes them immovable, also found in the dermis of higher mammals.
- Cartilage, bones and blood are various types of specialised connective tissues.
- The intercellular material of cartilage is solid and pliable and resists compression. Cells of this tissue (chondrocytes) are enclosed in small cavities within the matrix secreted by them.
- Most of the cartilages in vertebrate embryos are replaced by bones in adults. Cartilage is present in the tip of nose, outer ear joints, between adjacent bones of the vertebral column limbs and hands in' adult".
- Bones have a hard and non-pliable ground substance rich in calcium salts and collagen fibres which give bone its strength.
- It is the main tissue that provides structural frame to the body. Bones support and protect softer tissues and organs.
- The bone cells (osteocytes) are present in the spaces called lacunae. Limb bones, such as the long bones of the legs, serve weight-bearing functions.

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- They also interact with skeletal muscles attached to them to bring about movements. The bone marrow in some bones is the site of production of blood cells.

**(g) Periosteum:**

- It is a membrane that forms an envelope around the bone.
- Periosteum is comprised of two distinct layers. Outer layer consist of thin white fibrous connective tissue. Inner layer consist of osteoblasts, osteoblasts are spider like bone cells, also known as bone forming cells, because they produces new bone materials.

**(h) Matrix:**

- Matrix is composed of protein called ossein. 'The matrix forms thin plates called lamellae.
- Lamellae are of three types. Haversian lamellae (occur around haversian canal) concentric or circumferential lamellae (inner to periosteum and outer to endosteum) and interstitial lamellae (between haversian system).
- In the lamellae minute bone cells osteocytes are present.

**(i) Endosteum:**

It is present outer to the bone marrow cavity. Endosteum is a membrane which lines the marrow cavity. It is comprised of two distinct layers, one is of fibrous connective tissue and another is osteoblasts.

**(j) Bone marrow:**

Bone marrow is a specialized type of soft, diffuse connective tissue called "Myeloid tissue". It takes part in production of blood 'cells hence known as haemopoietic tissue. It is composed of adipose tissue, areolar tissue and blood. It is of two types –

**(i) Red bone marrow:** Red in colour due to presence of lot of blood vessels. In foetal life and at birth it is present in entire skeleton. After 5th year red bone marrow replaced by yellow bone marrow, at 20-25 years red bone marrow present at ribs, sternum, clavicles, vertebrae, scapula, pelvis, epiphysis of humerus and femur. Produces RBCs, WBC platelets, granular, leucocytes like basophils eosinophils and neutrophils.
**(ii) Yellow bone marrow:** Yellow in colour and has much fatty tissue (adipose tissue), present in shaft of long bones. Produces blood cells in emergency i.e. at the time of excessive loss of blood, yellow bone marrow may be replaced by red bone marrow in anaemia.
Blood is a fluid connective tissue containing plasma, red blood cells (RBC), white blood cells (WBC) and platelets. It is the main circulating fluid that helps in the transport of various substances.
**(k) Plasma:** It constitutes about 5% of body weight. It represents matrix of blood. Plasma is slightly alkaline and transparent. It forms 55-.60% by volume of blood. Plasma contains: Water (91-92%), Solid (8-9%). Plasma Solid part consists of organic (7%) and inorganic (1%) substances.
**(l) Blood corpuscles:** Blood corpuscles form 40-50% of the blood and are of three types' viz. Red blood corpuscles, white blood corpuscles and platelets.
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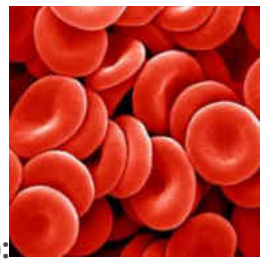

**(i ) Red blood corpuscles (RBCs or Erythrocytes):**
These occur only in vertebrates and are the most abundant (99%) of blood corpuscles, imparting the characteristic red colour to the blood. The shape, size and structure of RBCs vary in different types of vertebrates, but their function is the same in all, namely to transport respiratory gases, especially the oxygen ($O_2$).
**- RBCs of frog:** Amphibian RBCs are largest amongst the vertebrates. Those of Amphiuma and Proteus are largest amongst amphibians about 82 mm. These are flattened and oval, dislike but slightly biconvex due to a large oval and centrallyplaced nucleus.
**- RBCs of mammals:** Mammals have smallest RBCs amongst the vertebrates. Those of Musk deer are smallest amongst the mammals. Whereas the RBCs of other vertebrates are oval and nucleated, those of mammals are roughly circular (except those of the family camellidae - camels; llamas, dromedaries which are oval in shape) and non-nucleated.
**- RBCs of human:** They are about 7.4mm in diameter and its thickness is 1 to 1.5mm. It is pale yellow in colour but appear to be red in group. Surface area of all RBCs of a person totals about 1500 to 2000 times the surface area of the body itself.
**- Structure of RBCs:**

- Each RBC is bounded by a dynamic, enzyme-containing plasma membrane.
- In a human RBC, about 26.5 crore molecules of haemoglobin are packed in the intracellular framework.
- Water constitutes about 60% of RBC. The rest is solid.
- Haemoglobin forms about 34% of wet and 90% of dry weight of an RBC.
- Thus, 100 ml of normal human blood contains about 15 gm of haemoglobin on an average,
- An apparatus named haemoglobinometer is used to determine the haemoglobin contents of blood.

