

Tissues

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Animal Tissues are of 4 types:

1. Epithelial Tissue 2. Connective Tissue 3. Muscular Tissue 4. Nervous Tissue.

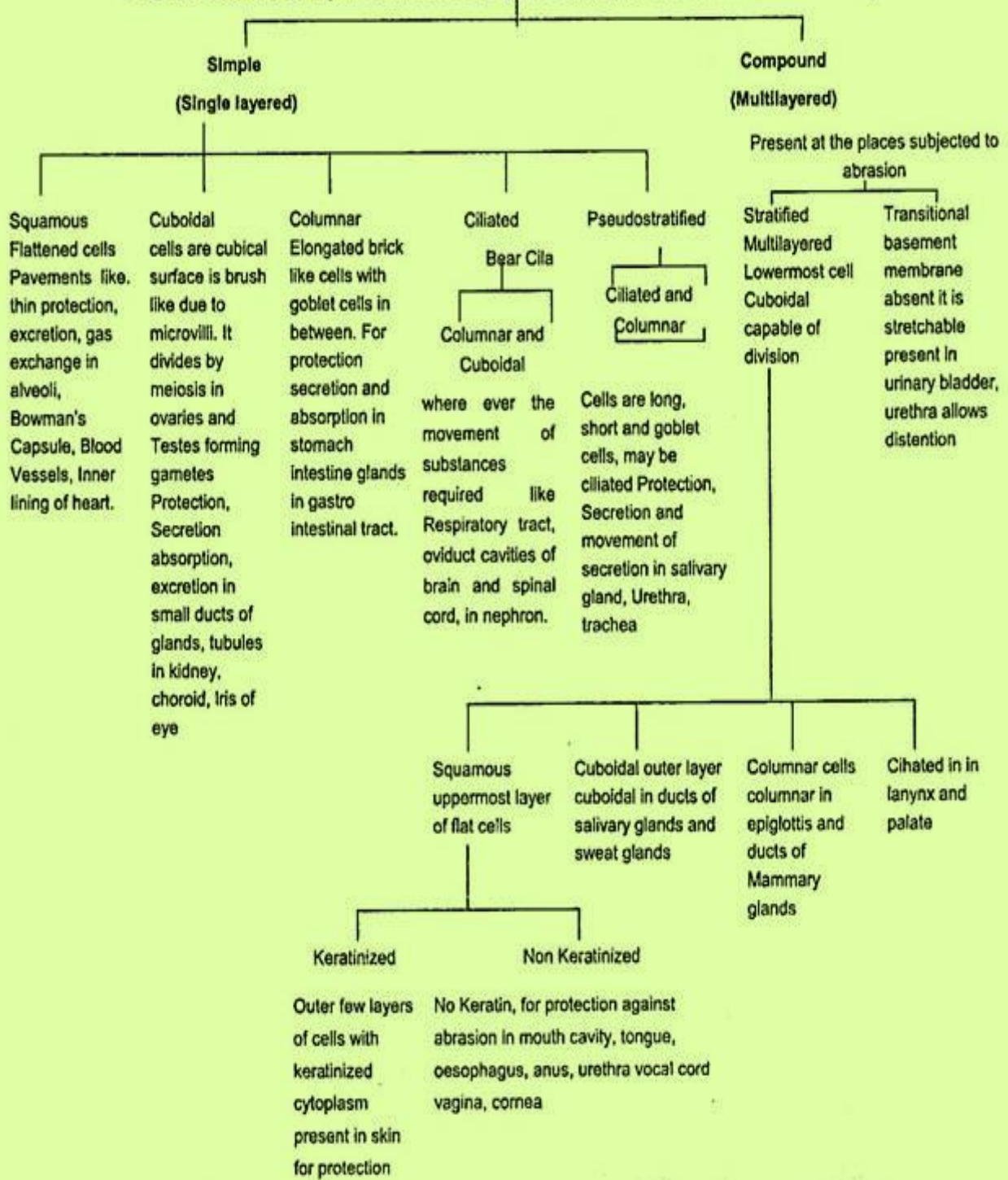
1. Epithelial Tissue:

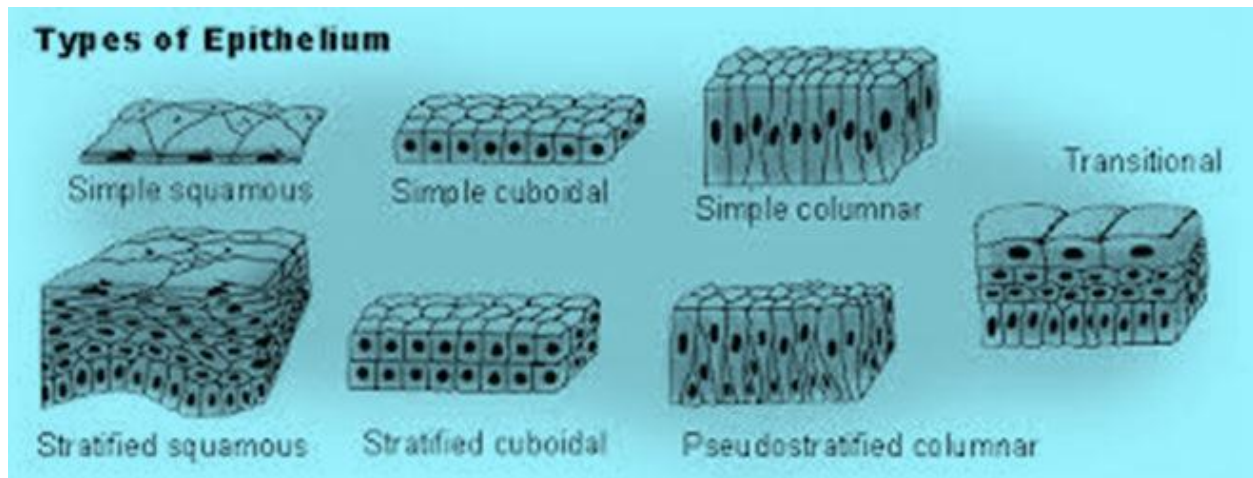
Epithelial tissue is the protective covering and inner lining of the body and organs. Epithelial tissue was first to evolve during the course of evolution and is first formed during embryonic development. These tissues develop from all the three germ layers of the embryo viz. ectoderm, mesoderm and endoderm.

The important features of the epithelial tissues are:

- (i) Tissues are either single layered or multilayered.
- (ii) Cells are closely packed with little intercellular material and no blood vessels but may have nerve endings.
- (iii) Epithelial tissues rest on a non-cellular basement membrane.
- (iv) This tissue has great power of regeneration.
- (v) Epithelial cells are held together by tight junction (zonula occludens), gap junctions, zonula adherens, desmosomes (macula adherens) or interdigitation.
- (vi) The plasma membrane of the cells may be specialized into microvilli, stereocilia, kinocilia and flagella.

Classification of Epithelial Tissue (Structure, location and Function)





Classification of simple epithelium:

1. Simple Squamous Epithelium (L., squame = scale):

Structure:

The simple squamous epithelium consists of thin, extremely flattened cells which are closely fitted like the tiles of a floor. Hence it is also called pavement epithelium. Although the cells are of irregular shape, in the surface view they appear roughly polygonal. The cells are fairly large in size with centrally placed nuclei. The nucleus of each cell is thicker than the cytoplasm and it gives bulged appearance on the surface.

Location:

The simple squamous epithelium lines the Bowman's capsule of the kidney tubules, the terminal bronchioles and alveoli of lungs, the blood vessels, lymph vessels, heart and coelomic cavities. Functions: The thin, delicate nature of squamous epithelium permits rapid movement of molecules (such as diffusion of gases). The squamous epithelium also helps in protection, excretion and secretion of coelomic fluid.

The squamous epithelium when occurs in the blood vessels and lymph vessels, it is called endothelium, in the chambers of the heart, endocardium and in the walls of thoracic and abdominal cavities mesothelium. The cell outlines of endothelium and mesothelium are wavy and termed tessellated epithelia.

2. Simple Cuboidal Epithelium:

Structure:

The cells of the cuboidal epithelium are almost cube-like, i.e., they are as tall as wide. The nucleus is spherical and lies in the centre of the cell. The cells appear as polygonal in surface view and cuboidal in vertical section.

Location:

The cuboidal epithelium occurs in the kidney tubules, thyroid gland, gonads, and also in sweat, salivary glands and pancreatic ducts.

In the salivary and pancreatic ducts it is non-secretory. In the sweat, salivary and thyroid glands it is secretory. In the proximal convoluted tubule of the kidney, the cuboidal cells exhibit numerous microvilli at their free ends. Since the latter give brush like appearance, the epithelium is called brush-bordered cuboidal epithelium. The cuboidal epithelium which lines the ovaries and the seminiferous tubules is known as germinal epithelium and it produces new cells for the gamete formation.

