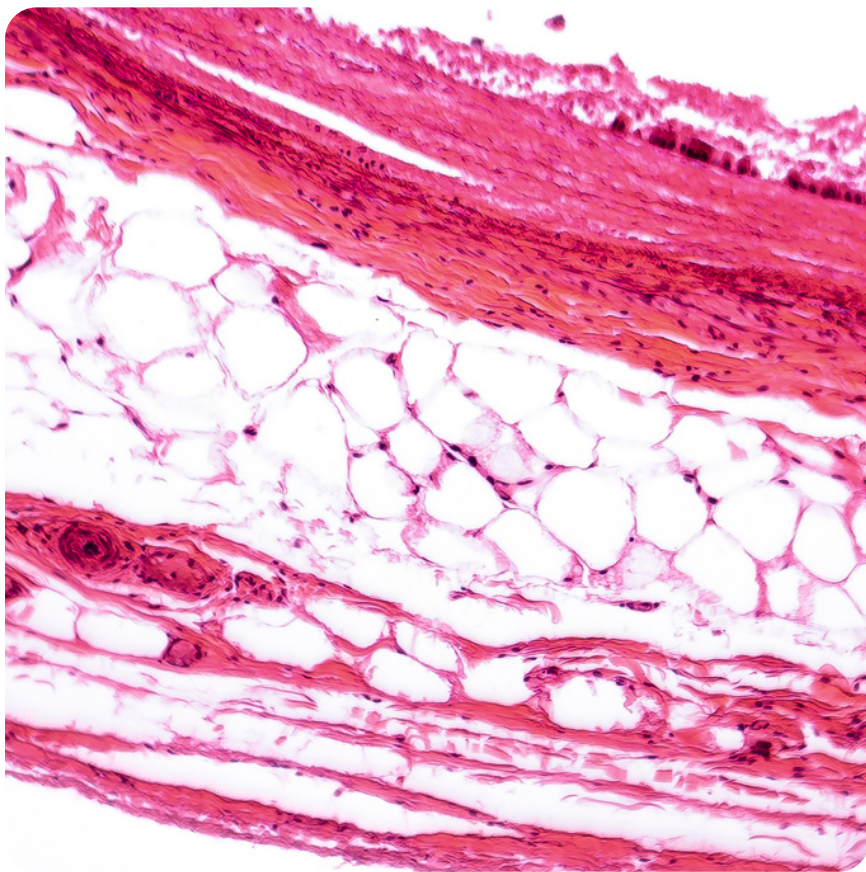


# ZOOLOGY

ENTHUSIAST | LEADER | ACHIEVER



**STUDY MATERIAL**

Structural organisation in Animals  
(Animal Tissues)

ENGLISH MEDIUM

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**Marie François Xavier Bichat**

(14 November 1771 - 22 July 1802) was a French anatomist and physiologist who is best remembered as the father of modern histology and descriptive anatomy. Despite working without a microscope, he was the first to introduce the notion of tissues as distinct entities, and maintained that diseases attacked tissues rather than whole organs or the entire body, causing a revolution in anatomical pathology. Bichat was born at Thoirette in Jura, France. His father was Jean-Baptiste Bichat, a physician who had trained at Montpellier and was Bichat's first instructor. His mother was Jeanne-Rose Bichat, his father's wife and cousin. He entered the college of Nantua, and later studied at Lyon. He made rapid progress in mathematics and the physical sciences, but ultimately devoted himself to the study of anatomy and surgery under the guidance of Marc-Antoine Petit (1766-1811), chief surgeon to the Hotel-Dieu at Lyon. The revolutionary disturbances compelled him to flee from Lyon and take refuge in Paris in 1793. There he became a pupil of P. J. Desault, who was so impressed with his genius that he took him into his house and treated him as his adopted son. For two years he took active part in Desault's work, at the same time pursuing his own research in anatomy and physiology. Desault passed in 1795. At age 29 he was appointed as the chief physician to the Hotel-Dieu. In 1796, he and several other colleagues formally founded the Société d'Emulation de Paris, which provided an intellectual platform for debating problems in medicine. He died at age 30, fourteen days after falling down a set of stairs at Hotel-Dieu and acquiring a fever. He is buried at Père Lachaise Cemetery.

**MARCELLO MALPIGHI**

(10 March 1628 - 29 November 1694) was an Italian biologist and physician, who is referred to as the "Father of microscopical anatomy, histology, physiology and embryology". Malpighi's name bears to several physiological features related to the biological excretory system, such as the Malpighian corpuscles and Malpighian pyramids of the kidneys and the Malpighian tubule system of insects. The splenic lymphoid nodules are often called the "Malpighian bodies of the spleen" or Malpighian corpuscles. The botanical family Malpighiaceae is also named after him. He was the first person to see capillaries in animals, and he discovered the link between arteries and veins that had eluded William Harvey and Malpighi has been the earliest person to observe red blood cells under a microscope. His treatise *De polypo cordis* (1666) was important for understanding blood composition, as well as how blood clots. In it, Malpighi described how the form of a blood clot differed in the right against the left sides of the heart.



## STRUCTURAL ORGANISATION IN ANIMALS (ANIMAL TISSUES)

### 01. INTRODUCTION

- **Introduction**
- **Organ and organ system**
- **Epithelial tissues**
- **Cell Junctions**
- **Glands**
- **Connective tissues**
- **Cartilage**
- **Bone**

In unicellular organisms, all functions like digestion, respiration and reproduction are performed by a single cell. In the complex body of multicellular animals the same basic functions are carried out by different groups of cells in a well organised manner. The body of a simple organism like Hydra is made of different types of cells and the number of cells in each type can be in thousands. The human body is composed of billions of cells to perform various functions. How do these cells in the body work together?

In multicellular animals, a group of similar cells along with intercellular substances perform a specific function. Such an organisation is called **tissue**.

You may be surprised to know that all complex animals consist of only four basic types of tissues. These tissues are organised in specific proportion and pattern to form an organ like stomach, lung, heart and kidney. When two or more organs perform a common function by their physical and/or chemical interaction, they together form organ system, e.g., digestive system, respiratory system, etc. Cells, tissues, organs and organ systems split up the work in a way that exhibits division of labour and contribute to the survival of the body as a whole.

### 02. ORGAN AND ORGAN SYSTEM

The basic tissues mentioned above organise to form organs which in turn associate to form organ systems in the multicellular organisms. Such an organisation is essential for more efficient and better coordinated activities of millions of cells constituting an organism. Each organ in our body is made of one or more type of tissues. For example, our heart consists of all the four types of tissues, i.e., epithelial, connective, muscular and neural. We also notice, after some careful study that the complexity in organ and organ systems displays certain discernible trend. This discernible trend is called evolutionary trend (You will study the details in class XII). You are being introduced to morphology and anatomy of three organisms at different evolutionary levels to show their organisation and functioning. Morphology refers to study of form or externally visible features. In the case of plants or microbes, the term morphology precisely means only this. In case of animals this refers to the external appearance of the organs or parts of the body. The word anatomy conventionally is used for the study of morphology of internal organs in the animals. You will learn the morphology and anatomy of earthworm, cockroach and frog representing invertebrates and vertebrates.



**Tissue** : A group of cells in which cells are similar in structure, function and origin is called tissue.

A group of similar cells along with intercellular substances perform a specific function. Such an organisation is called tissue. But in a tissue, cells may be dissimilar in structure and function but they are always similar in origin.

**Organ** : Tissues are organised in specific proportion and pattern to form an organ.

**Organ system** : When two or more organs perform a common function by their physical &/or chemical interaction, they together form organ system.

**Division of labour** : Cells, tissues, organs and organ systems split up the work in a way that exhibits division of labour.

**On the basis of functions & structure tissues are of four types :**

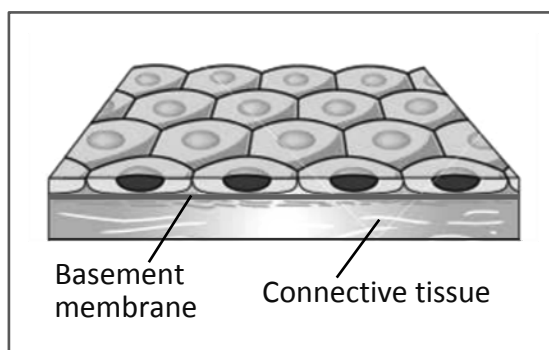
1. **Epithelium/Epithelial Tissue** : Covering & protective tissue.
2. **Connective Tissue** – To connect structures, provide support to the body and transport substances in the body.
3. **Muscular Tissue** – Helps in contraction & locomotion.
4. **Nervous tissue** – To generate and conduct nerve impulses in body.

#### HISTORICAL BACKGROUND

- Word Epithelium was given by – **Ruysch**
- Word animal tissue was coined by – **Bichat** (Plant tissue by - Grew).
- Study of tissue – **Histology**.
- Histology word was given by – **Mayer**
- Father of Histology – **Bichat**
- Detail study of tissue is called **Microscopic anatomy**.
- Founder of microscopic anatomy – **Marcello Malpighi**

### 03. EPITHELIAL TISSUE

1. During embryonic development epithelium originates first.
2. Power of regeneration is present in this tissue while power of regeneration is absent or least power is found in nervous tissue.
3. This tissue faces either a body fluid or outside environment and thus provides a covering or a lining.



4. Word epithelium is composed of two words.

**Epi – Upon          Thelia – growth**

A tissue which grows upon another tissue is called Epithelium.

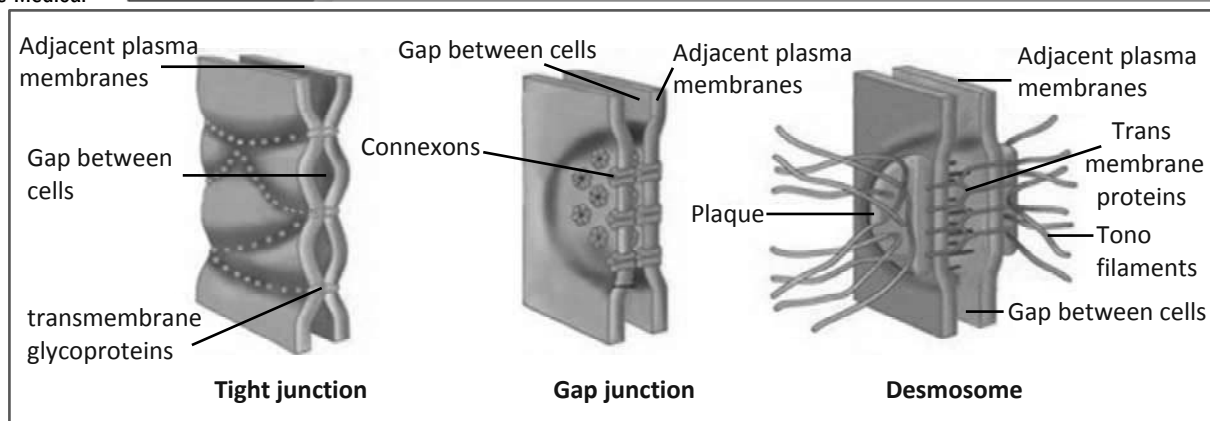
5. It always rest upon underlying connective tissue. Epithelium is the only tissue in which cells are always arranged in uniform layer. Epithelium cells are compactly packed with little intercellular matrix.
6. Due to absence of intercellular spaces blood vessels, lymph vessels & capillaries are unable to pierce this tissue so blood circulation is absent in epithelium. Hence cells depend for their nutrients on underlying connective tissue.
7. **Basement membrane** : Between epithelium and connective tissue, a thin non living acellular basement membrane is present which is highly permeable. Basement membrane consist of 2 layers.

- **Basal lamina** : Towards epithelium tissue and it is made up of glycoproteins, which is secreted by epithelium cells.
- **Fibrous lamina** : Towards connective tissue, in which collagen and reticular fibres are suspended in mucopolysaccharide which is matrix of connective tissue. Mucopolysaccharide is present in the form of Hyaluronic acid.

