

# Elementary Tissues

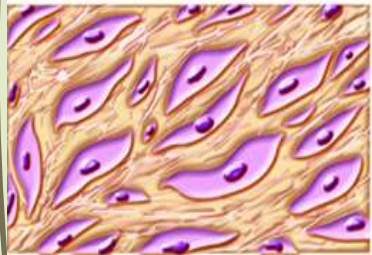
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# Introduction

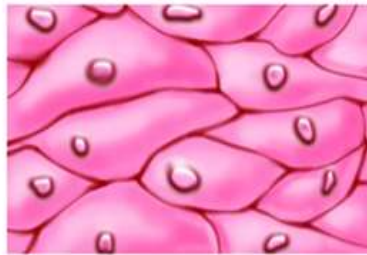
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**Tissue** is a *group of cells* having a *common embryonic origin that function together* to carry out specialized activity.

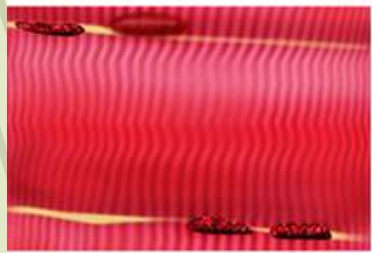
**Types of body tissues:** According to the structure and functions, tissues can be divided as follows



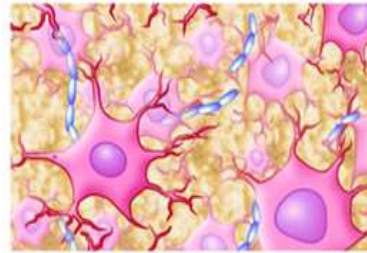
Connective tissue



Epithelial tissue



Muscle tissue



Nervous tissue

1. **Epithelial tissue:** It covers body surfaces, lines hollow organs, body cavities and ducts.
2. **Connective tissue:** It protects and supports the body and its organs. It acts as energy store (reserve fat), and provides immunity.
3. **Muscle tissue:** It generates physical force needed to generate body heat.
4. **Nervous tissue:** It detects changes inside and outside the body environment and generates nerve impulses responsible for muscular contractions and glandular secretions.

# Epithelial Tissue

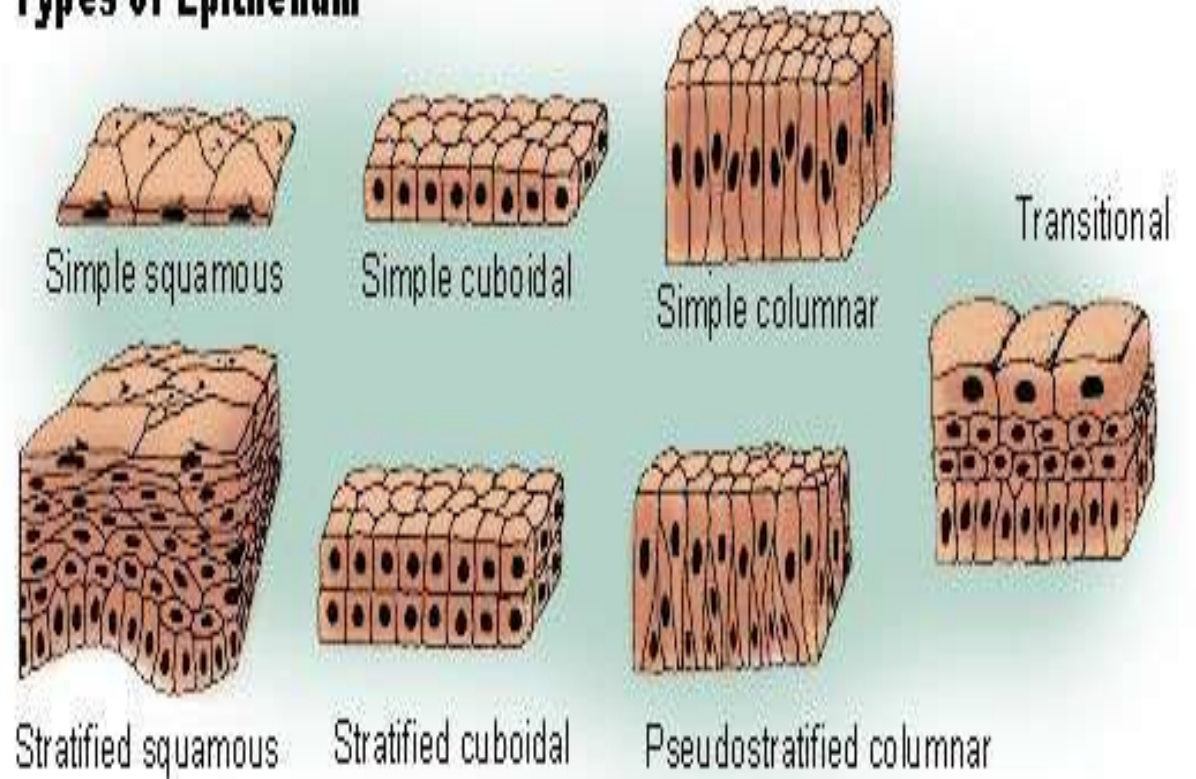
- An epithelial tissue or epithelium consists of *cells arranged in continuous sheets*, in either single or multiple layers.
- Epithelial tissues are widespread throughout the body. They *form the covering* of all body surfaces, *line body cavities and hollow organs*, and are the major tissue in glands.
- They perform a variety of functions that include *protection, secretion, absorption, excretion, filtration, diffusion*, and *sensory reception*.
- The cells in *epithelial tissue* are tightly packed together with very little intercellular *matrix*. Because the tissues form coverings and linings, the cells have one free surface that is not in contact with other cells.
- Epithelial cells may be squamous, cuboidal, or columnar in shape and may be arranged in single or multiple layers.

# Some common kinds of epithelium are listed below:

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- Simple squamous
- Simple cuboidal
- Simple Columnar
- Simple ciliated
- Stratified squamous
- Stratified cuboidal
- Stratified Columnar
- Stratified transition
- Pseudo-stratified columnar epithelium

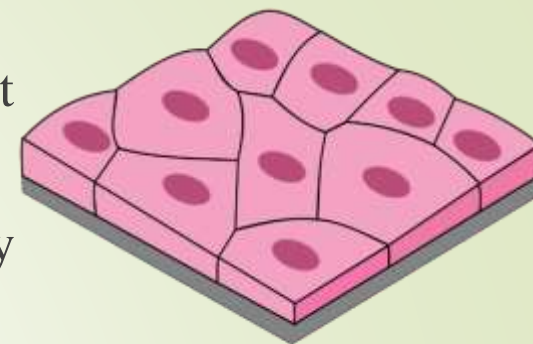
## Types of Epithelium





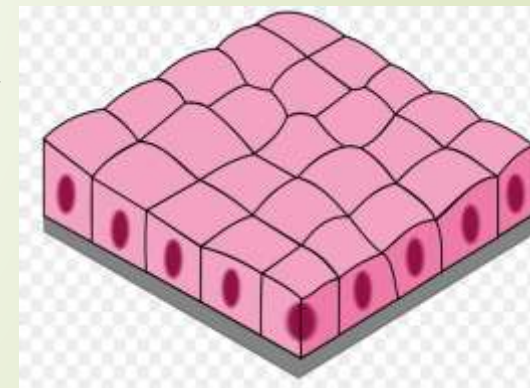
## Simple squamous epithelium

- It consist of a *single layer* of flat cells arranged on the basement membrane.
- The *nucleus of each cell is oval* or spherical in shape and is centrally located.
- These cells *line the heart, blood and lymphatic vessels, air sacs of lungs and glomerular capsule of kidneys.*
- It perform the function of *filtration, diffusion, and osmosis.*