Functions:

Protection, secretion, absorption and gamete formation.

3. Simple Columnar Epithelium:

Structure:

The cells of the simple columnar epithelium are tall, pillar like and are placed side by side. The free surface of a columnar epithelial cell is smooth. The oval nucleus lies close to the base of the cell. The cytoplasm is either clear or with droplets of secretory material. The cells look polygonal in surface view.

Location:

Simple columnar epithelium forms a lining of the stomach, small intestine, colon, gall bladder, gastric glands, intestinal glands and pancreatic lobules. Since here it performs the secretory function, it is called glandular epithelium. Certain cells of the columnar epithelium of stomach and intestine produce mucus which forms a fine mucus coating over the epithelium. These mucus producing cells are called goblet cells.

The epithelium having mucus-secreting cells along with the underlying connective- tissue is called mucous membrane or mucosa. The other columnar cells lining the intestine are specialized for the absorption of water and digested food. In order to increase the surface area for absorption they bear microvilli at the free ends. The columnar epithelium of this type is called brush-bordered columnar epithelium.

Functions:

Protection, secretion and absorption.

4. Simple Ciliated Epithelium:

Structure:

The simple ciliated epithelium consists of cells bearing fine, vibratile cilia on their free surface. Mixed with the ciliated cells, mucus secreting

goblet cells are found at intervals. The mucus produced by the goblet cells spreads over the epithelium as a thin layer. The epithelial cells move the mucus and other substances over the epithelium by the lashing action of cilia.

The simple ciliated epithelium is of two types:

(i) Cuboidal Ciliated Epithelium:

It consists of cuboidal cells bearing cilia on their free surfaces. This type of epithelium is found in the nephrons. It helps in the flow of urine.

(ii) Columnar Ciliated Epithelium:

It consists of columnar cells that bear cilia on the free surface. It forms the lining of the oviducts, ventricles of the brain, central canal of the spinal cord, nasal passages and terminal bronchioles.

Functions:

Protection and movement of urine, mucus, eggs and cerebrospinal fluid in a particular direction.

5. Glandular Epithelium:

A cell, tissue or organ which is specialized to secrete mucus, enzymes, hormones or any other useful material is known as a gland. The gland is generally lined by the columnar or cuboidal epithelium and is called glandular epithelium.

Based on the presence or absence of ducts, kind and mode of secretion, number of cells in the gland, shape and complexity of the glands, etc.

The glands are classified into following types:

(A) Based on the Presence or Absence of Duct and Kind of Secretion:

Based on the presence of duct and kind of secretion, the glands are of three types:

a. Exocrine Glands:

A gland with a duct is called an exocrine gland (exo = outside, krinein = to secrete). The exocrine glands either pour their secretions on to the free epithelial surface directly or send their secretions through ducts to the sites of action. The salivary glands, gastric glands, intestinal glands, sweat glands, oil glands, tear glands, mammary glands, etc., are some examples for the exocrine glands. The exocrine glands associated with the alimentary canal produce enzymes. They may be unicellular or multicellular. They are highly vascular and are under nervous or hormonal control.

b. Endocrine Glands:

Glands without ducts are called endocrine (endo = inside, krinein = to secrete) or ductless glands. They pour their secretions directly into the blood stream. The endocrine glands secrete regulatory substances called hormones which reach the respective site of action called target organs, through the blood stream. Pituitary, thyroid, parathyroid, thymus, adrenal glands, etc., are some examples for endocrine glands.

c. Heterocrine Glands:

The gland which has both exocrine and endocrine component in it is called heterocrine gland. The exocrine part sends its secretion through a duct and the endocrine part releases the hormone directly into the blood. Pancreas and gonads are the examples for the heterocrine glands.

Epithelial tissue may be classified according to function as:

- (a) Sensory epithelium: to perceive stimuli.
- (b) Pigmented epithelium: in retina to impart colour.
- (c) Glandular epithelium: to secrete chemicals. A gland can be exocrine, endocrine or mixed.
- (d) Absorptive epithelium: for absorption.

2. Connective Tissue:

Connective tissues are mesodermal in origin. These have three components- intercellular matrix, cells and fibres.

(I) Intercellular matrix or ground substance:

It is composed of mucopolysaccharide mainly hyaluronic acid.

(II) Cells:

The various types of cells are:

(a) Fibroblast:

Produce fibres.