**So basement membrane is secreted by both epithelium and connective tissue.**

8. **Intercellular junction** : To provide both structural and functional link between its individual cell epithelial cells modify to form following structures (Intercellular Junctions) :
- (i) **Interdigitation** – Finger like processes of plasma membrane are inter locked with adjacent cell. These structures are mainly found in **transitional epithelium**.
  - (ii) **Adhering / Desmosomes** – This type of (Macula Adherens) Junction consists of disc - like protein plate with intermediate fibre known as tonofibrils composed of keratin like protein. These filaments are deeply situated in the cytoplasm of respective cell. **These structures provide mechanical support to stratified epithelium or perform cementing to keep neighbouring cells together. e.g. Stratified epithelium**
  - (iii) **Tight Junction** – At some places plasma membrane of adjacent cells become fused to form tight junction to stop substances from leaking across a tissue. These structures are mostly found in **columnar epithelium**.
  - (iv) **Gap Junction** – Faciliate the cells to communicate with each other by connecting the cytoplasm of adjoining cells, for rapid transfer of ions small molecules and sometimes big molecules.

e.g. Neural tissue, Muscle tissue



**9. Plasma membrane of free end is modified in three types of functional structures :-**

|   | Microvilli  | Cilia/Kinocilia   | Stereocilia                          |
|---|---|---|--------------------------------------|
| 1 | Minute process  | Long cylindrical process (same diameter from base to apex)  | Conical shape                        |
| 2 | Non motile  | Motile  | Non Motile                           |
| 3 | Non contractile   | Contractile   | Non contractile                      |
| 4 | Function :-<br>Increase surface area for absorption and secretion | Function :-<br>Helps in movement and locomotion. It moves particles or mucus in specific direction over the epithelium. (Movement is in uniform direction)  | Function :-<br>Increase surface area |
|   | Eg :- Wall of intestine, Gall bladder, PCT of nephron             | Eg : - Inner surface of hollow organs like bronchioles and fallopian tube. Uterus, Trachea, Ependymal epithelium (Inner lining of brain cavities (ventricle) and central canal of spinal cord) where it helps in cerebrospinal fluid conduction). | Eg :- Epididymis and vasa deferens   |

**Origin of Epithelium Tissue**

It is the only tissue which originated from all the three primordial germinal layers.

- eg. (i) **Ectodermal** – Epidermis (stratified squamous epithelium)
- (ii) **Mesodermal** – Mesothelium (simple squamous epithelium)
- (iii) **Endodermal** – Inner lining of gut (simple columnar epithelium)



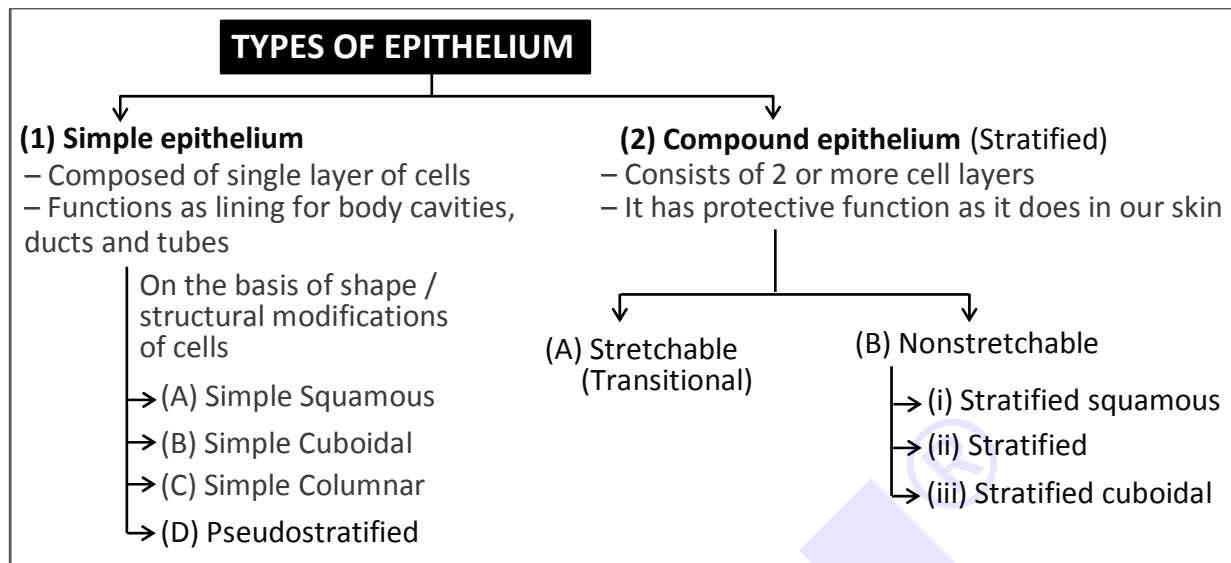
## BEGINNER'S BOX

## EPITHELIAL TISSUE

1. Epithelial tissue originate from :-  
 (1) Ectoderm                      (2) Endoderm                      (3) Mesoderm                      (4) All of these
2. Basement membrane is composed of :-  
 (1) Hyaluronic Acid + glycoproteins                      (2) Only mucopolysaccharides  
 (3) Endodermal cells                      (4) Epidermal cells
3. Stereocilia are present in :-  
 (1) Epididymis                      (2) Seminal vesicle                      (3) Ureter                      (4) Kidney
4. Brain ventricle & central canal of spinal cord is lined by :-  
 (1) Ependymal epithelium                      (2) Endothelium  
 (3) Mesothelium                      (4) Neurosensory epithelium
5. Desmosomes :-  
 (1) connect the epithelial cells                      (2) are types of lysosomes  
 (3) are granules of muscle fibres                      (4) found in bone
6. Ciliated Epithelium is found in :-  
 (1) Oviduct                      (2) Trachea                      (3) Brain ventricles                      (4) All of these
7. Gap junctions :-  
 (1) help to stop substances from leaking across a tissue.  
 (2) perform cementing to keep neighbouring cells together  
 (3) provide stretchability to the epithelium  
 (4) facilitate the cells to communicate with each other by connecting the cytoplasm of adjoining cells.
8. Condition necessary for the formation of organ system :  
 (1) Presence of all four basic type of tissues                      (2) Chemical interaction  
 (3) Physical interaction                      (4) All of these
9. Tissue which provide support to the body is :  
 (1) Epithelial tissue                      (2) Connective tissue                      (3) Muscular tissue                      (4) Nervous tissue
10. Intercellular junction which helps in exchange of substances is :  
 (1) Tight junction                      (2) Gap junction                      (3) Interdigitation                      (4) Desmosome



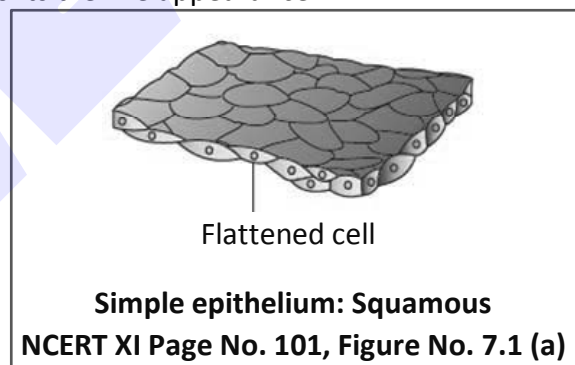
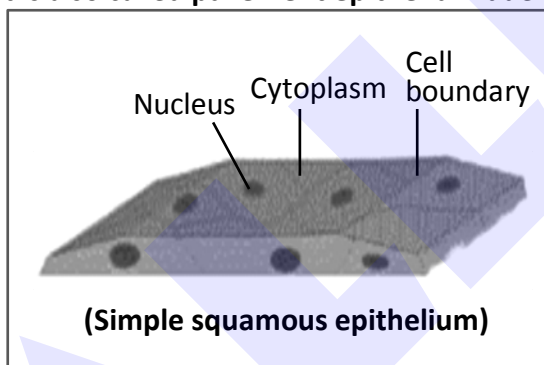
## CLASSIFICATION OF EPITHELIUM TISSUE



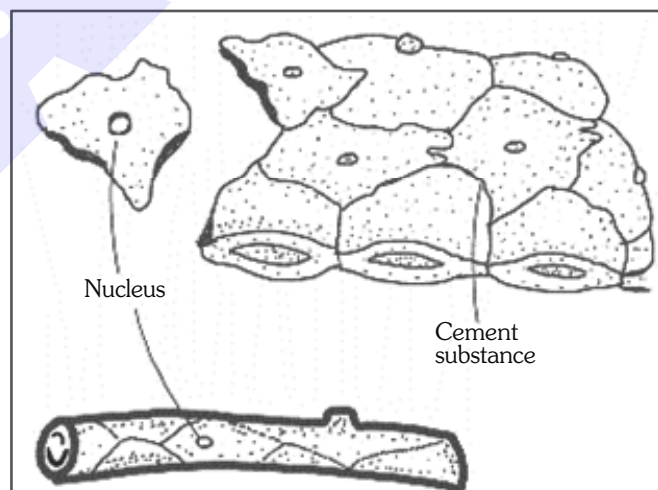
### (1) SIMPLE EPITHELIUM

#### (A) Simple Squamous Epithelium :

- The squamous epithelium is made up 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 functions like forming a diffusion boundary.
- It is also called **pavement epithelium** due to its tile like appearance.



- Also called **Tessellated epithelium** due to its wavy appearance.



- This epithelium is associated with **filtration & diffusion**.

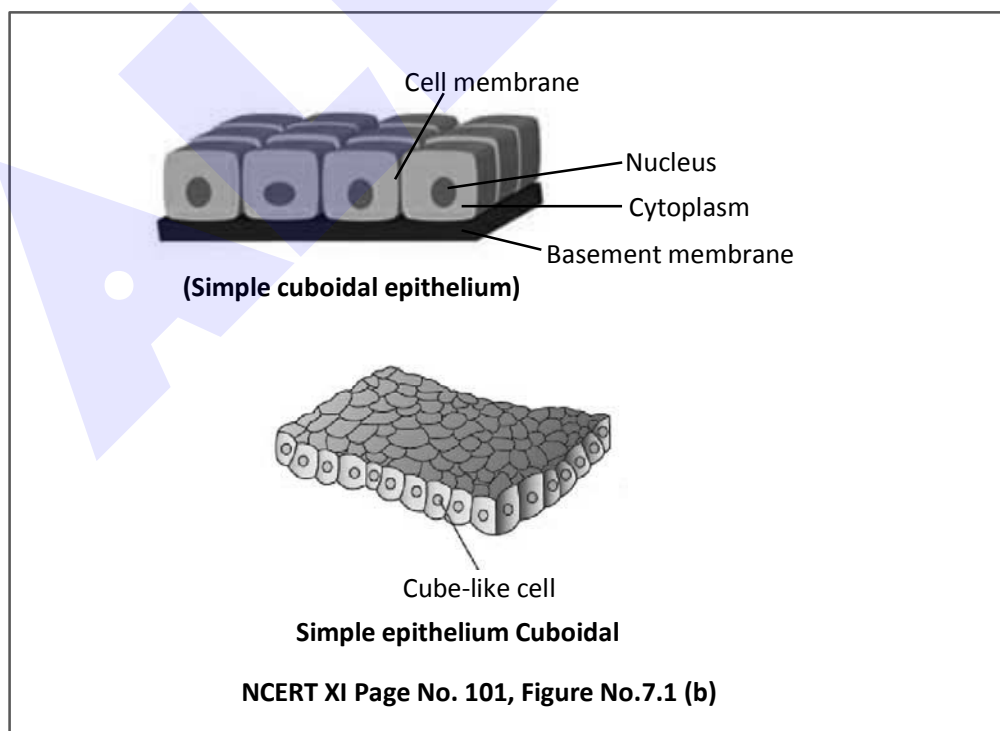
e.g. :-

- Outer surface of intestine.
- **Bowman's capsule** (Podocyte)
- **Alveoli of lungs** (Pneumocytes type-I) (air sacs of lungs)
- **Mesothelium** – Lining of coelom is called as mesothelium.
- **Endothelium** – Inner lining of blood vessels and lymph vessels.
- **Endocardium** – Inner most lining of heart is also made up of simple squamous epithelium.
- Thin part of loop of Henle of nephron.
- Peritoneum

### (B) Simple Cuboidal Epithelium :

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.