## Simple cuboidal epithelium

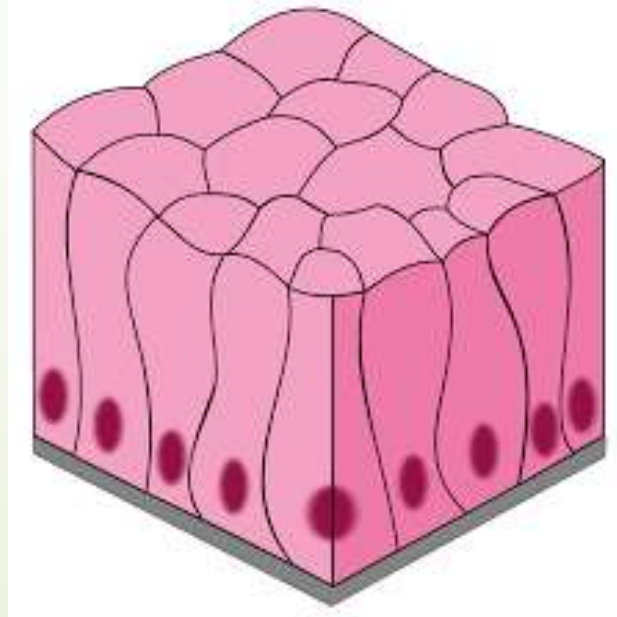
- It is made up of a *single layer of cube shaped cells* arranged on basement membrane.
- The *nucleus of each cell is spherical* in shape and is centrally located.
- It *lines the surface of kidney tubules and pancreas*, and also forms the *covering of ovaries.*
- It performs the function of *protection to the underlying tissues, secretion and absorption of filtered substances.*



## Simple columnar epithelium

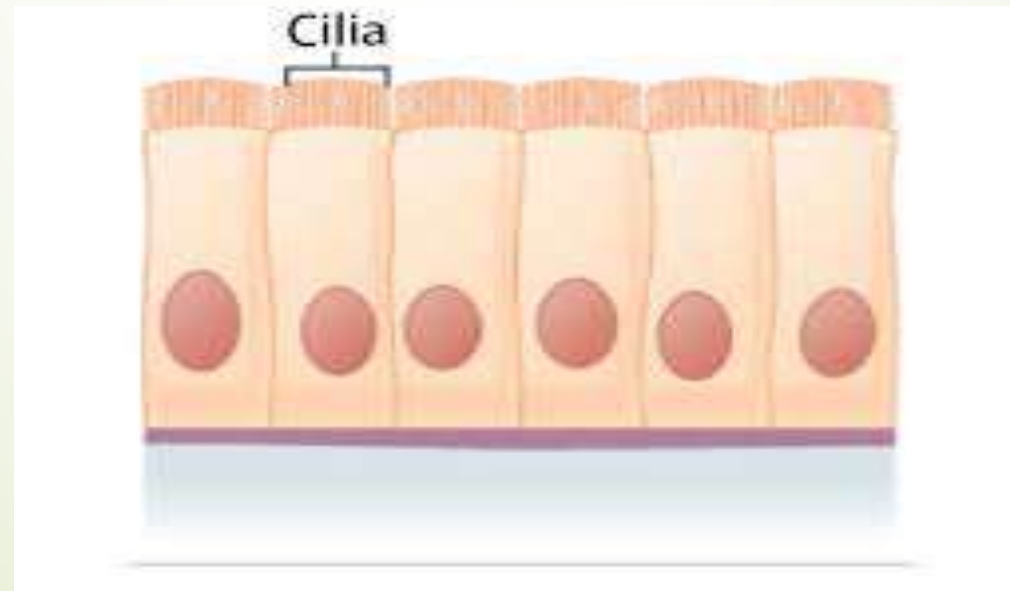
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- It is made up of a *single layer of rectangular cells* arranged on the basement membrane.
- the nucleus of each cell is *oval in shape* and is located near the base of the cell.
- They are found in the *nasal passage, eye, digestive system, reproductive system*. It also *lines the ears and buccal cavity*.
- The mucus secreting columnar epithelium cells are called *globet cells*.
- It perform the function of *protection, secretion, provide sensory input, absorbing and transporting nutrients in the small intestine*.



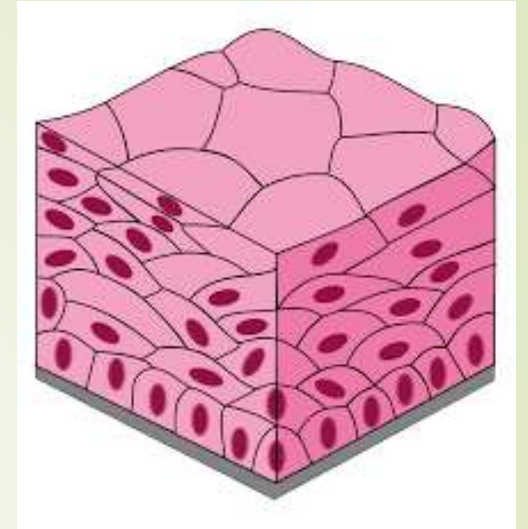
## Simple ciliated epithelium

- It is made up of *columnar epithelial cells* with many *hair like projections at the top* called as *cilia*.
- The *nucleus of each cell is oval* in shape and is located near the base of the cell.
- The cells are connected by tight junctions.
- It *lines the upper respiratory tract, uterine tubes, uterus, and central canal of spinal cord*.
- The *cilia move the mucus and other substances by ciliary action*. This prevents the adherence of any particulate matter such as bacteria, *thus preventing infection*.



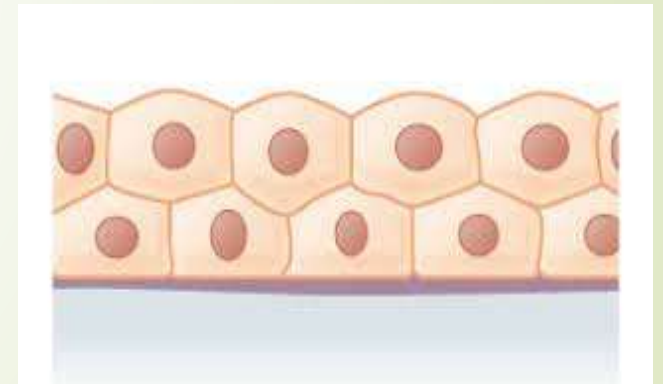
## Stratified squamous epithelium

- It is composed of *more than one layer* of cells having different shapes.
- the cells in the apical layer are flat and those present in deep layers vary in shapes from cuboidal to columnar.
- As the cell grows their blood supply is restricted and they become dehydrated, shrunken and harder.
- These tissues exist in two forms *keratinized and non-keratinized forms*.
- The function of stratified squamous epithelium tissue is to *provide protection against mechanical friction and chemical damage*.



## Stratified cuboidal epithelium

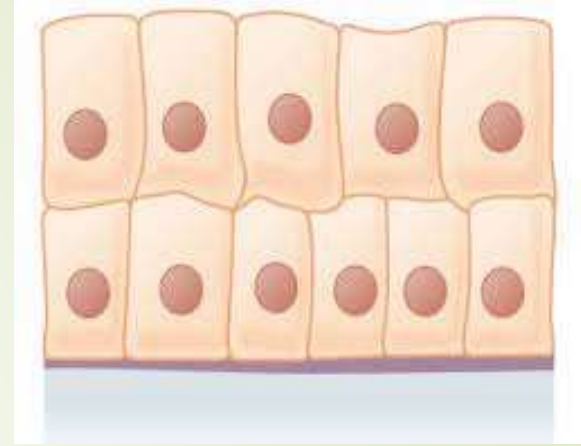
- It is made up of *two or more layers* of cells.
- The cells in apical layer are cuboidal in shape.
- It *lines the ducts of sweat glands, part of male urethra, uterus and anus*.
- It serves the *role of protection* but in some regions it plays an important *role in secretion and absorption*.





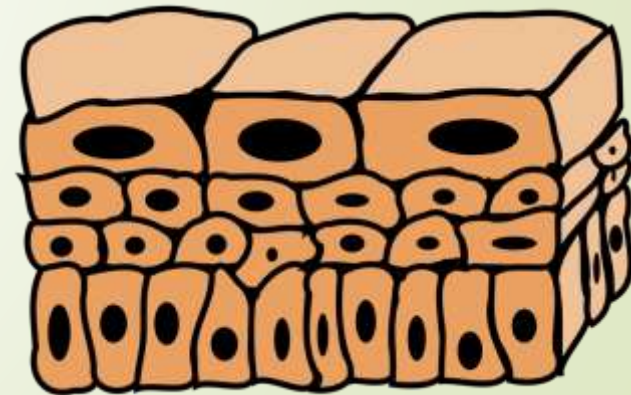
## Stratified columnar epithelium

- It is made up of *several layers of irregularly shaped cells*.
- In the apical layer the cells are columnar in shape.
- It *lines part of the urethra, large excretory ducts of glands and conjunctiva of the eye*.
- The function of stratified columnar epithelium is *protection and secretion*.