**- Function of RBCs:**

- The major function of erythrocytesis to receive oxygen of respiratory surfaces and then transport and readily deliver it to all cells of body.
- This important function is performed by haemoglobin which has a great ability to combine loosely and reversibly with Oxygen and is, hence, called "respiratory pigment".
- Haemoglobin, in annelids, is dissolved in the plasma because of absence of red blood corpuscles.

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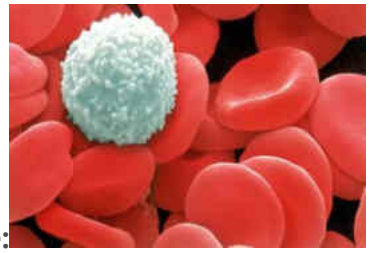
- In mollusc and some arthropods, etc., a different respiratory pigment, haemocyanin is found dissolved in the plasma. This pigment is bluish due to presence of copper in place of iron.

**- ESR:**

- It is called erythrocyte sedimentation rate.
- This test is measured by "Wintrobe's tube" and 'Western blotting" method.
- It is the rate of sinking/ settling down of RBC in the plasma to form rouleaux.
- Man has lower ESR as compared to women and it is lowest in new born.
- Normal value of ESR in male is about 5 mm and in female 10 mm in first hour.
- A rise in ESR indicates the presence of infective destructive inflammatory diseases.



**(ii) White blood corpuscles (WBCs) or Leucocyte:**

- They are nucleated, colourless and complete cells.
- They are bigger than RBC but their number is less.
- WBC shows least constancy in shape. The number of WBC is 5,000 to 10,000 per cubic mm.
- They are formed in red bone marrow, spleen, thymus and lymph nodes from myelocytes and the process is called as myelecoeisis.
- The life of WBC is of 15 hours to 2 days.
- The WBC are destroyed outside the blood vessels and the process by which the come out is called as diapedesis.
- An increase in the number of white blood corpuscles is called leucocytosis.
- More than 20,000 per cubic mm indicate some disease. A decrease below 5000/ Cu.mm is called leucopenia as in typhoid fever.

**(iii) Blood platelets:**

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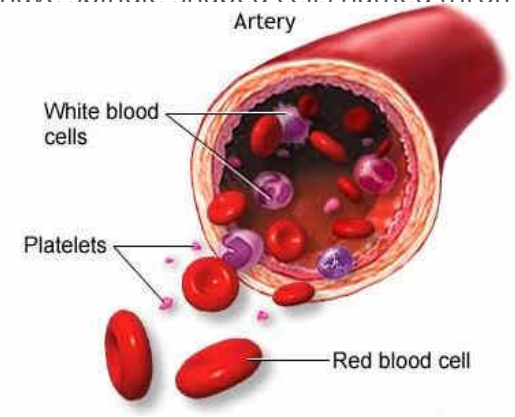
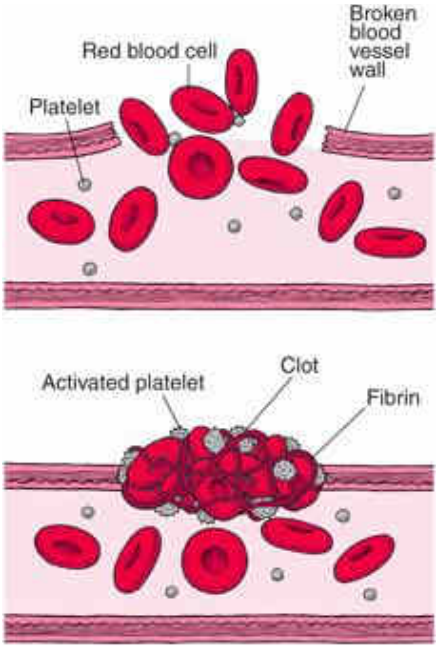
- These are protoplasmic disc that are found in mammalian blood (lower vertebrates have spindle-shaped cells named thrombocytes).




- Platelets arise as detached tips of protoplasmic processes extending from the cytoplasm of giant cells, megakaryocytes of red bone marrow.
- The shape is oval to round, often stellate.
- There are approximately 300,000 platelets in a cubic millimetre of blood.
- Platelets are nonnucleated.
- Life span is about 5-9 days.