(b) Adipocytes or Lipocytes:

Store fat.

(c) Plasmacytes or Plasma Cells:

Produce antibodies.

(d) Mast Cells:

Produce.

i. Histamine:

Vasodilator, in allergic and inflammatory reactions.

ii. Heparin:

Checks blood clotting.

iii. Serotonin:

Vasoconstrictor, checks bleeding and increases blood pressure.

(e) Macrophage or Histiocytes:

Phagocytic.

(f) Lymphocytes:

Phagocytic.

(g) Mesenchymal Cells:

Form other cells of connective tissue.

(h) Chromatophores:

Impart colour to skin.

(i) Reticular Cells:

Phagocytic.

(III) Fibres:

Fibres are of three types:

(a) Collagen Fibre:

White, made of collagen protein. These fibres are thick, unbranched, and inelastic and occur in bundles.

(b) Elastic Fibres:

Yellow, made up of elastin protein. These fibres are branched and elastic.

(c) Reticular Fibres:

Fibers are delicate, branched and inelastic, made up of reticulin protein.

Functions:

- (i) Attachment of organs and tissues together.
- (ii) Store fat as adipose tissue.
- (iii) Bone and cartilage act as supporting skeleton of the body.
- (iv) Blood and lymph transport various materials in the body.
- (v) Various cells help in defence of the body.
- (vi) Acts as shock absorber.
- (vii) Packing around organs.
- (viii) Help in the repair of tissues.

Classification of Connective Tissue:

II. Connective Tissue proper

II. Skeletal Tissue

III. Vascular Tissue

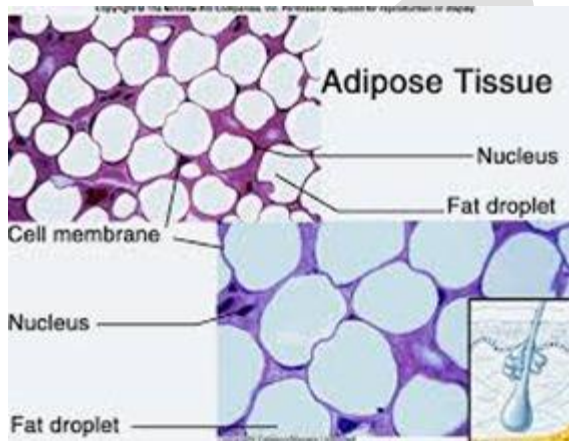
I. Connective Tissue proper is again divided into following five types:

i. Areolar Tissue:

- (a) Most widely distributed.
- (b) Having cells, matrix and fibres.
- (c) Binds various parts together also helps in the diffusion of material and movement of cells.

ii. Adipose Tissue:

Adipocytes with abundant fat present beneath the skin around the organs for support and protection.



iii. Dense Connective Tissue:

Consists mainly of collagen fibres and yellow elastin fibres. Cells basically are fibroblast, form tendon, ligament help in binding.

iv. Reticular Connective Tissue:

Mainly reticular fibres help in binding and defence.

v. Pigmented Tissue:

Contain chromatophores or pigment cells for colouration.

II. Skeletal Connective Tissue:

It is of following two types:

i. Cartilage

ii. Bone

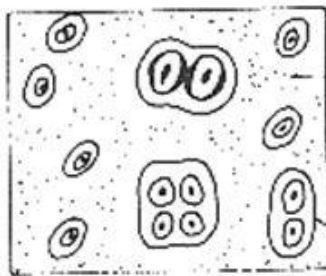
i. Cartilage:

(a) Soft skeletal tissue more abundant in vertebrate embryos.

(b) Normally covered by perichondrium.

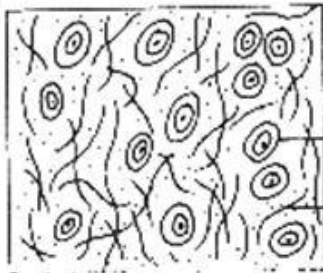
(c) Matrix is made up of water, proteoglycans, lipid, collagen fibres, chondroitin sulphate, Keratin sulphate, hyaluronic acid, fibres called chondrin.

(d) Matrix has lacunae containing 2 to 4 chondroblast cell which mature into non-secretory chondrocytes.