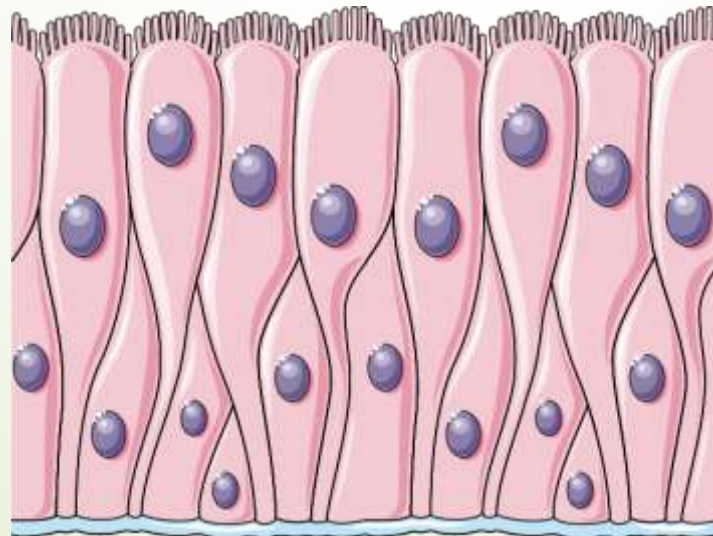
## Transitional epithelium

- it consist of *many layers of pear shaped cells*.
- The cells are variable in appearance.
- It *lines the hollow organs such as the uterus and urinary bladder*.
- It *protects the underlying structures and permits distension of organs*.



## Pseudostratified columnar epithelium

- The cells are *columnar in shape having hair like structure at the top called cilia*.
- The *nucleus is oval in shape* and is present at different position.
- All the cells are attached to basement membrane, but not all reach the apical surface.
- It *lines the airways of the upper respiratory tract*;
- Pseudo-stratified non-ciliated columnar epithelium lines *larger ducts of many glands, epididymis and part of male urethra*.
- It functions in *secretion and movement of mucus by ciliary action*.



# Functions of Epithelial tissue:

1. The principle function of epithelial tissues are *covering and lining of free surface*
2. The cells of the body's surface *form the outer layer of skin.*
3. Inside the body, epithelial cells form the *lining of the mouth and alimentary canal* and protect these organs.
4. Epithelial tissues help in the *elimination of waste.*
5. Epithelial tissues *secrete enzymes and/or hormones* in the form of glands.
6. Some epithelial tissue perform secretory functions. They secrete a variety of substances including *sweat, saliva, mucus, enzymes.*
7. It *protects the underlying tissue* from friction and injury.

# Connective tissue

- It is the *most abundant* and *widely distributed* tissue system in the body.
- It *binds together, supports and strengthens* other body tissues; as well as protects and insulates internal organs.
- It is made up of *fibres, cells* and *ground substances*.
  
- **Fibres**
  1. ***Collagen fibres:***
    - These are *very strong* and allow *tissue flexibility*.
    - These are made up of *protein collagen*.
    - It is the most abundant protein in mammals making up about 25% to 35% of total body protein content.
    - Collagen fibre is found in *bone, cartilage, tendons and ligaments*.



## 2. *Elastic fibres:*

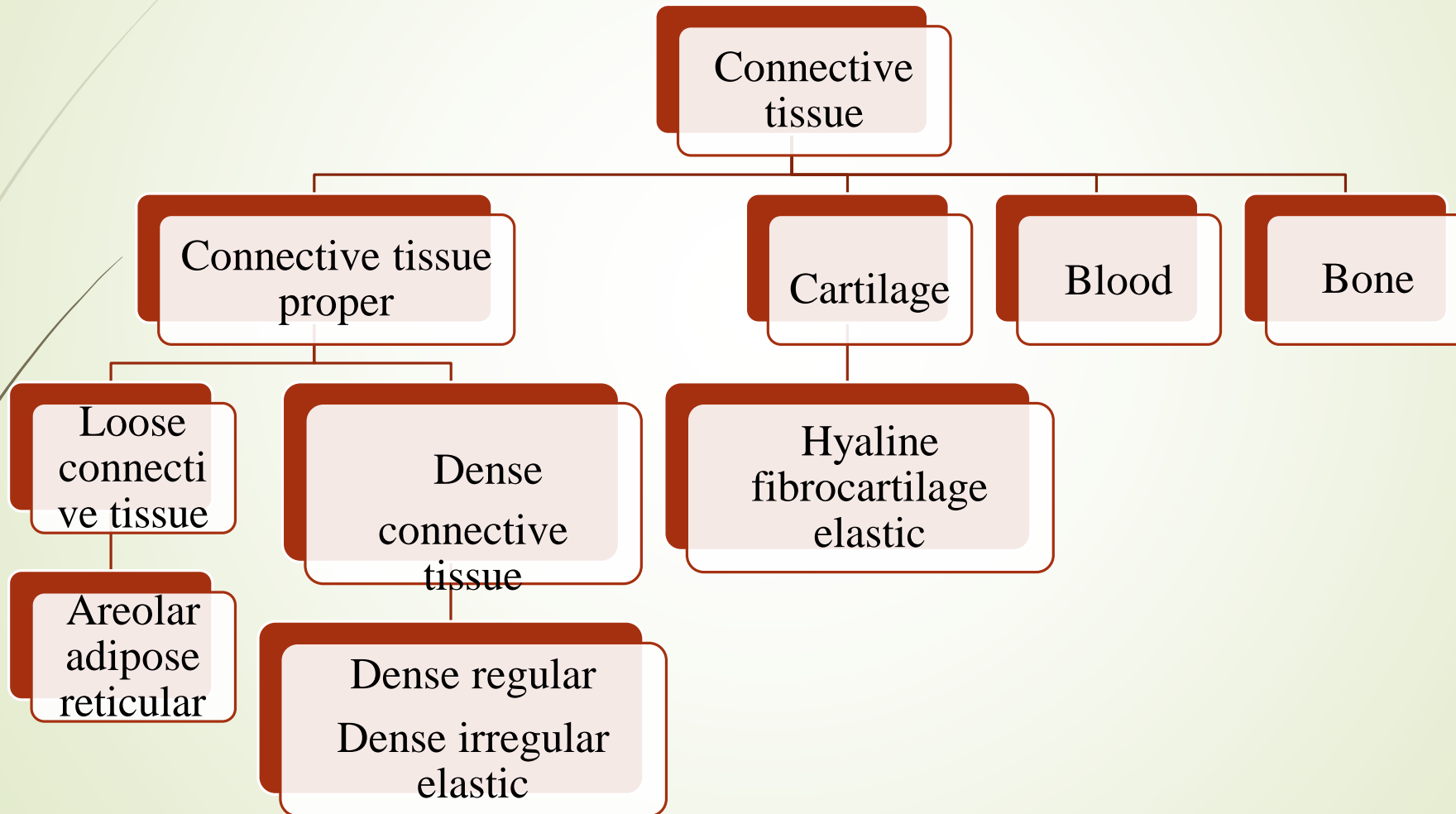
- These fibres are *smaller* in diameter. These are made up of *protein elastine* surrounded by *glycoprotein fibrillin* which gives *strength and stability to tissue*.
- Elastic fibres have the *ability to regain its original shape*, a property called as elasticity.
- These are found in the *skin, lungs, arteries, veins, elastic cartilage, periodontal ligament and foetal tissue*.

## 3. *Reticular fibres:*

- Consist of collagen protein arranged in *fine bundles covered with glycoprotein*.
- These are much *thinner than collagen fibres*. They provide support and strength.
- These are found in the liver, bone marrow and lymphatic organs.