- Cells are cube like with rounded nucleus present in the centre.
- Cells are same in length & width so they appear square shaped in vertical section.



- This epithelium helps in absorption, secretion.
- It is commonly found in ducts of glands and tubular parts of nephrons of kidneys.

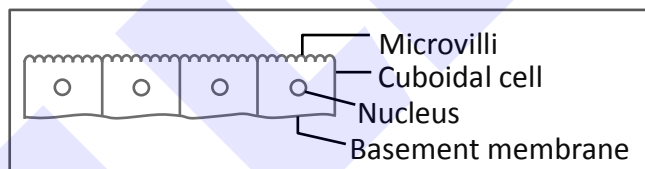
e.g.:-

- **Follicle of Thyroid gland**
- **Type II Pneumocytes of alveoli**
- **Acini of Pancreas**
- **Secretory unit of sweat glands**
- **Iris, Choroid, Ciliary body of eye, Epithelium of retina**
- **DCT of nephron**
- **Thick part of loop of Henle**
- This epithelium is also called **Germinal epithelium** because in gonads (testes & ovaries) cuboidal cells divide to form sperm & egg.

#### Modifications of simple cuboidal epithelium

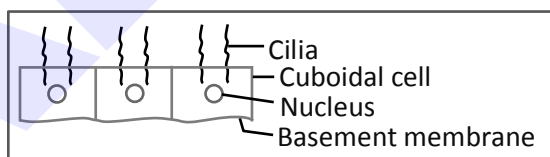
- (i) **Brush bordered cuboidal epithelium** : When microvilli are present on free end of cuboidal cells

- Found in PCT of nephron.



- (ii) **Ciliated cuboidal epithelium** : When cilia are present on free end of cuboidal cells.

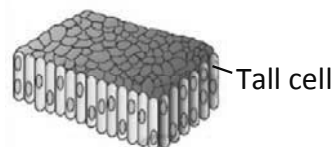
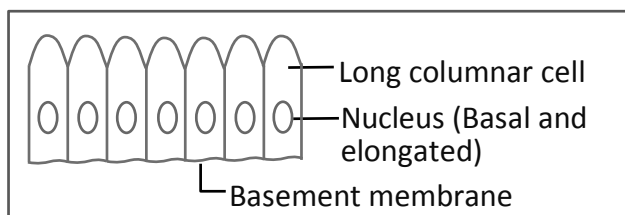
- Found in collecting duct.



#### (C) **Simple Columnar Epithelium** :

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.

- It is also found in liver, bile duct and uterus.



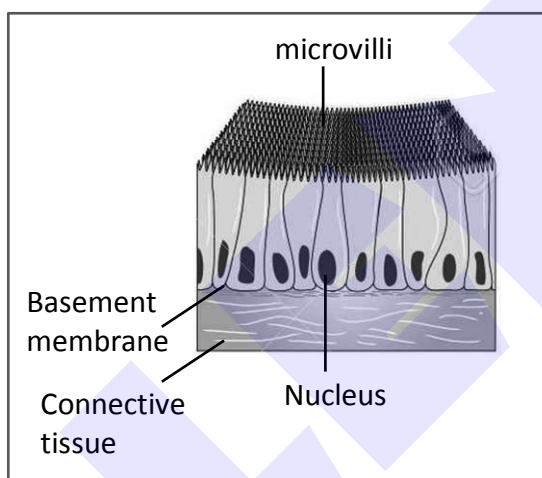
**Simple epithelium Columnar**  
**NCERT XI Page No.101, Figure No. 7.1 (c)**

### Modifications of Simple Columnar epithelium

- (i) **Brush Bordered Columnar epithelium** : When microvilli are present on free end of columnar epithelium.

e.g. Gall bladder

(helps in concentrating bile juice)



- (ii) **Glandular columnar epithelium** :

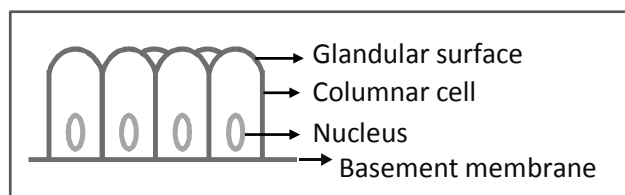
Unicellular mucous secreting **goblet cells** are also present in between the columnar cells.

eg. Stomach

Caecum

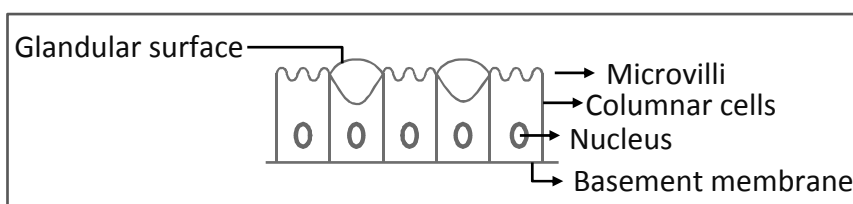
Colon

Rectum



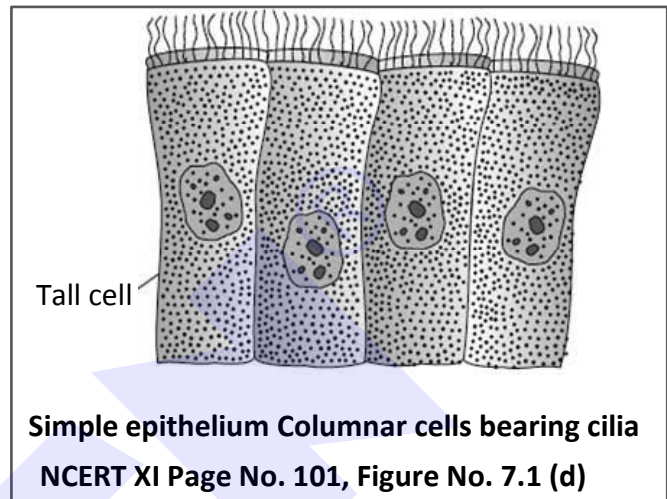
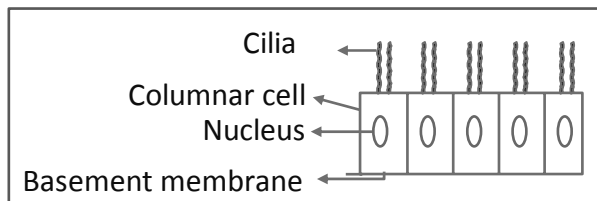
- (iii) **Glandular Brush-bordered columnar epithelium** : When microvilli are present on free end of columnar cells and in between these cells goblet cells are also present.

eg. Small intestine (Duodenum, jejunum, ileum)



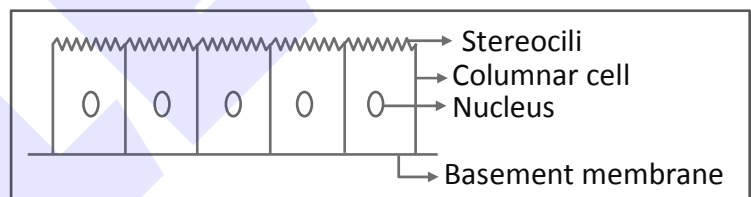
(iv) **Ciliated Columnar epithelium** : When cilia are present on free end of columnar cells.

- Eg.
- Fallopian Tube → (Conduction of gametes)
  - Ependymal epithelium → (Conduction of cerebrospinal fluid)  
(Inner lining of brain ventricle)
  - Bronchioles



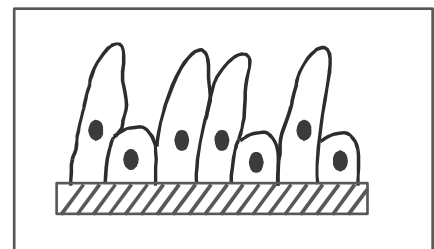
(v) **Stereo ciliated columnar epithelium** : When stereocilia are present on free end of columnar cells.

- Eg.
- Epididymis
  - Vas deferens
  - Macula & crista of ear



(D) **Pseudostratified Epithelium** :

- It is also a modification of columnar epithelium that contains long & short cells.
- Nucleus in both cells are present on different level so it appears bilayered because few cells are too short to reach the top surface but all cells are present on single basement membrane, so it is unilayered.



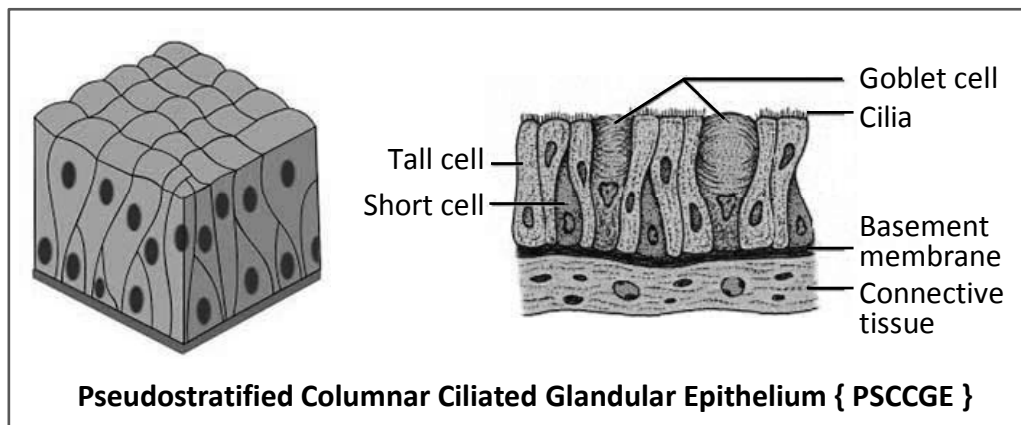
**MODIFICATION :**

**Pseudostratified columnar ciliated glandular epithelium (PSCCGE) :**

In this epithelium, cilia are present on free surface of long cells and goblet cells are also present in this epithelium.

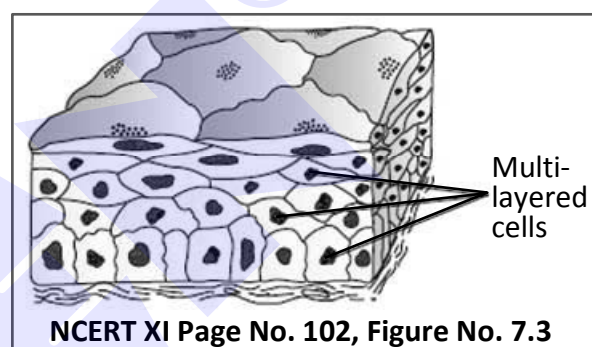
- e.g.
- Respiratory epithelium of nasal chambers
  - Trachea
  - Bronchi and bronchioles





## (2) COMPOUND EPITHELIUM

Compound epithelium is made up of more than one layer (multi-layered) of cells and thus has a limited role in secretion and absorption (Figure). Their main function is to provide 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.



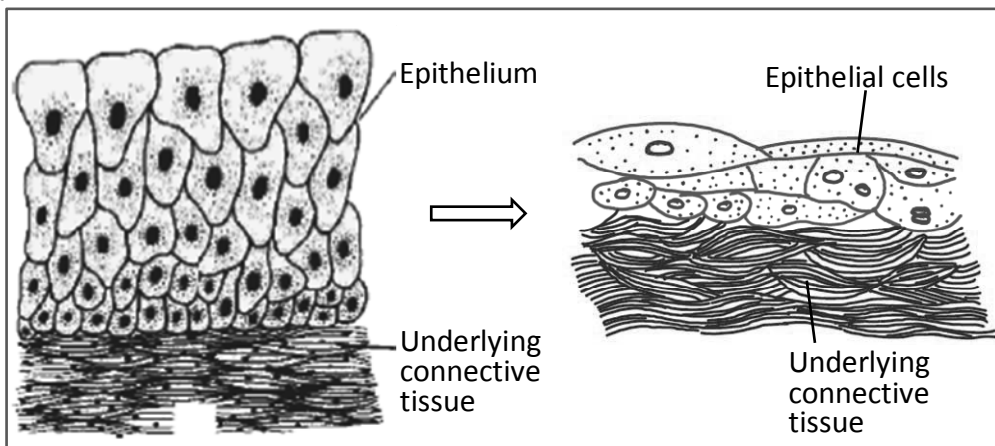
On the basis of stretching ability it is of 2 types:

(A) **Transitional Epithelium (Stretchable)**

(B) **Non-Stretchable/Stratified**

(A) **Transitional Epithelium (Urothelium) :**

- In this epithelium basement membrane becomes invisible during stretching.
  - In this epithelium 4-6 layers of cells are present.
  - Inner most layer of cell is composed of **cube like cells**.
  - Middle 2-4 layers are composed of pear shaped /Polyheadral cells.
  - Outermost 1 or 2 layers are of oval shaped cells.
  - These different shape of cells appears only in resting stage. When this tissue is stretched, all the cells become flattened.
  - Cells are interconnected by interdigitation.
  - Stretchable & water proof.
- e.g.
- Renal pelvis
  - Ureter
  - Urinary ladder
  - Proximal part of male urethra.