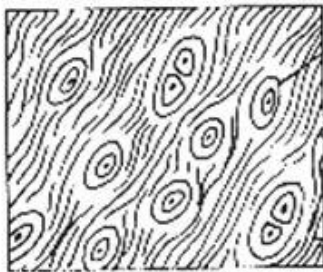
Hyaline Cartilage

ground substance



Fibrous Cartilage

ground substance with non-elastic collagen fibres



Elastic Cartilage

ground substance with yellow elastic fibres

Cartilage cells

It is of three types:

- a. Hyaline Cartilage- most prevalent and present at articular surface.
- b. Fibrous Cartilage- rich in white or yellow fibrous bundles forming cushion between vertebrae, Eustachian tube, and epiglottis.
- c. Calcified Cartilage- having deposition of CaCO_3 suprascapula of pectoral girdle.

ii. Bone:

- (a) Hardest tissue due to large deposition of calcium phosphate, calcium carbonate, calcium fluoride, magnesium phosphate. Matrix is called **ossein**.
- (b) Covering is periosteum, made up of collagen and Sharpey's fibres, also contain osteoblast.
- (c) Matrix is ossein, rich in salts and is arranged as concentric lamellae around Haversian canal which are connected by **Volkman's canal**.
- (d) Lacunae contain osteocytes containing canaliculi for connection between adjacent cells.
- (e) Haversian system or osteon is an important feature of mammalian bone.
- (f) In the centre of the long bone, bone marrow is present.

Fluid Connective Tissue:

Contain fluid matrix and free cells without fibres. Matrix is not secreted by cells.

It is composed of following components:

1. Blood:

Softest tissue in the body forming 30-35% of the ECF amounting to 5.5 litres in a 70 kg adult. Blood is slightly alkaline, pH is 7.4. Blood in arteries has more pH than veins. Blood has two components plasma and corpuscles.

Plasma is 60% of the blood, pale yellow due to bilirubin. It has 90-92% water, 9% salts mainly chloride, bicarbonate, sulphates and phosphates of Na, K, Ca, Fe, Mg, 7-8% plasma proteins including albumin, globulin, immunoglobulin (Ig), prothrombin, fibrinogen. Other substances include lysozyme, properdin, gases, hormones, excretory waste, heparin, vitamins, etc. Blood plasma helps in transport retention fluids in blood (albumin), maintenance of blood pH. Prevention of blood loss, conducting heat to skin for dissipation, immunity.

3. Blood Cells (Corpuscles 40%):

It consists of three components:

(a) Erythrocytes (RBC):

Most abundant cells in the body enucleated, biconcave, 5 million/mm³. These contain Hb for the conduction of O₂ and CO₂. Average life span is 120 days produced (haemopoiesis) in liver, bone marrow and destroyed (haemolysis) in liver and spleen.

(b) Leucocyte (WBC):

Nucleated 5000 – 10,000 /mm³. Biggest blood cells can show amoeboid movement with average life span 2 weeks.

Types: 5 types Neutrophil, Eosinophil, & Basophil (Granulocytes).

Lymphocyte & Monocytes(Agranulocytes)

Produced in bone marrow, lymph node, spleen Peyer's patches, meant for defence.

(c) Thrombocytes (Platelets):

250,000/ mm³ are cell fragments of megakaryocytes, smallest blood corpuscles, live for about a week and help in blood clotting by releasing thromboplastin.

2. Lymph:

(a) Comprising lymph plasma and lymph cells. Lymph plasma is similar to blood except that it has fewer blood proteins, Ca⁺⁺, phosphorus and high glucose.

(b) Lymph cells include lymphocytes Erythrocytes are absent.

(c) Platelets are comparatively fewer.