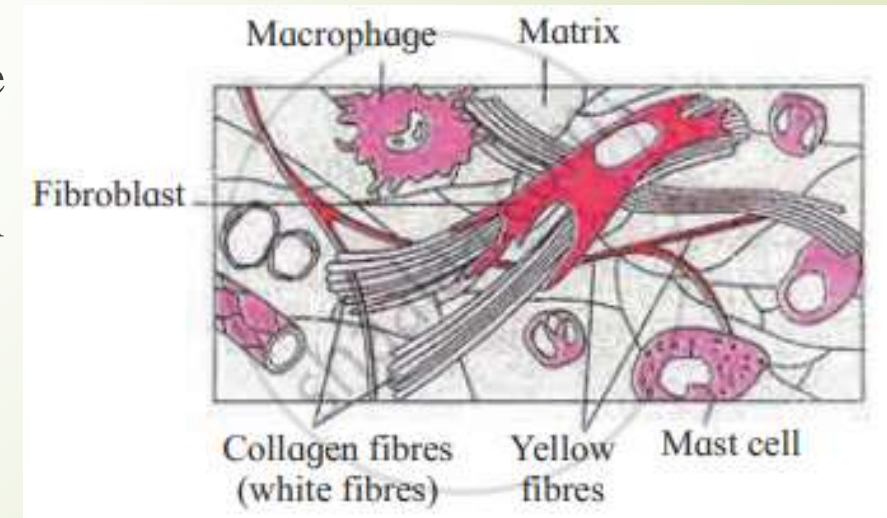
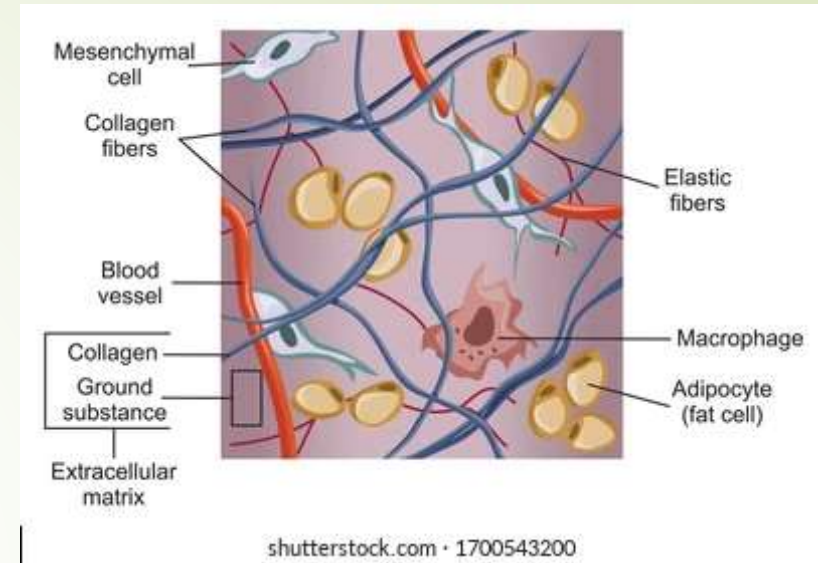
- **Cells**
- Each cell consist of *fibroblast, macrophages, plasma cells, mast cells, adipocytes* and *white blood cells*.
- **Ground substance:**
- It is an *amorphous gel-like substance* surrounding the cells. In the ground substance cells and fibres are suspended.
- It supports cells, binds them together, *store water and provides a medium* through which substances are exchange between blood and cells.
- Primarily composed of *water, glycosaminoglycans, proteoglycane, glycoproteins, hyaluronic acid*.

# Classification of connective tissue



# Connective tissue proper

- **Loose connective tissue**
  - These fibres are loosely woven.
  - Has *larger proportion* of ground substance.
  - Easily *distorted*. On distortion they become *tough and resist* further deformation.
  
- **Areolar connective tissue**
  - They form a loose network in the intercellular material and are not arranged in a particular pattern.
  - It consist of *collagen, elastic fibres, reticular fibres*, and several kind of cells such as *fibroblast, macrophages, plasma cells, adipocytes*, and *mast cells* embedded in ground substances.
  - The function of areolar connective tissue is to *provide strength, elasticity* and *support*.



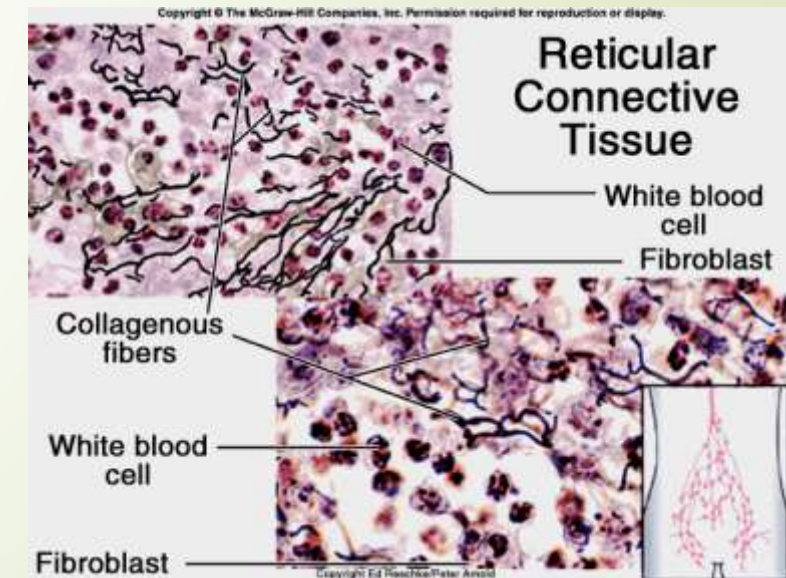
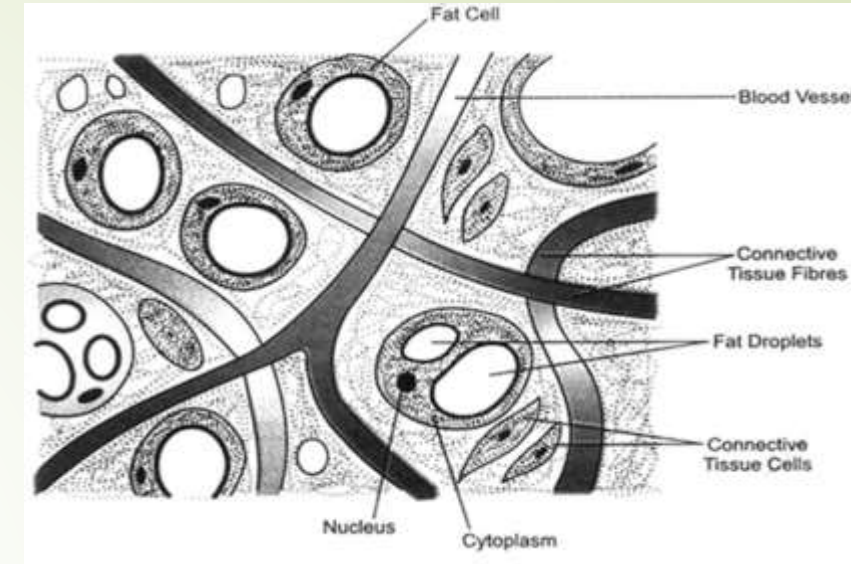


## Adipose connective tissue

- It consists of *adipocytes which store fats* as a large centrally located droplet.
- It is present in the *subcutaneous layer deep in the skin*, around heart and kidneys and yellow bone marrow.
- It *reduces heat loss from the skin*, serves as an energy reserve, gives shape to the limbs and body and *protects underlying organ from injury*.

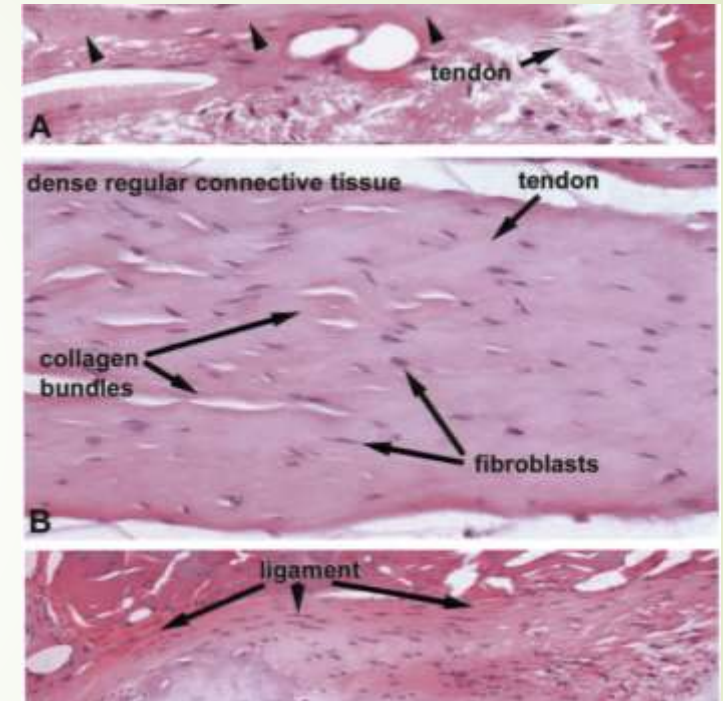
### ➤ Reticular connective tissue

- It consists of *reticular fibres* and *reticular cells*.
- It forms the *supporting framework* of liver, spleen, lymph nodes, red bone marrow and is also found around blood vessels and muscle.