**(B) Non Stretchable Epithelium :**

- On the basis of shape of the cells of outermost layer, it is of three types.
  - (i) **Stratified squamous epithelium**
  - (ii) **Stratified cuboidal epithelium**
  - (iii) **Stratified columnar epithelium**
- (i) **Stratified squamous epithelium**
  - Innermost layer of cells is of cuboidal/columnar.
  - They divide to form cells of outer layer in the epithelium, so this layer is called as **Germinativum** layer.
  - Middle layers are made up of polygonal cells.
  - These cells are interconnected with desmosomes which provide rigidity or mechanical support.
  - Cells of outermost layer are scale like flat cells.
  - On the basis of presence of keratin protein in the outer most cells, this epithelium is of two types :-
    - (a) **Keratinized stratified squamous epithelium :**

If keratin protein is present, cells become non nucleated and dead.

e.g. Epidermis of skin & skin derivatives. Hair, Horn, Hooves, Scales, feathers.
    - (b) **Non Keratinized stratified squamous epithelium :**

If Keratin protein is absent. Cells are nucleated and Living.

e.g. It lines the moist surface of Buccal cavity, Pharynx, Oesophagus, Anal canal, Vagina etc.

      - Cornea of eye, Conjunctiva of eye.
      - Inner lining of cheeks, lips, hard palate.
- (ii) **Stratified cuboidal epithelium**
  - Cell of outermost layer are cube like, nucleated and living.
  - e.g.
    - Secretory duct of sweat glands, mammary gland, salivary glands and sebaceous glands.
    - Pancreatic duct.

**(iii) Stratified columnar epithelium**

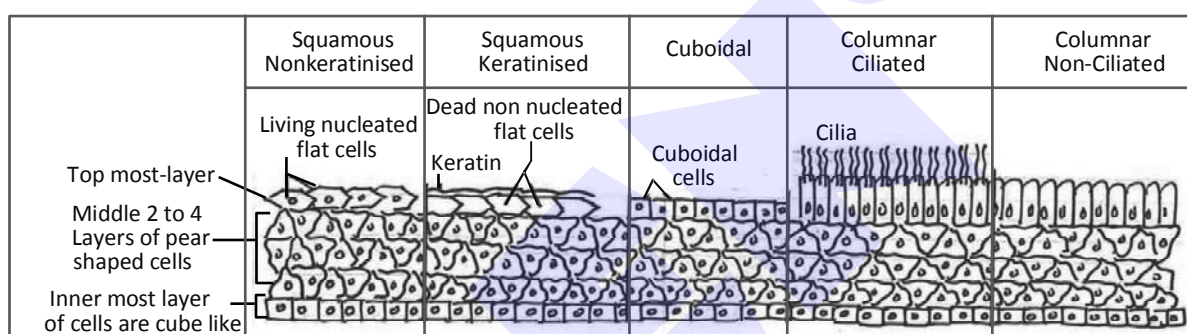
Outermost layer is composed of pillar shaped cells, cells are nucleated. On the basis of presence of cilia this epithelium is of 2 types -

**(a) Ciliated Stratified columnar epithelium**

e.g. Larynx, Buccopharyngeal cavity of Frog.

**(b) Non-Ciliated Stratified columnar epithelium**

e.g. Distal part of male urethra, Epiglottis.

**STRATIFIED EPITHELIUM****04. GLANDS**

A cell or a group of cells which secretes chemical substances are called glands.

All glands are composed of Epithelium tissue. Some columnar or cuboidal cells get specialised for secretion known as Glandular epithelium.

Glands can originate from all the three germinal layers.

**CLASSIFICATION OF GLANDS****(1) ON THE BASIS OF METHOD OF SECRETION****(A) Endocrine Glands :**

Secretory duct absent and secrete hormones. Their products called hormones are secreted directly into the fluid bathing the gland.

**(B) Exocrine gland :**

Secretory duct present – secretes mucus, saliva, earwax, oil, milk and enzymes.

**(C) Heterocrine/mixed gland :**

Both endocrine & exocrine parts are present.

e.g. Pancreas, Gonads etc.

## (2) ON THE BASIS OF NATURE OF SECRETION

3 types of glands are there

### (A) Eccrine / Acrine/Merocrine Gland :

In these glands secretory cells secrete substances by simple diffusion (Exocytosis). No part of cytoplasm is destroyed in secretion. Their secretions are watery.

e.g. **Sweat glands, Goblet cells, Salivary gland, Tear gland, Intestinal glands, Mucous gland.**

### (B) Apocrine Gland :

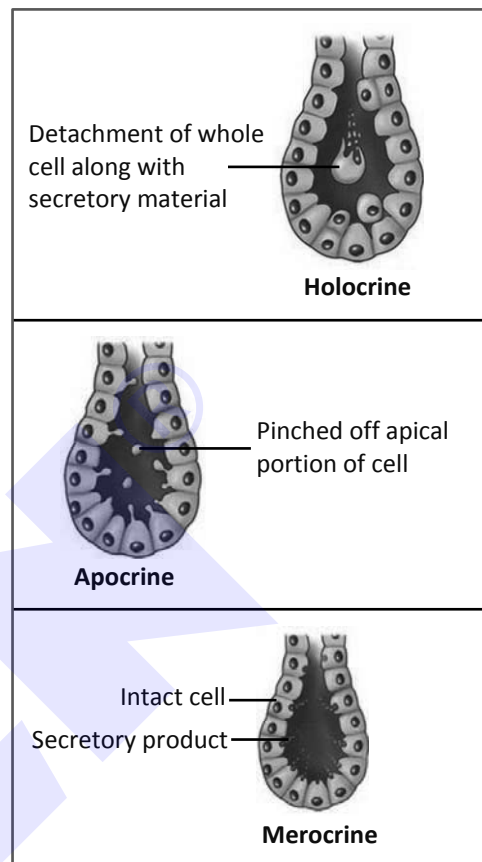
In this type of glands secretory products are collected in apical part of secretory cell and apical portion is also shed alongwith secretory matter. Secretory matter is comparatively concentrated.

e.g. **Mammary glands.**

### (C) Holocrine Glands :

The production or secretion is shed with whole cell leading to its destruction. i.e whole cell is shed as secretion (Secretory matter is highly concentrated)

e.g. **Sebaceous, meibomian & Zeis gland.**



## (3) ON THE BASIS OF NUMBER OF CELLS

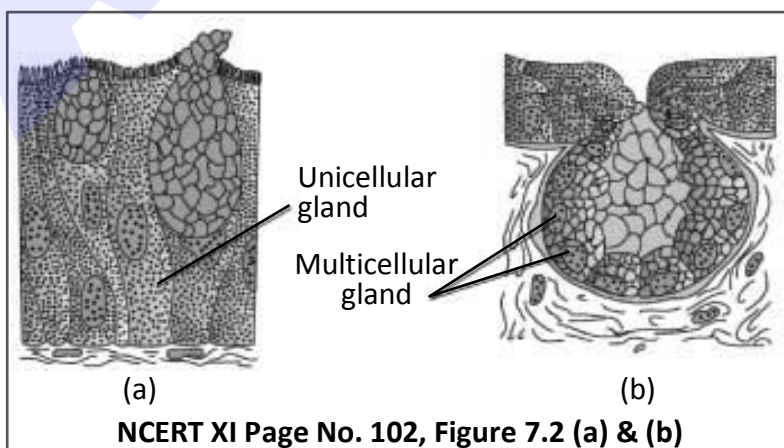
### (A) Unicellular glands

e.g. Goblet cells, Paneth cells

### (B) Multicellular glands

e.g. All glands except Goblet cells and Paneth cells

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).



NCERT XI Page No. 102, Figure 7.2 (a) & (b)



## BEGINNER'S BOX

## TYPES OF EPITHELIUM AND GLANDS

1. Pseudostratified epithelium is present in :-
 

|                       |                                 |
|-----------------------|---------------------------------|
| (1) Nephron & Neuron  | (2) Larynx & Pharynx            |
| (3) Trachea & Bronchi | (4) Urinary Bladder & Intestine |
2. Transitional epithelium is found in :-
 

|                                |                     |
|--------------------------------|---------------------|
| (1) Renal pelvis & Ureter      | (2) Urinary bladder |
| (3) Upper part of male urethra | (4) All of above    |
3. Columnar epithelium with microvilli or brush border is present in :-
 

|                  |             |              |             |
|------------------|-------------|--------------|-------------|
| (1) Gall Bladder | (2) Stomach | (3) Appendix | (4) Pharynx |
|------------------|-------------|--------------|-------------|
4. The internal lining of blood vessels is called as :-
 

|                         |                           |
|-------------------------|---------------------------|
| (1) Mesothelium         | (2) Endothelium           |
| (3) Pavement Epithelium | (4) Stratified Epithelium |
5. Which of the following tissue covers moist surface of buccal cavity and pharynx?
 

|                             |                         |
|-----------------------------|-------------------------|
| (1) Cuboidal epithelium     | (2) Columnar epithelium |
| (3) Transitional epithelium | (4) Compound epithelium |
6. Non keratinised stratified squamous epithelium is found in :-
 

|          |             |                |               |
|----------|-------------|----------------|---------------|
| (1) Skin | (2) Stomach | (3) Oesophagus | (4) Intestine |
|----------|-------------|----------------|---------------|
7. Inner lining of gut, stomach & liver is made up of :-
 

|                     |                                   |
|---------------------|-----------------------------------|
| (1) Simple squamous | (2) Simple cuboidal               |
| (3) Simple columnar | (4) Pseudo stratified epithelium. |
8. Cells of Peritoneum comprise :-
 

|                         |                          |
|-------------------------|--------------------------|
| (1) Ciliated Epithelium | (2) Glandular Epithelium |
| (3) Columnar Epithelium | (4) Squamous Epithelium  |
9. Stratified squamous Epithelium :-
 

|  |
|--|
| (1) Outer most layer squamous & Inner most is cuboidal |
| (2) Outer most layer cuboidal & Inner most is squamous |
| (3) Outer most layer columnar & Inner most is cuboidal |
| (4) Outer most layer cuboidal & Inner most is columnar |
10. The correct statement with respect to epithelial tissue is :-
 

|  |  |
|--|--|
| A – cells are compactly packed               | B – cells have no intercellular matrix |
| C – cells have little intercellular material | D – it is single or multilayered       |
| (1) A & D                                    | (2) B & C                              |
| (3) A, C & D                                 | (4) All of these                       |



## 05. CONNECTIVE TISSUE

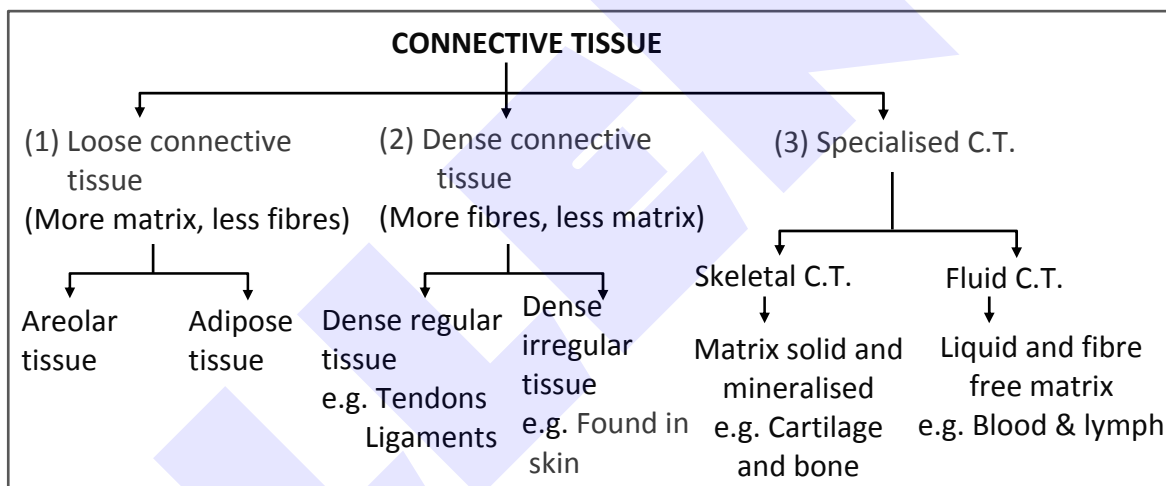
Connective tissues are the most abundant and widely distributed in the body of complex animals. They are named connective tissue because of their special function of linking and supporting other tissues/organs of the body. They range from soft connective tissues to specialised types, which include cartilage, bone, adipose, and blood.