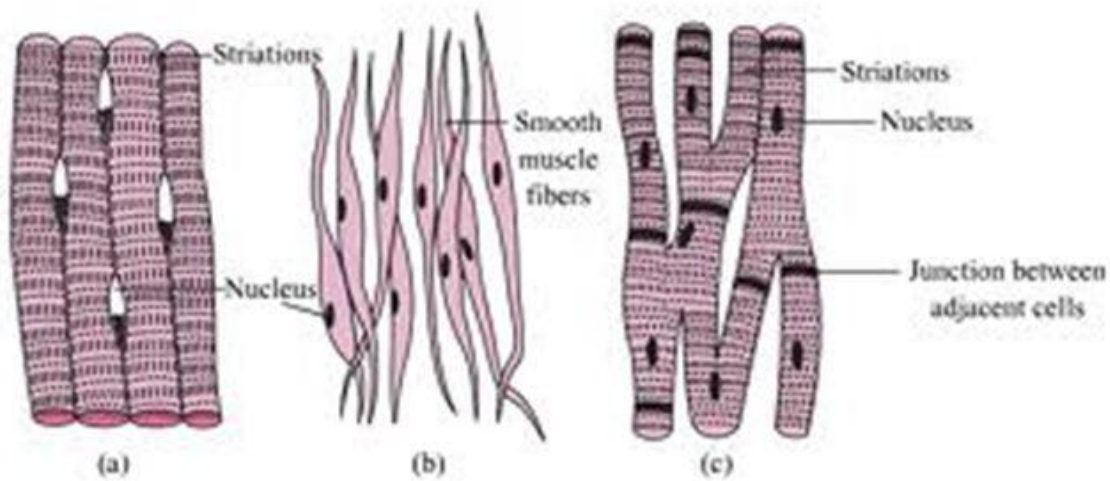
(d) Lymph is produced in lymph node, tonsils, thymus gland, spleen, Peyer's patches and liver.

(e) Lymph transports substances, helps in defence, maintains blood volume, absorbs fat.

3. Muscular Tissue:

Muscular tissues are made up of myocytes which contain myofibrils present in the sarcoplasm. Muscle fibres may be covered by sarcolemma.

Muscular tissue possesses the properties of excitability, contractility and conductivity, which allow these tissues to bring about movements of the body, peristalsis, and facial expression and in delivering the baby.



Types of Muscles:

1. Striped or Striated or Skeletal or Voluntary Muscles:

- i. Found in bundles and have light and dark bands, covered by sarcolemma.
- ii. These fibres are multinucleated syncytial.
- iii. Dark bands of the myofibrils are called 'A' band and light bands 'I' band which is bisected by 'Z' line.
- iv. Distance between two 'Z' lines is called a sarcomere which is the unit of contraction.
- v. Sarcomere is made up of bundles of primary or myosin filament which are thicker and actin filaments or secondary filament which are thin and are composed of actin, troponin and tropomyosin.
- vi. Other components include Potassium, Na, Ca, P, Mg, glycogen, myoglobin, ATP, phosphocreatine, creatine etc.
- vii. Help in the movement of skeleton and heat production.

viii. Controlled by CNS.