# Dense connective tissue

- **Dense regular connective tissue**
- In this type, fibres are *densely packed*.
- The content of *fibres is higher* and the content of cells is lower as compared to loose connective tissue.
- Bundles of collagen fibres are *arranged parallel* to provide strength to tissue.
- It forms *tendons* (attach muscle to bone) and *ligaments* (attach bone to bone)
- The tissue is *silvery white* and *tough in nature*.
- It *provide strong attachment to structure*.



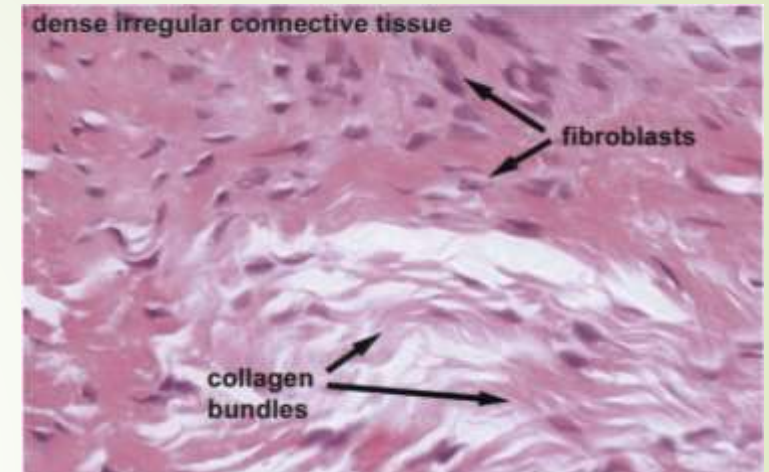


## ■ Dense irregular connective tissue

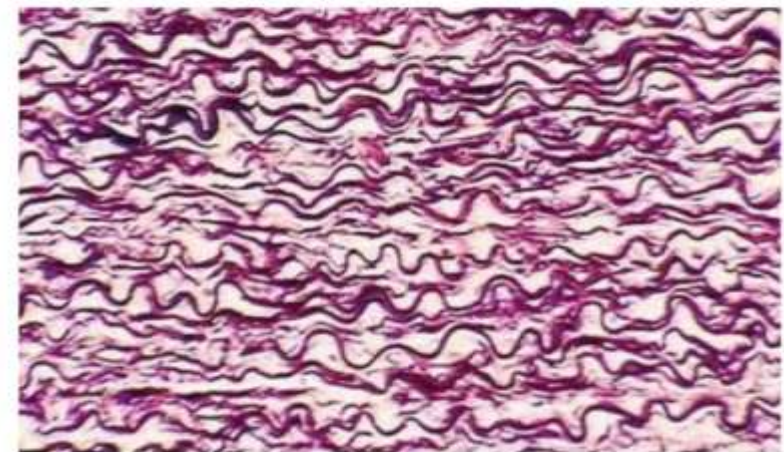
- It consist of collagen fibres which are *irregularly arranged* and a few fibroblast that appears in rows between the fibres.
- It is present in tissue beneath the skin, dermis of skin, periosteum of bone, membrane capsules around kidney, liver, testes and lymph node, pericardium of heart and heart valves.
- It *provides strength to different organs*.

## ■ Elastic connective tissue

- It consist of *free branching elastic fibres*.
- Fibroblast are present in spaces between fibres.
- Present in *lung tissue, wall of elastic arteries, trachea, bronchial tubes and vocal cords*.
- It is *yellowish in color* and *allow stretching* of various organs.



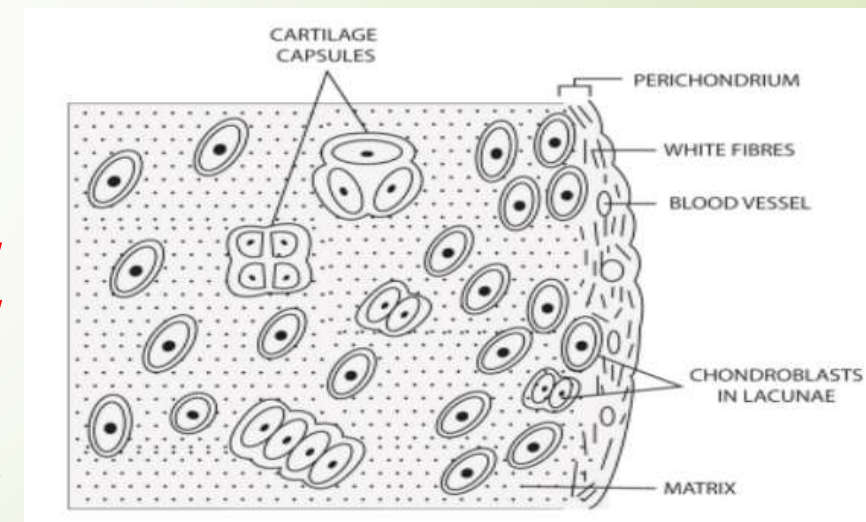
Elastic Connective Tissue (Dense Connective Tissue)



Hint: note the wave-like, rubber-band structure of elastic fibers and relate it to their flexibility

# Cartilage

- It consists of a network of closely packed collagen fibres and elastic fibres embedded in gelatinous substance called chondroitin sulfate of the ground substance.
- The cells of mature cartilage are called as chondrocytes.
- **Hyaline cartilage**
  - *Bluish* white in color.
  - Consist of *fine collagen fibres* and many *chondrocytes*.
  - Present at the end of *long bones, anterior ends of ribs, nose and part of larynx, trachea, bronchi, bronchial tubes, embryonic and fetal skeleton*.
  - Provide small surfaces for movements at joints, flexibility and support.



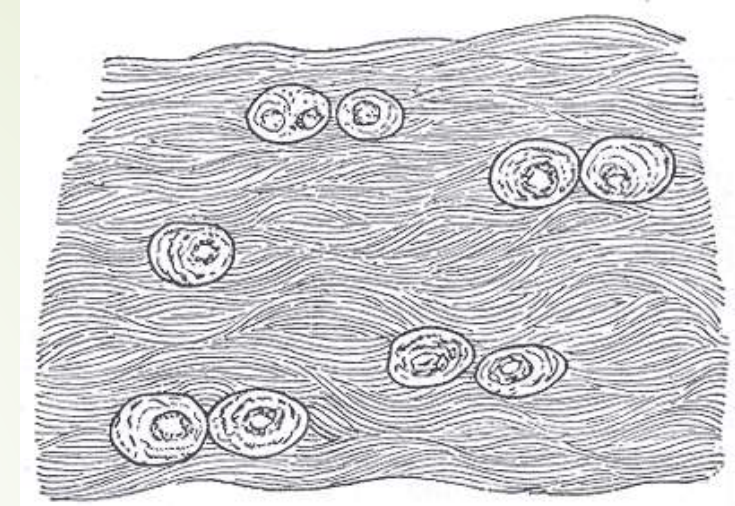


## ■ Fibro cartilage

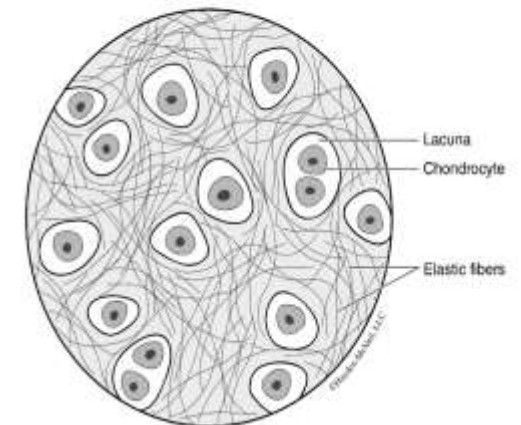
- *Strongest* form of cartilage.
- The chondrocytes are scattered among the bundle of collagen fibres within the extracellular matrix.
- *Tough* and *slightly flexible*.
- Present in inter-vertebral disc.
- Covers and *protects bony structures of body*.

## ■ Elastic cartilage

- Chondrocytes are located within a threadlike network of elastic fibres within the extracellular matrix.
- Present in *pinna of ear and top of larynx*.
- Provide *strength and elasticity* and maintains the shape of certain organs such as the external ear.