O. Hartwig called them **Mesenchyme** because they originated from embryonic mesoderm

On the basis of **matrix** connective tissue is of 3 types.

1. **Connective Tissue Proper** :- Matrix soft and fibrous
2. **Connective Tissue Skeleton** :- Dense and mineralised matrix. **Due to deposition of minerals it becomes hard.**
3. **Connective tissue Vascular** :- Liquid and fibres free matrix.

In all connective tissue except blood, cells secrete fibres of structural protein (like collagen & elastin) and matrix.



### (1) CONNECTIVE TISSUE PROPER

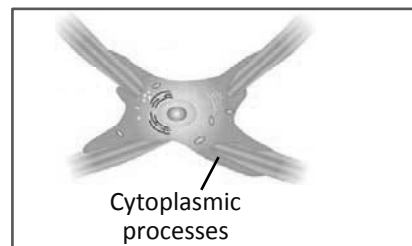
Connective Tissue Proper is composed of three components

- (A) Different types of cells.
- (B) Fibres.
- (C) Matrix.

#### (A) Cells of Connective Tissue Proper :

##### (i) Fibroblast cells

- Largest cell of connective tissue proper.
- Maximum in number.
- Branched cytoplasmic process arise from these cells so they appear irregular in shape.
- Main function or primary function of these cells is to produce fibres. Fibres are composed of protein.

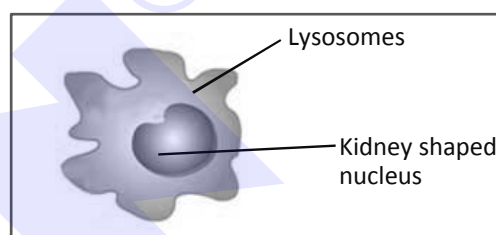


- They also synthesize most part of matrix of connective Tissue. (Chief matrix producing cell)
- Old fibroblast cells (fibrocyte) are inactive cells and synthesize only little part of matrix.
- Fibroblast cells are also considered as undifferentiated cells of connective tissue because they can be modified into **Osteoblast** & **Chondroblast** cells to produce bone & cartilage.
- Areolar tissue present beneath the skin.

**Function :** (1) To produce fibres (2) To secrete matrix

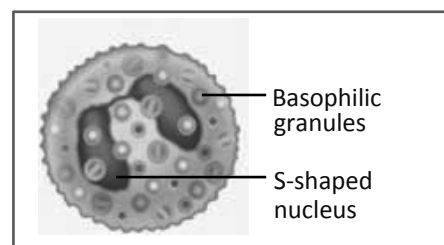
**(ii) Macrophages (Histiocyte)**

- Amoeboid in shape with bean (Reniform) or kidney shaped nucleus.
- Cytoplasm quantity is more and cytoplasm is agranular but due to presence of more number of lysosome it appears granular.
- They are phagocytic in nature. They destroy bacteria & viruses by phagocytosis.
- Also called as **scavenger cells** of connective tissue because they destroy dead or damaged cells to clean connective tissue.



**(iii) Mast cells (Mastocytes)**

- Amoeboidal in shape.
  - These are like basophils of blood in structure and function.
  - In these cells 'S' shaped nucleus is present which is divided into 2 or 3 lobes.
  - In their cytoplasm basophilic granules are present which can be stained with basic dye Methylene Blue.
  - It is important cell of connective tissue proper as they perform important functions.
- (a) Histamine :-** Histamine is a amino acid derivative. It is a vasodilator which dilate blood vessels and increase blood circulation in affected area.



- It also increase permeability of blood capillaries.
- When allergic substance enter into body mast cell stimulate and secrete histamine so a part of blood comes out from blood capillaries with WBC and accumulate in intercellular spaces. This part of blood is called as **exudate** which causes swelling in affected area. This swelling is red, warm & painful. This type of swelling is called **inflammation**.

**(b) Serotonin :-**

- It is also called as 5-hydroxy tryptamine.
- It is a amino acid derivative. It is a vasoconstrictor. It constricts vessels & decrease blood circulation.
- At the site of cut or injury mast cell secrete serotonin which decrease high blood loss.

**(c) Heparin :-** Heparin is a mucopolysaccharide. It is a natural anti coagulant. It prevents clotting of blood in uninjured blood vessels. (Prevent the conversion of prothrombin into thrombin.)

**(d) Matrix** is also synthesized by Mast cells.

**(iv) Adipose cells**

- Oval shaped cells which stores fat.
- Fat is collected in the form of fat globule. Fat globule is formed by the fusion of small oil droplets.
- On the basis of number of fat globules adipocytes are of two types.

**(a) Monolocular adipocytes :**

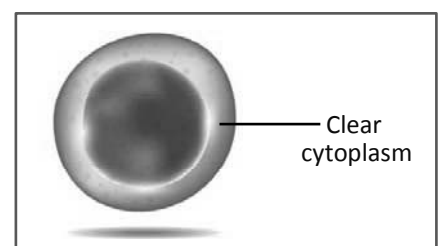
- In these cells single large and central fat globule is present.
- Nucleus and cytoplasm is peripheral and cytoplasm is less in amount.
- Due to compression of fat globule, nucleus become flattened in shape. These adipocytes form **white fat**.

**(b) Multilocular adipocytes :**

- In these cells many small fat globules are distributed in the cytoplasm around nucleus
- Cytoplasm is more in quantity.
- Nucleus is rounded & found in the centre.
- These adipocytes form **brown fat**. Brown colour is due to the presence of Cytochrome pigment.

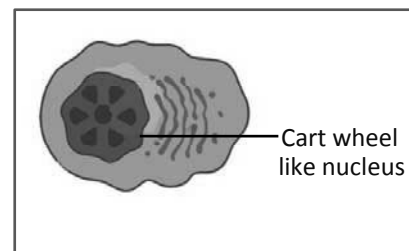
**(v) Lymphocytes**

- Amoeboidal in shape with a large nucleus and cytoplasm is present as peripheral layer. Cytoplasm quantity is less.
- It's function is to produce, transport & secretes antibodies.
- They divide to form plasma cells of connective tissue proper.



**(vi) Plasma cell :- cart wheel cell**

- Amoeboidal in shape.
- In these cells rounded nucleus is present in which chromatin material is arranged like spokes (radial rows) in a wheel so they are also called as **Cart wheel cells**.



- According to scientists these cells are formed by the division of lymphocytes. So they are also called as **clone of lymphocytes**.

**Function :** To produce, Secrete & transport of antibody.

**(vii) Mesenchyme cell :-**

- Small sized pluripotent cells of connective tissue proper

**(B) Fibres :****(i) Collagen fibres (White fibres)**

- They are bright & white fibres composed of collagen protein.
- It is present in maximum quantity in vertebrates.
- They are wavy & tough fibres always arranged in bundle. Bundle is called fascia.
- On boiling they convert into gelatin.

**(ii) Elastic fibres — (Yellow fibres)**

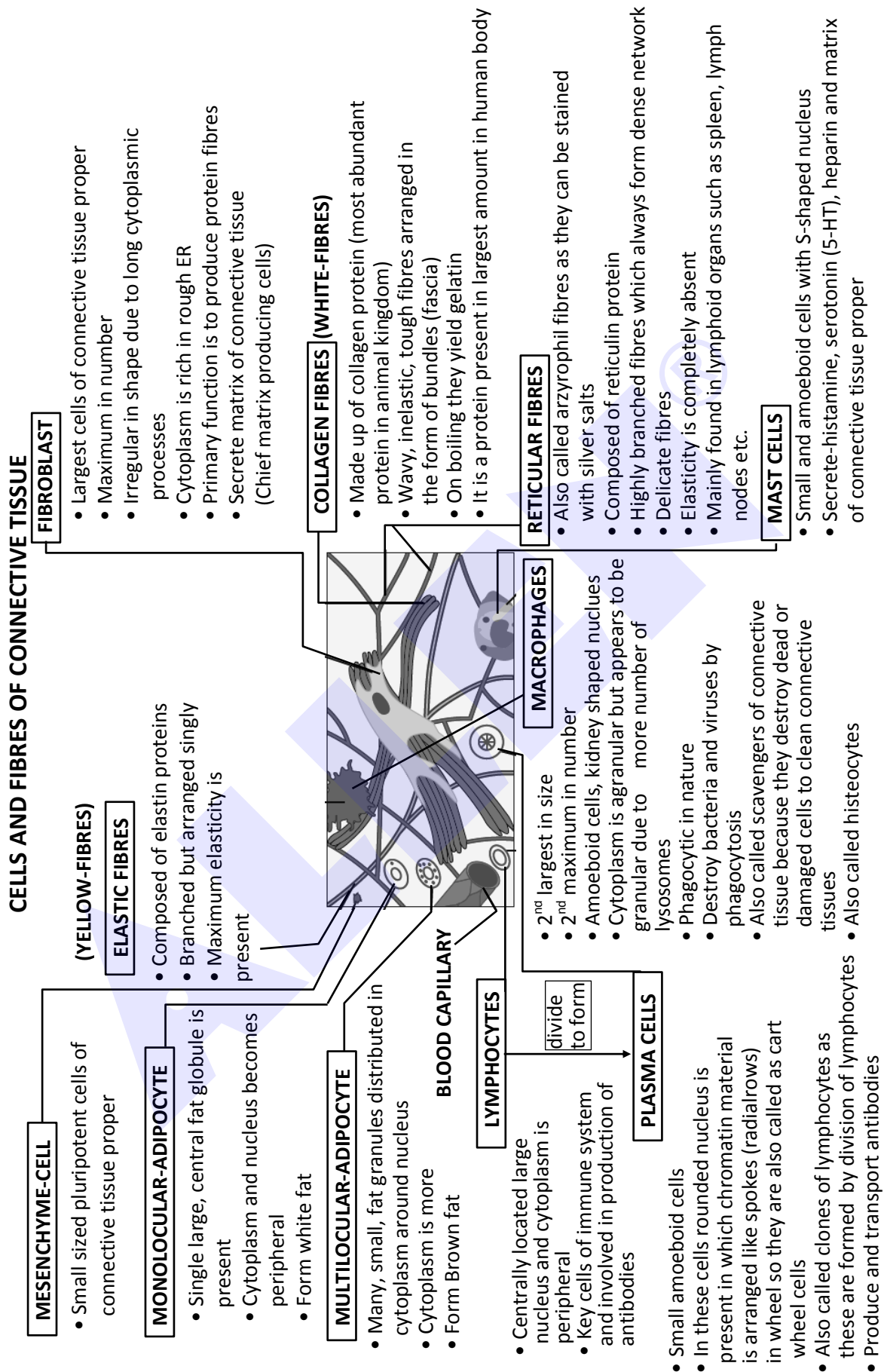
- They are yellow in colour and composed of elastin protein.
- They are branched fibres but always arranged singly. Branches of these fibres form network.
- In these fibres maximum elasticity is present.
- They are highly resistant to chemicals.
- When boiled they do not dissolve.