## Coagulation or Clotting of blood:

- Process of formation of blood clot is also known as blood coagulation. Normal time of blood clotting is 3 to 8 minutes. Blood clotting is checked in blood vessels by presence of anticoagulant.
- When an injury is caused to a blood vessel bleeding starts which is stopped by a process called blood coagulation or clotting. This process can be described under four major stages.
- I.Damaged platelets or tissue cells release thromboplastin

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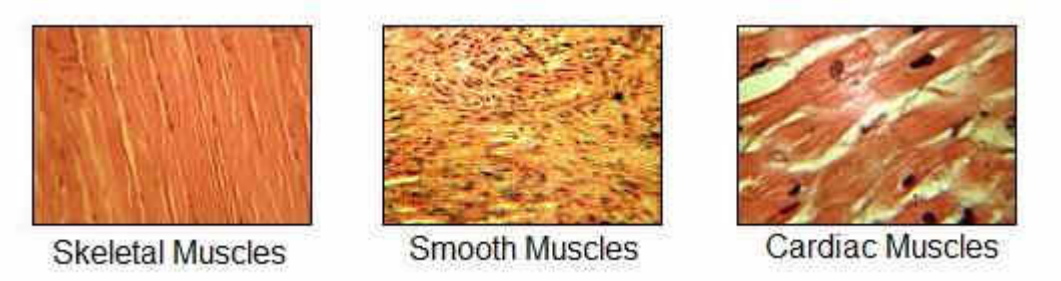
- Blood coagulation is helped by thrombocytes.

**- Lymph:** Lymph can be defined as blood minus RBCs but more WBCs. Lymph is chiefly made of plasma plus leucocytes. Most important centre for the formation of lymph is interstitial space. Interstitial fluid, intercellular fluid, tissue fluid and lymph all are same in composition. Exchange of materials between blood and tissue fluid occurs through blood capillaries.
**- Functions of lymph:** The basic function of lymph is to bring back, into the vascular circulation, the cell debris, large colloid particles and the part of the blood plasma that had diffused out from arterial capillaries into the tissue fluid but has failed to return back into venous capillaries. The white corpuscles of the lymph are the same as those of the blood and have the same functions of defense and of assistance in tissue repair and healing. In intestinal wall, lymph capillaries, called lacteals, are specially meant for absorption of fats.

## (3) Muscle Tissue

- Each muscle is made of many long, cylindrical fibres arranged in parallel arrays. These fibres are composed of numerous fine fibrils, called myofibrils.
- Muscles are of three types, skeletal, smooth, and cardiac.
- Skeletal muscle tissue is closely attached to skeletal bones. In a typical muscle such as the biceps, striated (striped) skeletal muscle fibres are bundled together in a parallel fashion. A sheath of tough connective tissue encloses several bundles of muscle fibres.
- The smooth muscle fibres taper at both ends (fusiform) and do not show striations. Cell junctions hold them together and they are bundled together in a connective tissue sheath. The wall of internal organs such as the blood vessels, stomach and intestine contains this type of muscle tissue. Smooth muscles are 'involuntary' as their functioning cannot be directly controlled.
- Cardiac muscle tissue is a contractile tissue present only in the heart. Cell junctions fuse the plasma membranes of cardiac muscle tells and make them stick together.
- Communication junctions (intercalated discs) at some fusion points allow the cells to contract as a unit, i.e., when one cell receives a signal to contract, its neighbours are also stimulated to contract.

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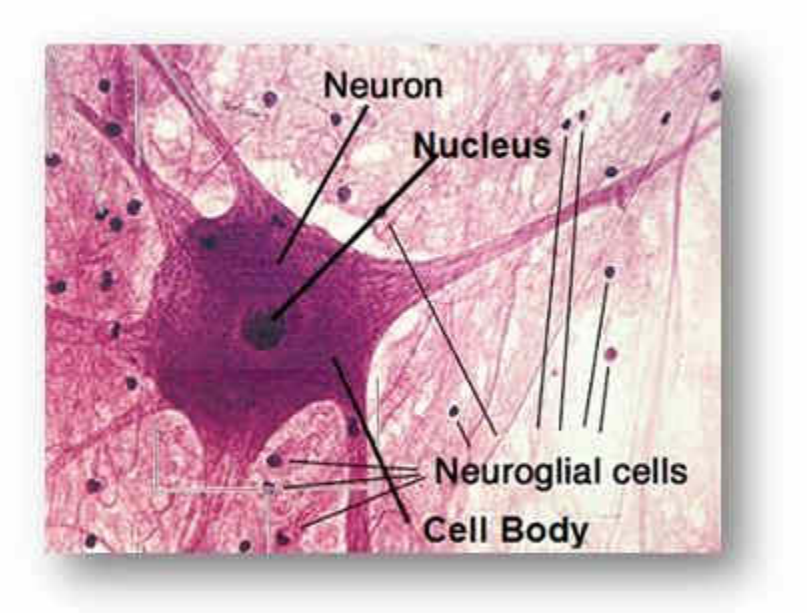
## (4) Neural Tissue




- Neural tissue exerts the greatest control over the body's responsiveness to changing conditions.
- Neurons, the unit of neural system are excitable cells.
- The neuroglial cells which constitute the rest of the neural system protect and support neurons.
- Neuroglia makes up more than one half the volume of neural tissue in our body.

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