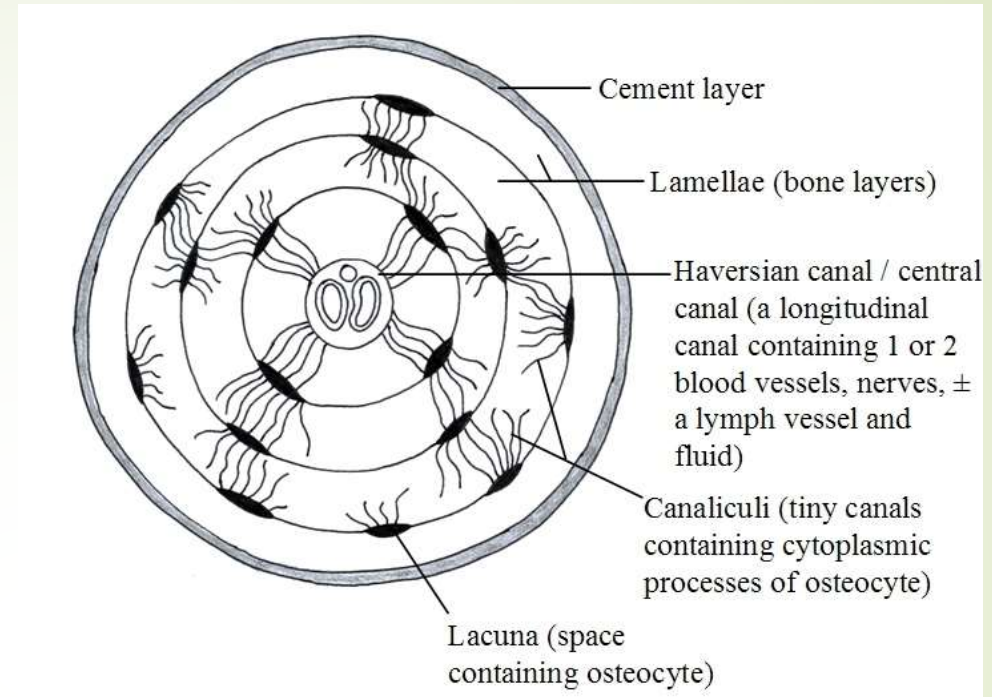
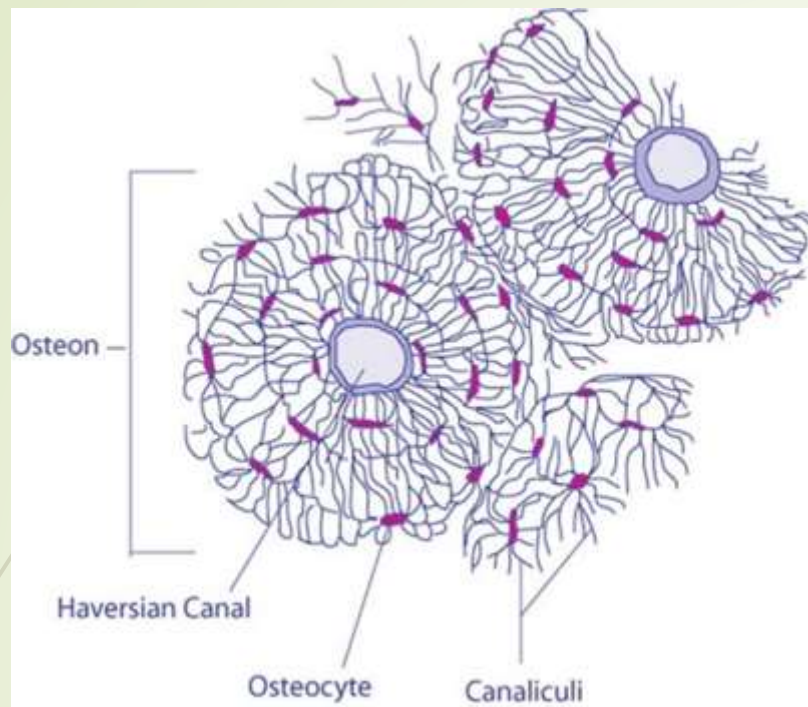


1. View the diagram of elastic cartilage (Figure 19.09).



# Bone

- It is the *hardest connective tissue*
- *Calcified matrix* containing many collagen fibres.
- Composed of *25% of water, 30% organic material and 45% inorganic salts.*
- Arranged in *concentric ring* structures called *osteons*. At the centre of ring is a structure called *haversian canal*.
- Haversian canal system consist of:
  - *Central haversian channel*: It contains blood vessels and nerves.
  - *Lamellae*: concentric plates of bones surrounding the central canal.
  - *Lacunae*: contains mature bone cells called as osteocytes.
  - *Canaliculi*: network of minute canals that allow interaction of the cells with the blood supply.



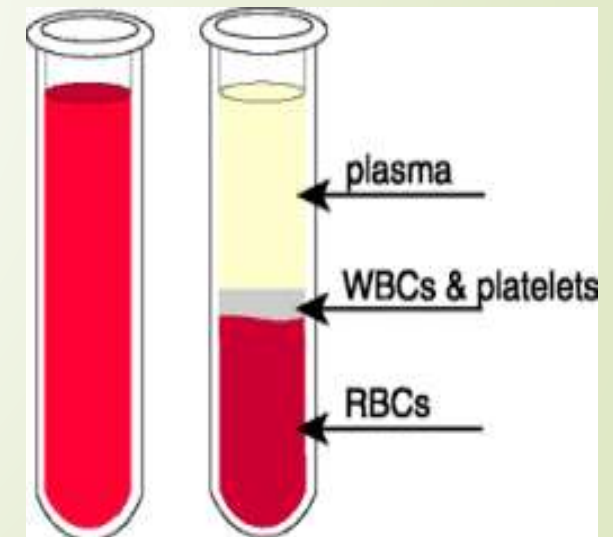
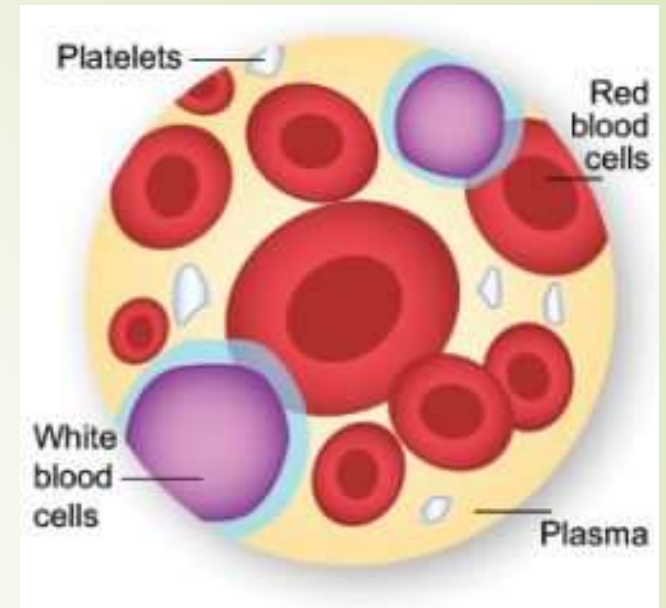
## Functions of bone tissue

1. Forms the supporting framework for the body.
2. Provide protection to delicate organs.
3. Forms joints essential for locomotion of body.
4. Forms red blood cells in red bone marrow.
5. Acts as store for calcium, minerals and fats.
6. Provide support and maintain shape.