**(iii) Reticular Fibres**

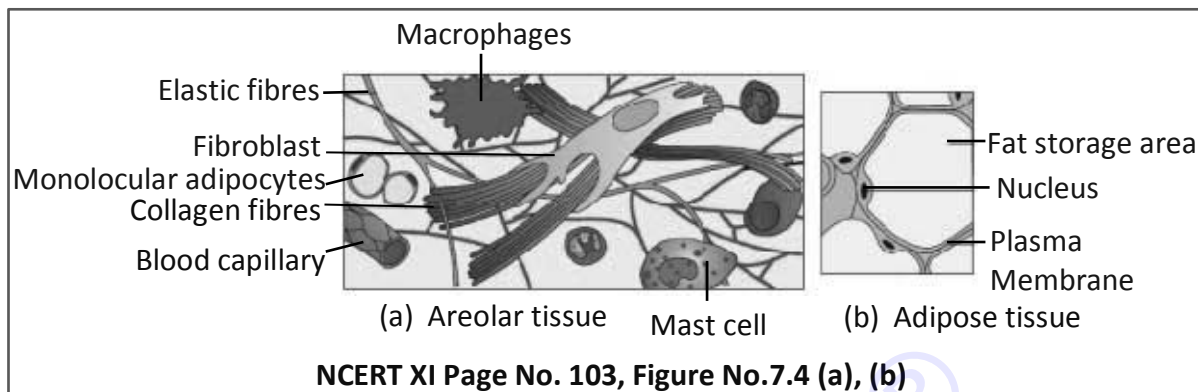
- Also known as arzyrophil fibre since they can be stained with silver salts.
- They are composed of reticulin protein.
- They are highly branched fibres which always form dense network.
- They are delicate fibres. Elasticity is completely absent.
- These are mainly distributed in lymphoid organs like spleen or lymph nodes

**(C) Matrix (Ground substance) :**

- Matrix is compsed of mucopolysaccharide (modified polysaccharide) which is present in the form of hyaluronic acid.





**(2) TYPE OF CONNECTIVE TISSUE PROPER**
**(A) Areolar Connective Tissue :**


- Also known as **loose** connective tissue or **spongy** tissue.
- It is most widely distributed tissue in the body.
- In this tissue maximum intercellular space or substances/matrix is present.
- Due to irregular arrangement of bundle of collagen fibres many gaps are present. These spaces are called **Areolae**.
- In areolae other components of connective tissue are distributed like fibres, cells & matrix.
- Few elastic fibres are present but reticular fibres are completely absent.
- In cells mast cells, macrophage & fibroblast are more in number.
- In these areolae blood vessels & nerve fibres are also present.
- It is also present beneath the skin.

e.g. **Tela Subcutanea:-** A thin continuous layer which connect skin with underlying skeletal muscles (Panniculus carnosus) . In mammals skin is tightly attached with muscles.

**Sub mucosa of Trachea, Bronchi, Intestine**

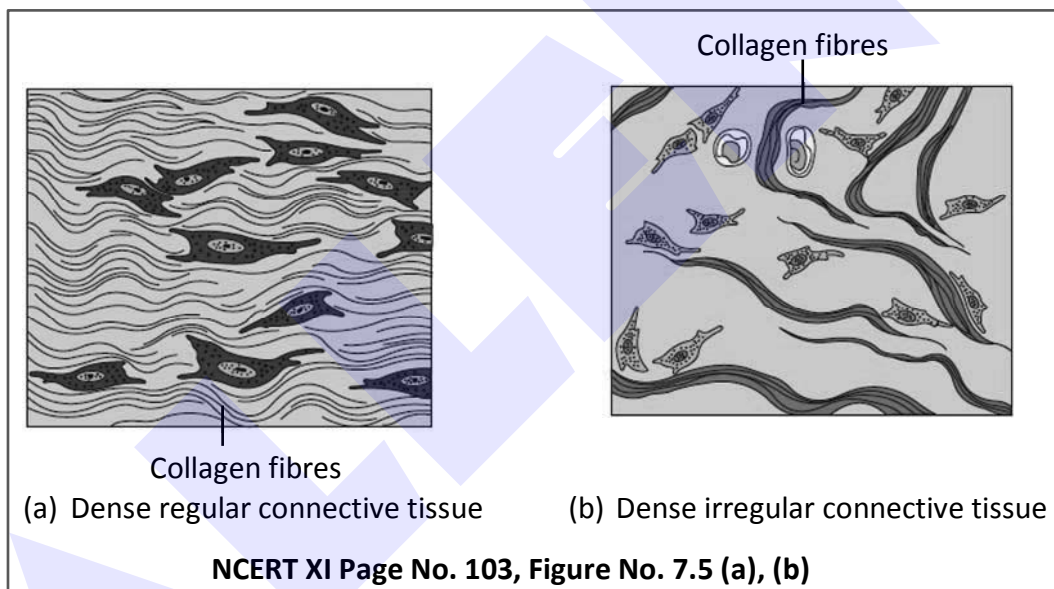
**(B) Adipose Connective Tissue :**

- It is a modification of areolar connective tissue (Loose connective tissue). But in areolae major component is adipocytes which store fats. Blood vascular system is also present in this tissue.  
It is also present mainly beneath the skin.
- If this tissue is treated with alcohol (organic solvent) Fat will be dissolved completely and adipocytes will become vacuolated.
- On the basis of adipocytes 2 type of fats are found in animals.
  - (i) White fat
  - (ii) Brown fat
- (i) **White fat:** It is composed of monolocular adipocytes in which single large fat globule, peripheral cytoplasm and peripheral nucleus is present. Due to less amount of cytoplasm, Mitochondria are also less in number. So they produce less energy.

- e.g.
- **Panniculus adiposus** :- A thin continuous layer of white fat under the dermis of skin which is also called **hypodermis** of skin.
  - **Yellow bone marrow.**
  - **Blubber** :- Thick layer of white fat found under dermis of skin. Found in whale, seal elephants.
  - **Hump of camel, Tail of marino sheep**
- (ii) **Brown fat**:- It is composed of multilocular adipocytes in which many fat globules are present. Cytoplasm is more in amount. Due to more number of mitochondria it produces 20 times more energy than white fat. Brown colour of fat is due to presence of cytochrome Pigment.
- Cold resistance device in new born baby is due to presence of brown fat.
  - Rodents like rat and some other mammals like shrew. They are hibernating animals & during hibernation they obtain energy from stored brown fat.

**(C) Dense Connective Tissue :**

- Fibres and Fibroblast are compactly packed.



**(i) White fibrous connective tissue**

- In this tissue bundle of collagen fibres are more in quantity & other components of connective tissue proper are less in quantity.
- Yellow fibres & reticular fibres are completely absent.
- In cells fibroblast and mast cells are more in number.

On the basis of arrangement of fibres & matrix this tissue occurs in two forms.

**(a) Cord (Dense regular tissue) :**

- Bundle of collagen fibres & matrix are distributed in regular pattern (alternate pattern).
- Fibroblast cells are arranged in a series. Mast cells are scattered in matrix.

e.g. **Tendon** :- A structure which connects muscles & bones.

Strongest tendon of the body is **Tendocalcaneal tendon**. This tendon connects gastrocnemius muscle of shank with calcaneum bone of ankle.

(b) **Sheath (Dense irregular)** : In this form there is no regular pattern of fibres & matrix. Cells and fibres are criss - crossed arranged.

- e.g.
- **Pericardium** — Outer covering of heart.
  - **Periosteum** — Outer covering of bone.
  - **Perichondrium** — Outer covering of cartilage.
  - **Epimysium** — Covering of muscle.
  - **Renal capsule** — Around kidney.
  - **Glisson's capsule** — Around hepatic lobule
  - **Duramater** — Outermost covering of brain.
  - **Cornea of eye**
  - **Tunica albuginea** — Outermost covering of testis.

(ii) **Yellow fibrous connective tissue**

- In this tissue yellow fibres are more in quantity but collagen fibres are also present.
- Reticular fibres are absent.
- On the basis of distribution of fibres & matrix they are of two types.

(a) **Cord (Dense regular)** : In this form bundle of collagen fibres & matrix distributed in a regular pattern & in matrix yellow fibres form network.

- e.g.
- **Ligament** – A structure which connects bones.
  - Strongest Ligament of body is **ilio femoral ligament**.
  - This ligament connects ilium bone of pelvic girdle with femur bone of hind limb.

(b) **Sheath (Dense irregular)** : Irregular distribution of fibres and matrix with elastic fibre.

- e.g.
- **Wall of lymph vessels & blood vessels, wall of alveoli of lungs.**
  - **True vocal cords, wall of bronchiole.**
  - **It is also present in the skin**

(D) **Reticular Fibrous Connective Tissue :**

- It is also called lymphoid Tissue.
- It is mostly found in lymphoid organs.
- Provide support and strength and form the stroma (Frame work) of soft organs.

- e.g.
- **Spleen**
  - **Lymph nodes (Tonsils, Payer's Patches).**
  - **Endosteum (covering of bone marrow cavity).**

(E) **Mucoid Connective Tissue :**

Also called **embryonic** tissue. It is mainly found during embryonic life. Its matrix is composed of jelly like material called **Wharton's Jelly**.

- e.g.
- **Umbilical cord (connect placenta with foetus)**
  - **Vitreous humor — In vitreous body of eye.**
  - **Comb of cock.**

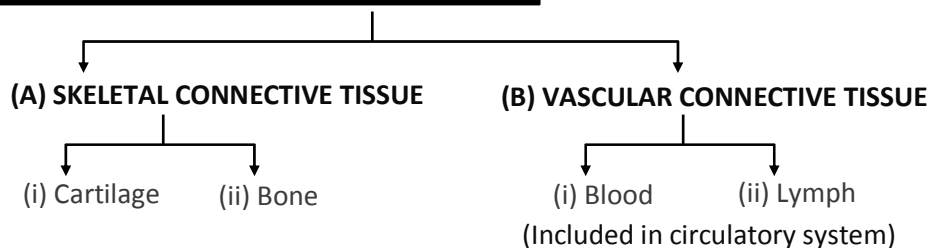


## BEGINNER'S BOX

## CONNECTIVE TISSUE

1. Muscles are connected to Bone by means of :-  
 (1) Cartilage                      (2) Ligaments                      (3) Tendon                      (4) Adipose tissue
2. Brown adipose cells contain :-  
 (1) Only one fat globule                      (2) More than one fat globules  
 (3) Without fat-globules                      (4) Peripheral nucleus
3. Histiocytes destroy bacteria by :-  
 (1) Phagocytosis                      (2) Producing Antitoxins  
 (3) Producing antibodies                      (4) Producing antigen
4. Plasma cell :-  
 (1) Is modified B – lymphocytes of blood                      (2) Produce antigen  
 (3) Produce Heparin, Histamine, serotonin                      (4) Produce matrix & Fibres
5. Yellow, White & Reticular fibres made up of protein  
 (1) Elastin, Reticulin, Collagen respectively  
 (2) Reticulin, Elastin, Collagen respectively  
 (3) Collagen, Elastin, Reticulin protein  
 (4) Elastin, Collagen, Reticulin protein
6. Which of the following is known as spongy connective tissue :-  
 (1) Dense fibrous connective tissue                      (2) Adipose connective tissue  
 (3) Areolar connective tissue                      (4) Reticular fibrous connective tissue
7. Which type of connective tissue used to form submucosa of intestine :-  
 (1) Dense fibrous C.T.                      (2) Adipose C.T.  
 (3) Reticular fibrous C.T.                      (4) Areolar C.T.
8. a. Monocular                      b. less mitochondria                      c. less energy  
 The above three features are related to  
 (1) White fat – rat                      (2) White fat–new born baby  
 (3) Brown fat – camel hump                      (4) White fat – yellow bone marrow
9. Yellow fibrous connective tissue is found in :-  
 a. Renal capsule                      b. True vocal cords                      c. Walls of blood vessels                      d. Epimysium  
 (1) a, b                      (2) b, c                      (3) c, d                      (4) a, b, c
10. Lymphocytes are more in :-  
 (1) White fibrous connective tissue                      (2) Reticular fibrous connective tissue  
 (3) Yellow fibrous connective tissue                      (4) Adipose connective tissue