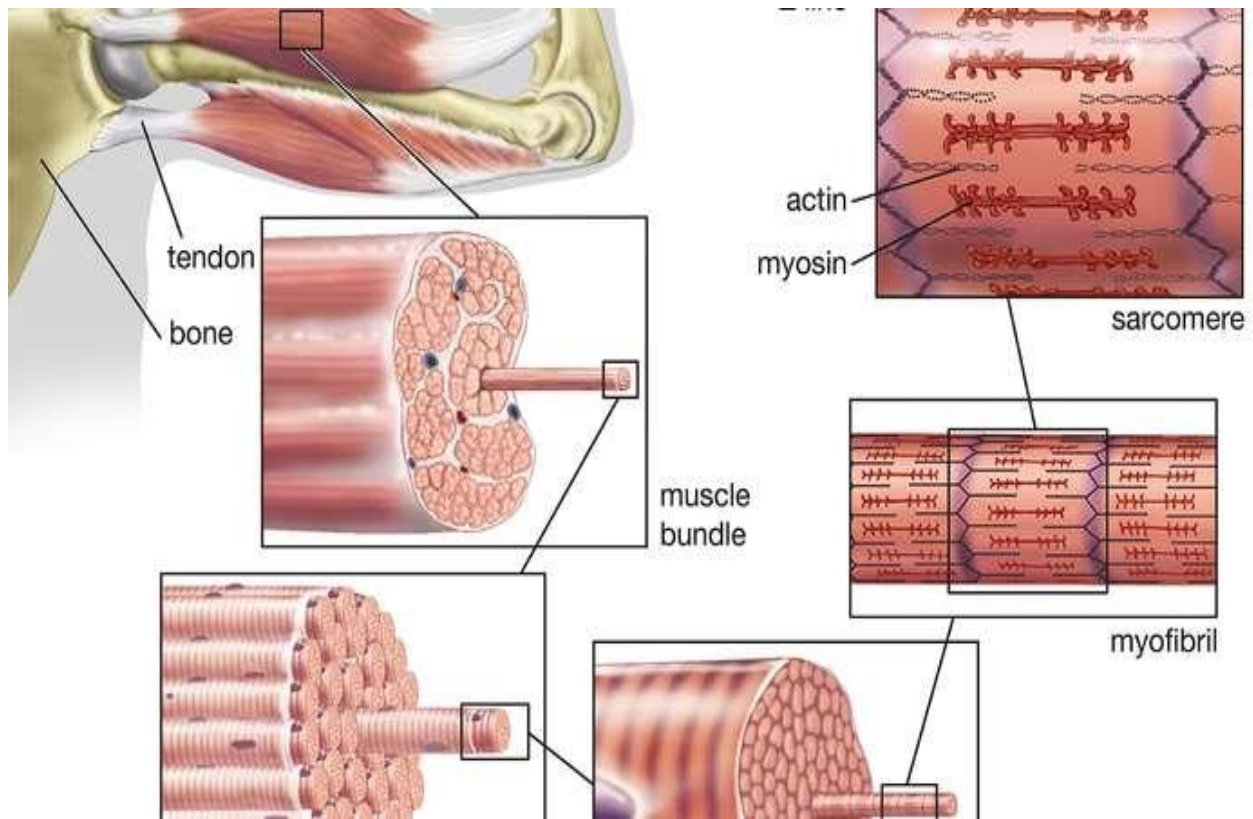


Fig. Skeletal Muscle

2. Non- Striated or Smooth or Visceral Muscles:

- i. Found as sheet in various involuntary organs of the body.
- ii. Muscle cells are spindle shaped and uninucleated.
- iii. These muscles are controlled by ANS and are not under the control of our will.
- iv. These muscles may be single unit or multiple unit.

3. Cardiac Muscles:

- i. Found in heart and major blood vessels at the junction with heart.

- ii. They have the properties of both skeletal and smooth muscles.
- iii. They lack sarcolemma and are uninucleated and branched.
- iv. Myofibrils have intercalated discs, which boost up the conduction of muscles.
- v. These muscles never get tired.
- vi. They are myogenic and have rich blood supply.
- vii. They are under the control of ANS.

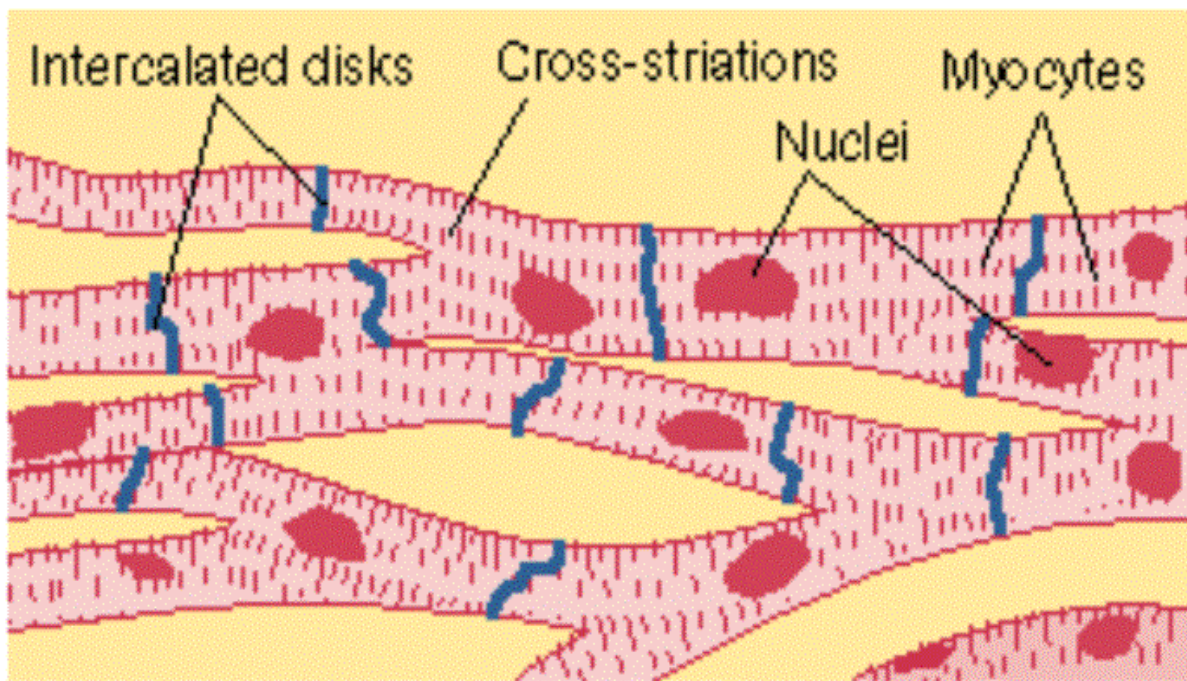


Fig. Cardiac Muscle

4. Nervous Tissue:

Develops from embryonic ectoderm and possess the properties of excitability and conductivity.