# Blood

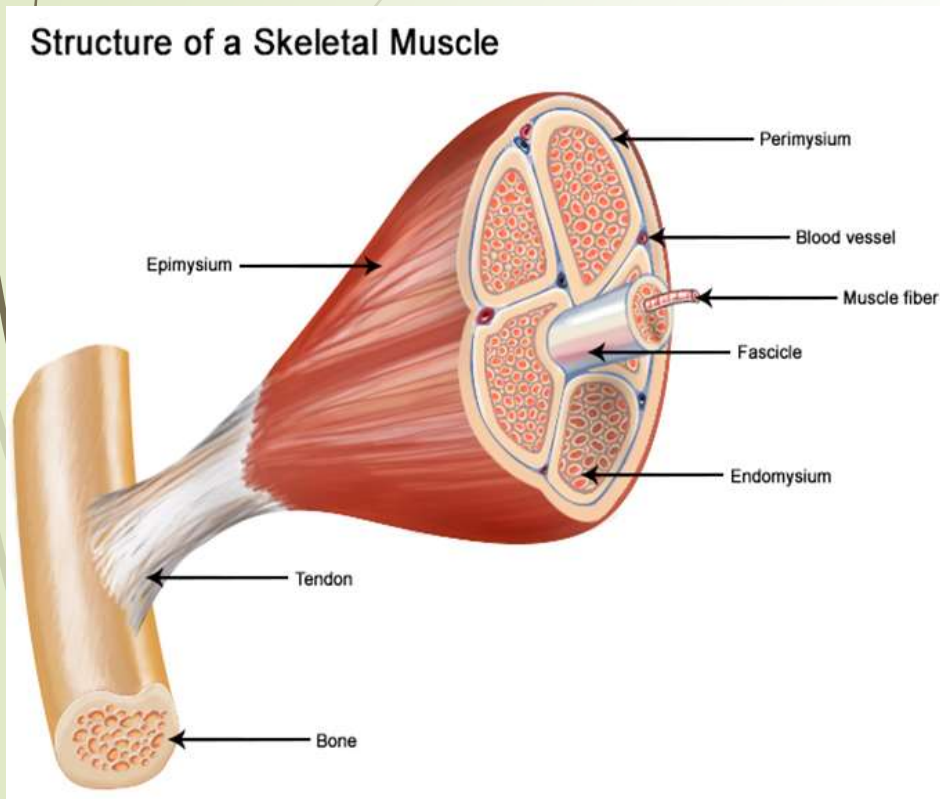
- Connective tissue with *liquid extracellular matrix* called as *blood plasma*.
- Composed of *55% plasma and 45% of blood cells*.
- Plasma is composed of *90-92 of water, 7% plasma proteins and clotting factors, and 1% of mineral salts, sugar, hormones and vitamins*.
- Blood cells are of three types:
  1. *Erythrocytes (RBC)*
  2. *Leucocytes (WBC)*
  3. *Thrombocytes (Platelets)*
- Blood performs many important functions within the body, including:
  1. Supply of oxygen to tissues (bound to hemoglobin, which is carried in red cells)





2. Supply of nutrients such as *glucose, amino acids, and fatty acids (dissolved in the blood or bound to plasma proteins)* (e.g., blood lipids)
3. Removal of waste such as *carbon dioxide, urea, and lactic acid*
4. Immunological functions, including *circulation of white blood cells*, and detection of foreign material by antibodies
5. *Coagulation*, the response to a broken blood vessel, the conversion of blood from a liquid to a semisolid gel to stop bleeding
6. *Messenger functions*, including the transport of hormones and the signaling of tissue damage
7. *Regulation of core body temperature*

# Muscle tissue



- It consists of *elongated cells* called *muscle fibres* that can use ATP to generate force.
- Composed of *fibres, nerves and connective tissues*.
- Have superficial covering called *fascia*. Inside fascia, the muscle tissue is surrounded by *epimysium*.
- The muscle fibres within a fasciculus are separated by connective tissue called the *endomysium*.
- *Myofibrils are the functional unit of muscle tissue*.
- There are three types of muscle tissue-
  1. *Skeletal/ striated/ voluntary muscle tissue*
  2. *Cardiac muscle*
  3. *Smooth/ non-striated/ involuntary muscle tissue*

# Skeletal muscle

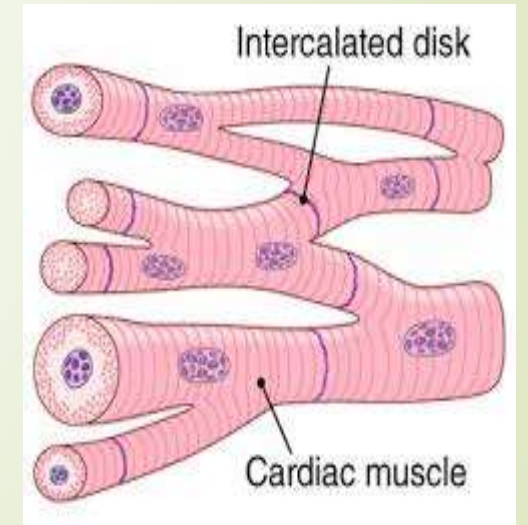
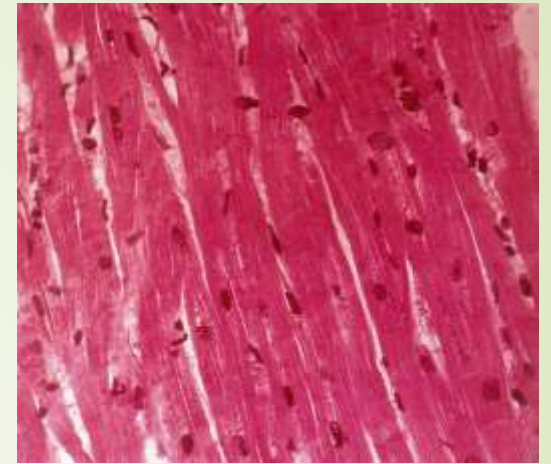
- ▶ The cells *are multinucleated* and *cylindrical* in shape.
- ▶ Fibres are *parallel* to each other.
- ▶ It shows *alternate dark and light bands i.e striation* and hence the named striated muscle.
- ▶ Skeletal muscle is attached to bones and its contraction makes possible locomotion, facial expressions, posture, and other voluntary movements of the body.
- ▶ Skeletal muscles *generate heat as a byproduct* of their contraction and thus participate in *thermal homeostasis*.
- ▶ Skeletal muscle tissue is *arranged in bundles*, surrounded by connective tissue.





# Cardiac muscle

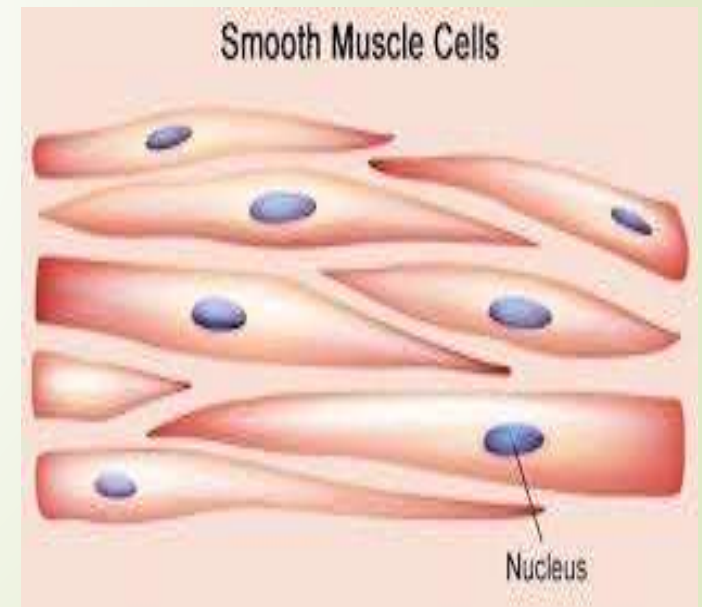
- **Cardiac muscle** forms the contractile *walls of the heart*.
- It is *striated but involuntary* i.e the activity of fibres is beyond ones control hence called as involuntary muscle tissue.
- Each fibre is *parallel* to each other, *branched* and *multinucleated*.
- The *cells of cardiac muscle*, known as *cardiomyocytes*, also appear striated under the microscope.
- A principal characteristic of cardiomyocytes is that *they contract on their own intrinsic rhythms without any external stimulation*.
- Cardiomyocyte attach to one another with specialized cell junctions called *intercalated discs*. Intercalated discs have both anchoring junctions and gap junctions.
- The cardiac muscle *pumps blood* through the body and is under *involuntary control*.





# Smooth muscle

- A smooth muscle fibre is *usually small*. The cells are spindle shaped.
- *Thickest* in the centre and *tapering at the end*.
- Contains *single, centrally located nucleus*. Arranged in sheets or layers.
- Alternate light and dark bands are absent hence called as *smooth/ non-striated*.
- Smooth muscle tissue contraction is responsible for involuntary movements in the internal organs.
- It forms the contractile component of the *digestive, urinary, and reproductive systems as well as the airways and arteries*.
- It *contracts and relaxes* to regulate the blood pressure and the flow of blood.