### (3) SPECIALISED CONNECTIVE TISSUE

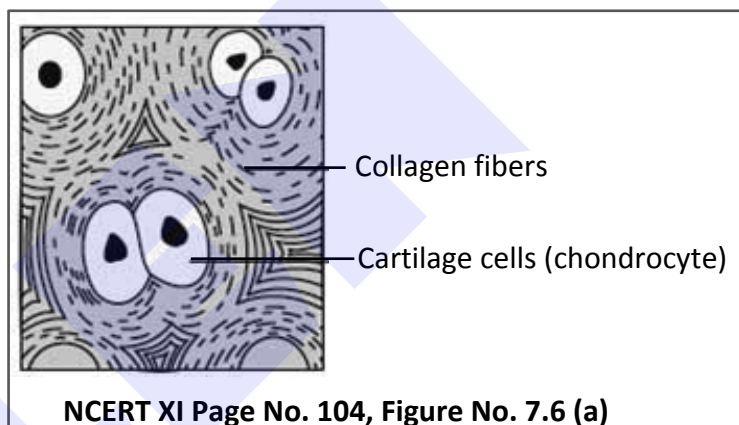


#### (A) Skeletal Connective Tissue :

- Matrix is dense & mineralised. Due to deposition of minerals it becomes hard.
- Also known as **Supporting Tissue** i.e. Provide support to the body.
- It is of 2 types :- Cartilage and Bone

##### (i) Cartilage

- Outmost covering of cartilage is called **Perichondrium** which is composed of white fibres connective tissue.
- Cartilage producing cells are arranged on periphery of cartilage known as **Chondroblast**.
- These are active cell & divide to form chondrocytes, and synthesize the matrix of cartilage.
- Mature cells of cartilage is called **Chondrocytes**.
- They are found in vacuole like space in matrix called **Lacuna**, In which 1 – 4 Chondrocytes are present.
- **Chondroclast** are cartilage destroying cells.
- Matrix of cartilage is called **chondrin** composed of chondromucoprotein having Chondroitin-6-sulphate and mucopolysacchride (Hyaluronic acid).
- Matrix of cartilage provides rigidity & elasticity to cartilage (matrix solid, pliable and resists compression).
- Blood circulation is absent in the matrix of cartilage but blood supply is present in perichondrium.



#### Types of Cartilage

##### (a) Hyaline cartilage :

- It is maximum in human body.
- Most of the part of embryonic skeleton is composed of this cartilage. So maximum bones of body are cartilagenous bones because they are developed from cartilage.



- Outermost covering **perichondrium** is present.
  - Matrix of this cartilage is **glass like** clear or hyaline matrix because fibres are completely absent in the matrix of this cartilage.
  - Colour of matrix is **bluish** & it is translucent/glass like.
- eg.
- **Nasal septum**
  - **'C' shaped rings of trachea and bronchi** (Incomplete in dorsal surface)
  - **Sternal part of ribs** (Coastal cartilage)
  - **Larynx**
  - **Articular cartilage** :- At the junction of two long bones on articular surface. At the end of long bone periosteum is absent and Hyaline cartilage is present known as Articular cartilage.

**(b) Fibrous cartilage :**

**(I) Elastic cartilage**

- In the matrix of this cartilage yellow fibres form network so it is highly flexible cartilage of body.
- Colour of matrix is pale yellow.

- e.g.
- **Tip of Nose**
  - **Ear Pinna**
  - **Epiglottis**
  - **Wall of Eustachian tube**

**(II) White fibrous cartilage**

- Perichondrium is absent because complete WFCT is converted into cartilage.
- In matrix bundle of collagen fibres are more in quantity so it is **strongest cartilage**.

- e.g.
- **Pubic symphysis** : Pubis bone (Half part of pelvic girdle Os innominatum are interconnected by pubic symphysis.
  - **Intervertebral disc** : A pad of cushion like structure which absorb mechanical shock & jerks and protect vertebral column. Central part of this disc is soft called as Nucleus pulposus.
- Slight elongation of body after death or in sleeping posture is due to relaxation of this disc.

**(c) Calcified cartilage :**

- It is modified hyaline cartilage but due to deposition of calcium salts its matrix becomes hard like bones.
  - It is **hardest cartilage** of the body.
  - Ca salt deposits in the form of Hydroxy apatite  $[\text{Ca}_{10}(\text{PO}_4)(\text{OH})_2]$ .
- e.g. Head of femur & humerus in man.

**(ii) Bone**

- Study of Bone – **Osteology**
- Process of bone formation – **Ossification**
- Hardest Tissue – Bones
- Softest Tissue – Blood.
- Hardest substance – Enamel.
- Outermost covering of bone is **Periosteum** composed of white fibrous connective tissue.
- Bone producing cell is called **Osteoblast**. They divide to form **Osteocyte** & synthesize organic part of matrix.
- Mature cell of bone is called as **Osteocyte** which is found in lacuna. Only one osteocyte is found in one lacuna.
- Bone destroying cells are **Osteoclast** cells.
- Bones have a hard and non pliable ground substance rich in Ca-salts and collagen fibres which gives bone its strength.

**Matrix – Hard and Non-Pliable**

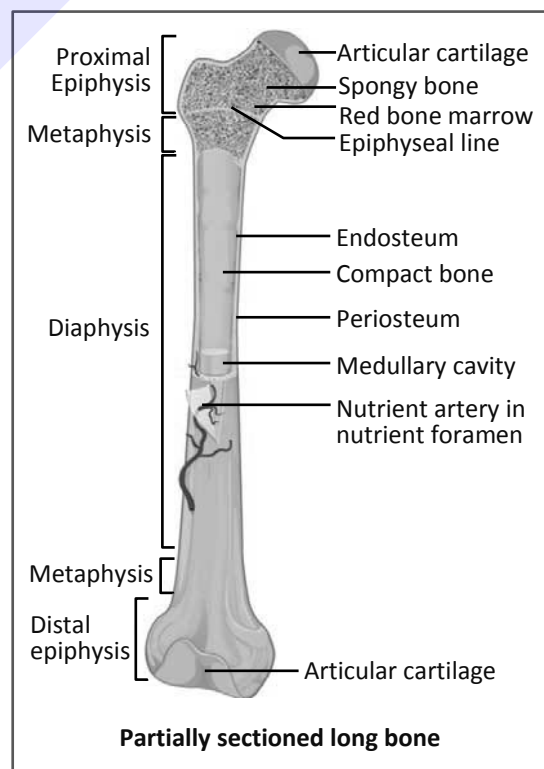
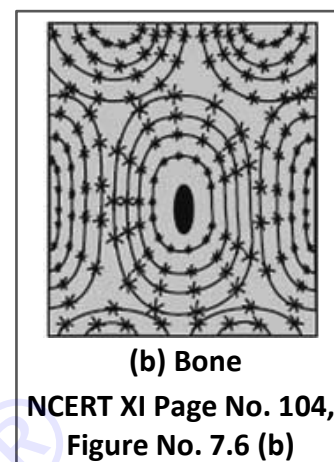
It has two parts

- **Inorganic Part :-** 65 – 68%  
 $\text{Ca}_3(\text{PO}_4)_2$  – 80% max. rest 20%  $\text{CaCO}_3$  (10%),  
 $\text{Mg}_3(\text{PO}_4)_2$  (10%), Fluorides (very less).
- **Organic part :-** 32 – 35% Ossein in which bundle of collagen fibres suspended in sulphated mucopolysaccharide.

**Structure of long bone**

Long bone has three region

- Epiphysis
- Diaphysis
- Metaphysis



**(a) Epiphysis :**

- Ends of long bone is called **Epiphysis**. This part is composed of spongy bone. If this part is present at the joint, then on articular surface **periosteum** is absent & articular cartilage (Hyaline cartilage) is present.
- It consist of lamellae that are arranged in an irregular pattern of thin columns called Trabeculae. Between the trabeculae are present spaces filled up with red bone marrow.
- It is composed of myeloid tissue which produce blood corpuscles so epiphysis act as a haemopoietic organ.

**(b) Diaphysis :**

- Middle part or shaft of long bone is diaphysis which is composed of **compact bone**.
- In this region hollow cavity is present called bone marrow cavity filled with yellow bone marrow. Function of YBM is storage of fat.

**(c) Metaphysis :**

- It formed little part between epiphysis & Diaphysis.
- In this region **epiphyseal plate** is present which is made up of osteoblast cells. They divide to form osteocyte and also synthesize matrix of bone, so epiphyseal plate is responsible for elongation of bone.
- After complete development of long bone this plate is destroyed. So in completely developed bone only 2 regions are found while in a developing bone 3 regions are present.

**SPECIAL POINTS**

***Spongy Bones***

- Bones in which haversian canal systems are absent. All spongy bones of body are haemopoietic.

e.g. Ribs, Pubis, Sternum, Vertebrae, Clavicle, End of long Bones, Scapula

***Compact Bone***

In this bone haversian system is present.

e.g. Diaphysis of long bone.

***Diploic/Heterotypic***

- In these bones middle part of bone is composed of spongy bone, in which spaces between the trabeculae is filled with RBM. While this bone is covered by compact bone on upper & lower surface.

e.g. All flat bones of skull.

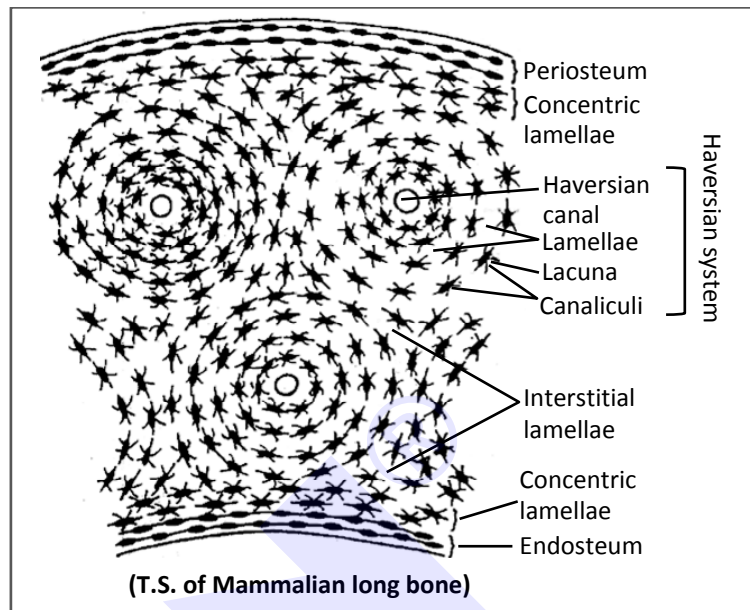
**INTERNAL STRUCTURE OF MAMMALIAN BONE**

It has following major structures.

- A. Periosteum
- B. Matrix
- C. Endosteum
- D. Bone marrow cavity

**(A) Periosteum :**

- It consists of two layers.
- Outer layer consist of WFCT in which blood circulation is present.
- Inner layer - consists of single layer of osteoblast cells, which divide to form osteocyte and secrete layers of matrix.


**(B) Matrix :**

It is composed of inorganic & organic compounds.

- In the matrix of bone two types of canals are present : -

**Haversian canal :**

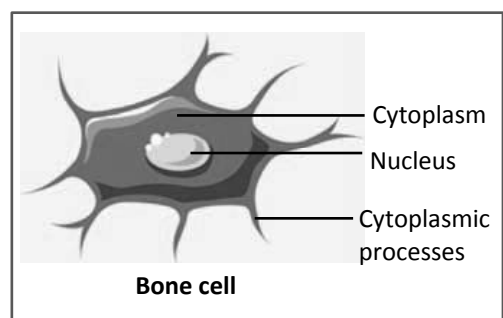
Longitudinal canals which are arranged parallel to long axis of bone. In these canals one or two blood capillaries and nerve fibres are present.