Nervous tissue has following four components:

(a) Neuron:

It is structural and functional unit of the nervous tissue. These are the longest cells of the body. When fully formed they never divide and remain in interphase. Special flask shaped neuron called Purkinje cells occur in cerebellum of brain. It was believed that centriole is absent in a nerve but their presence has now been confirmed.

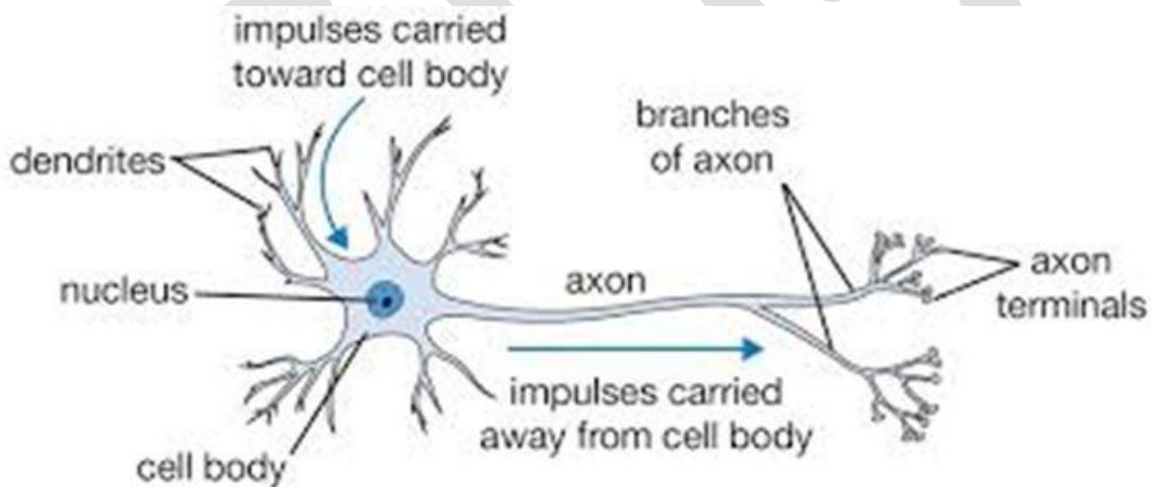


Fig: Neuron

Each neuron has two parts:

- (i) Cyton or cell body or soma
- (ii) Neurites.

A neuron consists of all the normal components of a cell. Its cytoplasm is called nucleoplasm which also contains neurofibrils, neurotubules and ribonucleoprotein particles (RER) called Nissl's granules. Neurofibrils help in the conduction of impulse. Cyton is concerned with growth and metabolism.

Neurites:

These are the processes arising from neuron and are of two types:

(i) Dendron

(ii) Axon

Dendron or dendrites are shorter processes which are afferent processes as they conduct impulses toward cyton.

Axon is single very long process. Its contact point with cyton is called axon hillock. This process lacks Nissl's granules in its cytoplasm called axoplasm. The covering of axon is called axolemma and it ends are axon terminal or telodendria. Axon terminal meet the dendrite of another neuron through synaptic knob.

Each Synaptic knob contains abundant mitochondria and secretory vesicles containing acetylcholine **neurotransmitter**. Each axon may also possess side branches called collateral fibres. Axon is efferent process. Axon may be covered with **myelin sheath made by Schwann cells which act as insulating layer**.

Depending upon the myelin sheaths neurons may be myelinated or non-myelinated. Myelinated fibres are present in white matter and non-myelinated in grey matter. The isolated grey matter masses present in CNS are called as nuclei. Nerves are either sensory which bring impulse

from receptors to CNS or motor which carry impulses from CNS to effector or mixed which contain both sensory and motor fibres.

(b) **Neuroglia or glial cells** represent connective tissue of nervous system. They do not conduct impulse, but help, in nutrition, protection, etc.

(c) **Ependymal cells** are found in the lining of cavities of brain and spinal cord. They are ciliated in the embryonic condition. They help in maintaining the flow of CSF.

(d) **Neurosecretory** cells secrete different kinds of neurotransmitters.