## Comparison of Structure and Properties of Muscle Tissue Types

<b>Tissue</b>	<b>Histology</b>	<b>Function</b>	<b>Location</b>
Skeletal	Long cylindrical fiber, striated, many peripherally located nuclei	Voluntary movement, produces heat, protects organs	Attached to bones and around entrance points to body (e.g., mouth, anus)
Cardiac	Short, branched, striated, single central nucleus	Contracts to pump blood	Heart
Smooth	Short, spindle-shaped, no evident striation, single nucleus in each fiber	Involuntary movement, moves food, involuntary control of respiration, moves secretions, regulates flow of blood in arteries by contraction	Walls of major organs and passageways

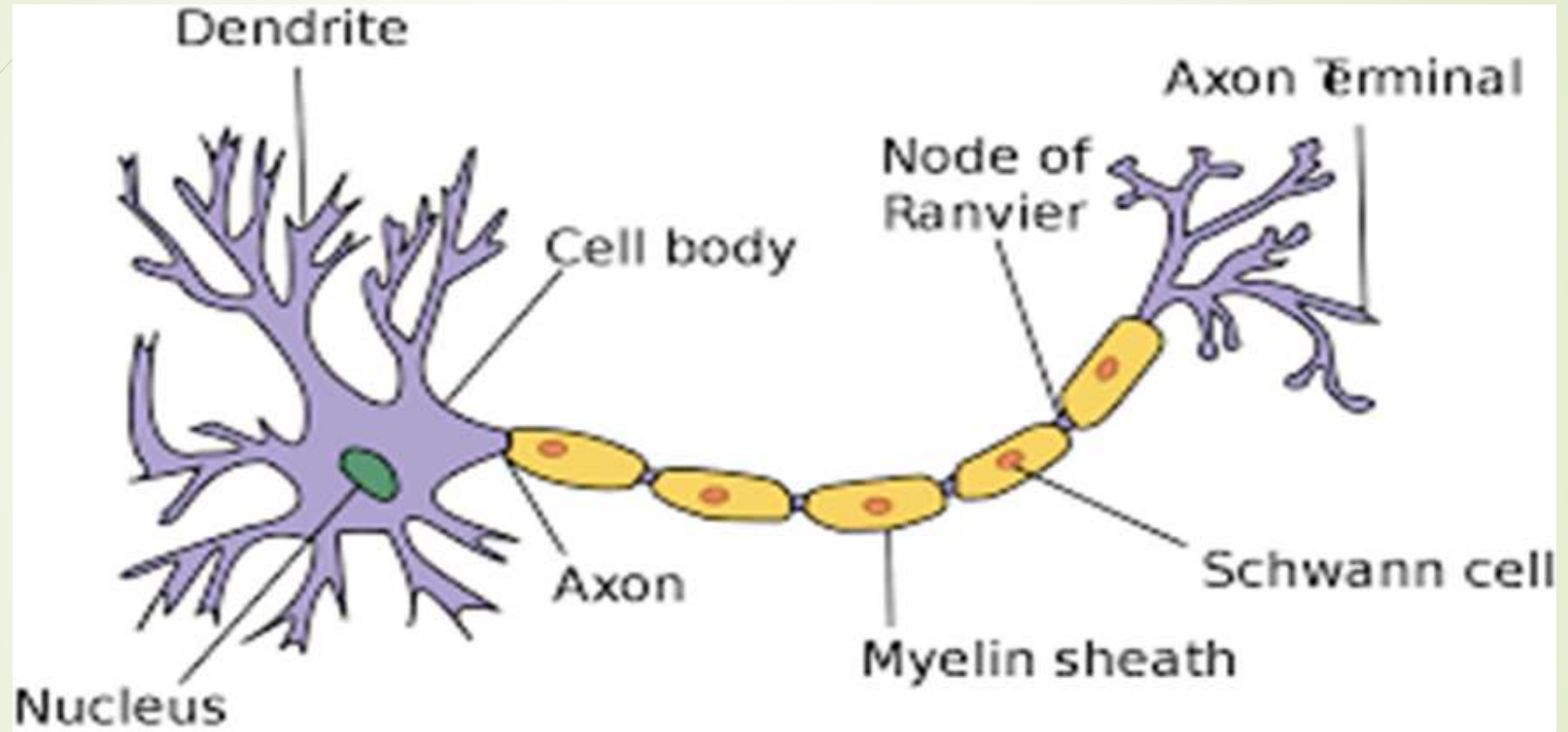
# Nervous tissue

- The nervous tissue is a *highly specialized tissue* system that *reacts to stimuli* and conducts impulses to various organs in the body.
- Nervous tissue *exhibit sensitivity* to various types of stimuli in both the internal and external environment.
- The stimuli are integrated and analysed to *provide a response in the effector organs*.
- The two main types of cells in the nervous system are;
  1. *Neurons*: signaling cells
  2. *Neuroglia*: support cells

## Neurons (Nerve cells)

- It consist of *cell body, axons, and dendrites*.
- The *cell body contains nucleus* and other organelles.
- *Dendrites* are usually *short and highly branched* forms that communicate between neurons.
- Each nerve cell contains *single axon which is thin, long and cylindrical process*.
- The axon is the major output portion of a neuron which *conducts the signal to effector organs*.
- *The axons are surrounded by white, fatty substance called myelin sheath*.
- *The unmyelinated region between the myelin segments are called nodes of Ranvier*.
- *Schwann cells* are specialized cells that produce myelin around the axon.

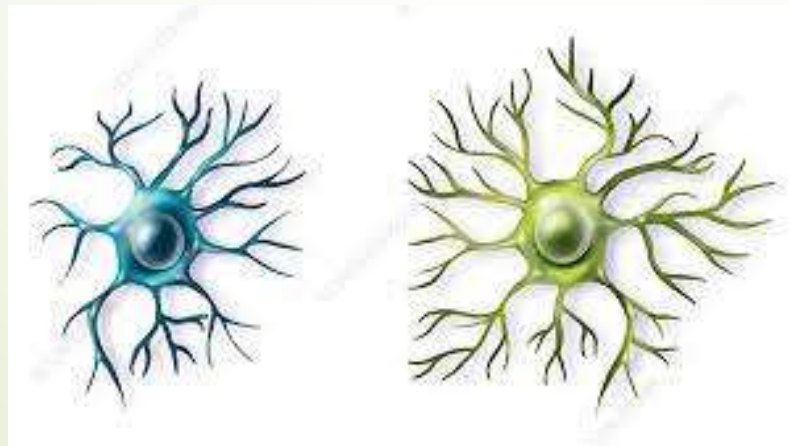




- On the basis of direction in which they transmit impulses, neurons are classified as:
  - **Afferent neurons:** transmit impulses from peripheral receptors to the CNS.
  - **Efferent neurons:** carry impulses from the CNS to effector organs.
  - **Interneurons:** serve as a connecting link between the afferent and efferent neurons.
- 
- On the basis of their structure, neurons can be classified as:
  - **Unipolar:** *dendrites arise from one end of the neuron.* These are sensory neurons which are located in skin, joints and muscles.
  - **Bipolar:** the *axon emerges from one end of the cell body* while the *dendrites emerge from the other end.*
  - Thus, in these neurons two processes arise from the cell body in opposite direction.
  - They are present in the retina of the eye.
  - **Multipolar:** many *dendrites arise from the cell body.* They are present in the brain and spinal cord.

# Neuroglia cells

- ▶ These cells *provide support, protection and nourishment to the neurons.*
- ▶ Glial cells can *reproduce.*
- ▶ They *cannot conduct signals.*
- ▶ They are more numerous and *smaller than the nerve cells.*
- ▶ The tree types of glial cells are *astrocytes, oligodendrocytes and microglia.*
- ▶ They controls the *uptake of neurotransmitters, help in recovery of neural injury and control the rate of signal propagation.*





# Exam Oriented Questions

1. Define tissue. Enlist the different types of tissues. Explain in detail epithelial tissue and connective tissue. (10M)
2. Define tissue and give its different types. (3M)
3. Write short note on nervous tissue.(3M)
4. Write a note on epithelial tissue and explain its different types. (5M)
5. Describe muscular tissue.(5M)
6. Give types and the common location of epithelial tissue in body. Explain characteristics of epithelial tissue.(5M)
7. Explain in detail the structure and function of epithelial tissue. (5M)
8. Explain the structure and function of nervous tissue. (5M)

## Reference

- ▶ D. K. Ingawale, S.K. Mandlik, Human Anatomy and Physiology, 3<sup>rd</sup> edition, Nirali prakashan, pg. 45-68.