**Volkman's canal :**

- These are transverse/horizontal or oblique canals. Haversian canals are interconnected by volkman's canal.
- Matrix of bone is deposited in the form of layer. These layers of matrix are called **Lamellae**.
- On the basis of arrangement three types of lamellae are present in the matrix.
  - (i) Haversian lamellae
  - (ii) Interstitial lamellae
  - (iii) Circumferential lamellae.

**(i) Haversian Lamellae**

- Concentric layers of matrix which are present around Haversian canal.
- Between these lamellae layer of osteocyte cells are also present.
- Haversian canal, Haversian lamellae & Osteocyte form **Haversian** system or **Osteon**.



- Presence of Haversian system is a typical feature of **mammalian** compact bones.
- Osteocyte are present in the lacuna. Each osteocyte is inter connected with adjacent osteocyte by their cytoplasmic process.
- Cytoplasmic process of osteocyte are present in the minute canals of lacuna called as **canaliculi**.

**(ii) Interstitial lamellae**

These layers of matrix are present in the space between two Haversian systems.

**(iii) Circumferential lamellae.**

Outer circumferential lamellae (Peripheral layer of matrix present just below the periosteum) and inner circumferential lamellae (around the bone marrow cavity).

**(C) Endosteum :**

Endosteum consist of two layers.

- Towards bone marrow cavity layer lined with reticular fibrous connective tissue.
- Towards matrix of bone endosteum lined with layer of osteoblast cells. They divide to form osteocyte & synthesize matrix. So growth of bone is bidirectional (Periphery & central region). While Growth of cartilage is unidirectional.

**(D) Bone marrow cavity**

In the central region hollow cavity is present which is filled with yellow bone marrow.

It is composed of white fat & its function is collection of fats or storage of fats.

**TYPES OF BONES**

On the basis of development or location of ossification bones are of four types.

**1. Cartilagenous bones/Replacing/Endochondral bone**

- These bones are developed from cartilage or they are formed by the ossification of cartilage.
- In the formation of these bones two types of cells are required.
  - Chondroclast:-** Which reabsorb cartilagenous matter.
  - Osteoblast:-** Which deposit bony matter into cartilage so cartilage is replaced by bone. Hence these bones are also called as replacing bones.

e.g. **Maximum bones of our body like forelimb and hindlimb bones, Ribs.**

**2. Membranous bones/Dermal bones/Investing bones**

These bones are developed from the connective tissue of dermis or formed by ossification in the connective tissue of dermis.

**Eg. Pubis, Sternum, Clavicle, Scapula bone, Flat bones of skull**

**3. Sesamoid Bones**

These bones are developed by the ossification of tendons at the joints.

- Eg.
- Pisiform (wrist bone) of man.
  - Patella (knee bone) Largest sesamoid bone.

#### 4. Visceral Bones :-

- If ossification takes place in the visceral organs then visceral bones are formed. These are rare bones, found in few animals. In rabbit & man these bones are absent.

|                           |   |  |
|---------------------------|---|--|
| e.g. <b>Os Cordis</b>     | : | Present in inter ventricular septum of deer's heart.   |
| <b>Os Palpebrae</b>       | : | In the eyelid of crocodile.                            |
| <b>Os Penis (Baculum)</b> | : | In the penis of rodents rat, shrew, bat, whale, tiger. |
| <b>Os Rostralis</b>       | : | In the snout of pig.                                   |

#### ★ Golden Key Points ★

(i) **Decalcified Bones** :- If a bone is kept in dil HCl for 3 days then complete mineral part of the matrix get dissolved in acid & organic part remain in the bone so bone becomes soft & flexible.

(ii) **Dried Bone** :- If a bone is kept in sunlight for long time then complete aqueous part of the bone disappear. In these bones empty lacuna & empty bone marrow cavity is present. Shape of bone remain unchanged.

If a bone is burn or kept into very high temp then complete organic part of bone is burn and mineral part of matrix remain as such in the form of ash called dried bone.

(iii) **Bright Bone** :- If a bone is kept into KOH then complete attached muscle fibres are dissolve in KOH & bone becomes clear & bright called bright bone. Bone will remain unchanged.

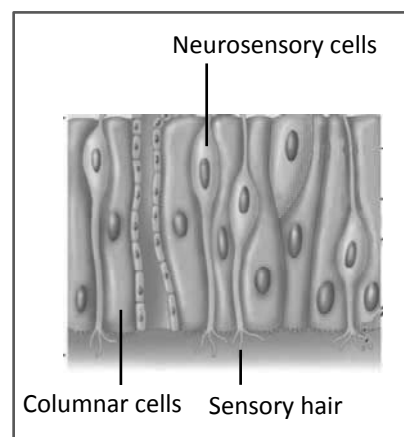
e.g. **Bones of laboratory**

#### (iv) Special Types of Epithelium

##### (a) Neuro sensory epithelium :

In the structure of this epithelium in between pillar shaped supporting cells modified sensory cells are present. On the free end of sensory cell sensory hair is present by which they receive sensation. Base of these cells is attached with sensory nerve.

- e.g.
- Gustatory Epithelium** – Covering of taste bud of tongue receive taste sensation.
  - Olfactory epithelium** – Schneidarian membrane receive smell sensation.
  - Stato – acoustic** – Lining of internal ear.
  - In Retina of eye receive optic sensation.



(b) **Myoepithelium** :- Around mammary and sweat gland (around secretory unit)

(c) **Pigmented epithelium (Cuboidal)** :- In Retina of eye.

#### (v) Ilio-femoral ligament - strongest ligament.

Another strongest ligament is **ligamentum flava**, present between two adjacent vertebrae.

(vi) **ligamentum nuchea** :- In quadrupeds like cow & buffalo strongest ligament present in the neck between two cervical vertebrae.

(vii) **Sharpey's fibres** :- extra bundle of collagen fibres which are present in the outermost layer of matrix called sharpey fibres. Which provide extra mechanical support to bone.





**BEGINNER'S BOX**

**SKELETON CONNECTIVE TISSUE**

- Longitudinal channels of Bone called :-  
(1) Haversian canal (2) Volkmann's canals (3) Narrow cavity (4) Lacunae
- Glass like cartilage is :-  
(1) Hyaline cartilage (2) Fibrous cartilage (3) Calcified cartilage (4) Elastic cartilage
- Formation of cartilaginous Bone involves :-  
(1) Deposition of Bony matter by osteoblasts & Reabsorption by chondrioclasts  
(2) Deposition of Bony matter by osteoblast only  
(3) Deposition of Bony matter by osteoclasts & Reabsorption by chondrioblast  
(4) None of above
- Major Inorganic components of Bone :-  
(1) Calcium phosphate (2) Calcium carbonate  
(3) Sodium hydroxide (4) Potassium hydroxide
- Haversian system is feature of :-  
(1) Amphibian Bones (2) Reptiles Bone (3) Pneumatic Bone (4) Mammalian Bone
- Bone desolving cells :-  
(1) Osteoblast (2) Osteocyte (3) Osteoclast (4) Fibroblast
- Eustachian tube is supported by :-  
(1) Elastic cartilage (2) White fibros cartilage  
(3) Calcified cartilage (4) Hyaline cartilage
- Perichondrium is :-  
(1) Adipose tissue (2) White fibrous connective tissue  
(3) Yellow fibrous connective tissue (4) Areolar connective tissue



**BEGINNER'S BOX**

**ANSWERS KEY**

**EPITHELIAL TISSUE**

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------|---|---|---|---|---|---|---|---|---|----|
| Ans. | 4 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 2 | 2  |

**TYPES OF EPITHELIUM AND GLANDS**

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------|---|---|---|---|---|---|---|---|---|----|
| Ans. | 3 | 4 | 1 | 2 | 4 | 3 | 3 | 4 | 1 | 3  |

**CONNECTIVE TISSUE**

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------|---|---|---|---|---|---|---|---|---|----|
| Ans. | 3 | 2 | 1 | 1 | 4 | 3 | 4 | 4 | 2 | 2  |

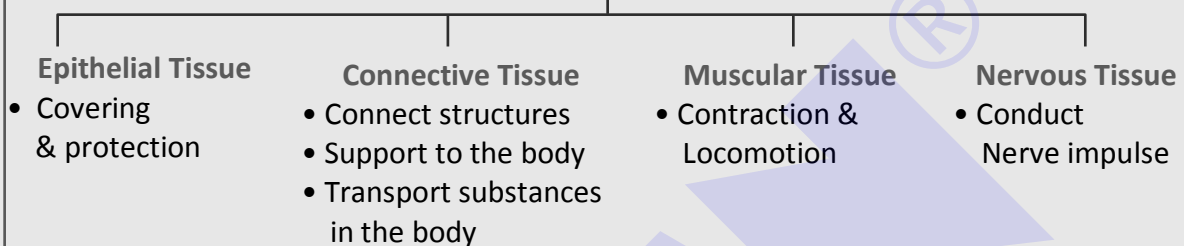
**SKELETON CONNECTIVE TISSUE**

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|------|---|---|---|---|---|---|---|---|
| Ans. | 1 | 1 | 1 | 1 | 4 | 3 | 1 | 2 |

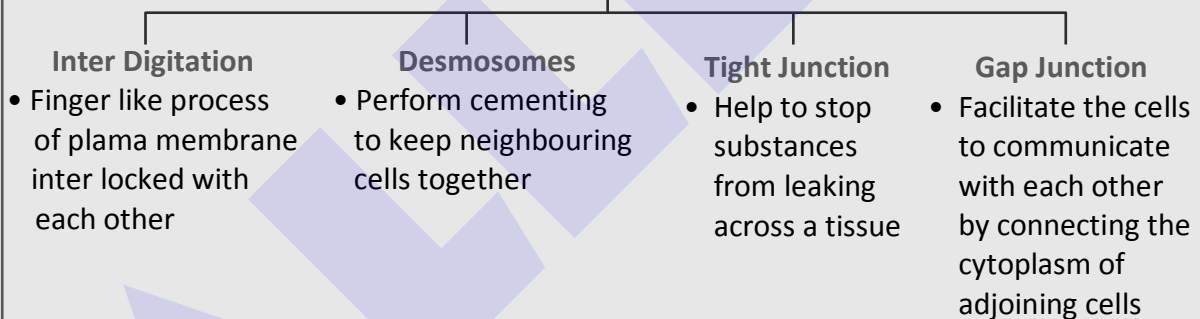


- A group of similar cells along with intercellular substances perform a specific function. Such an organisation is called tissue.

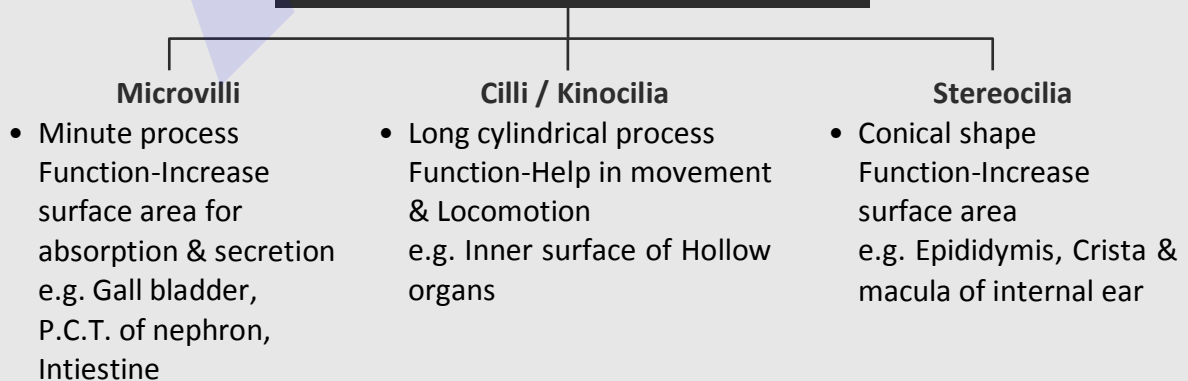
#### ON THE BASIS OF FUNCTION & STRUCTURE TISSUE ARE OF 4 TYPES

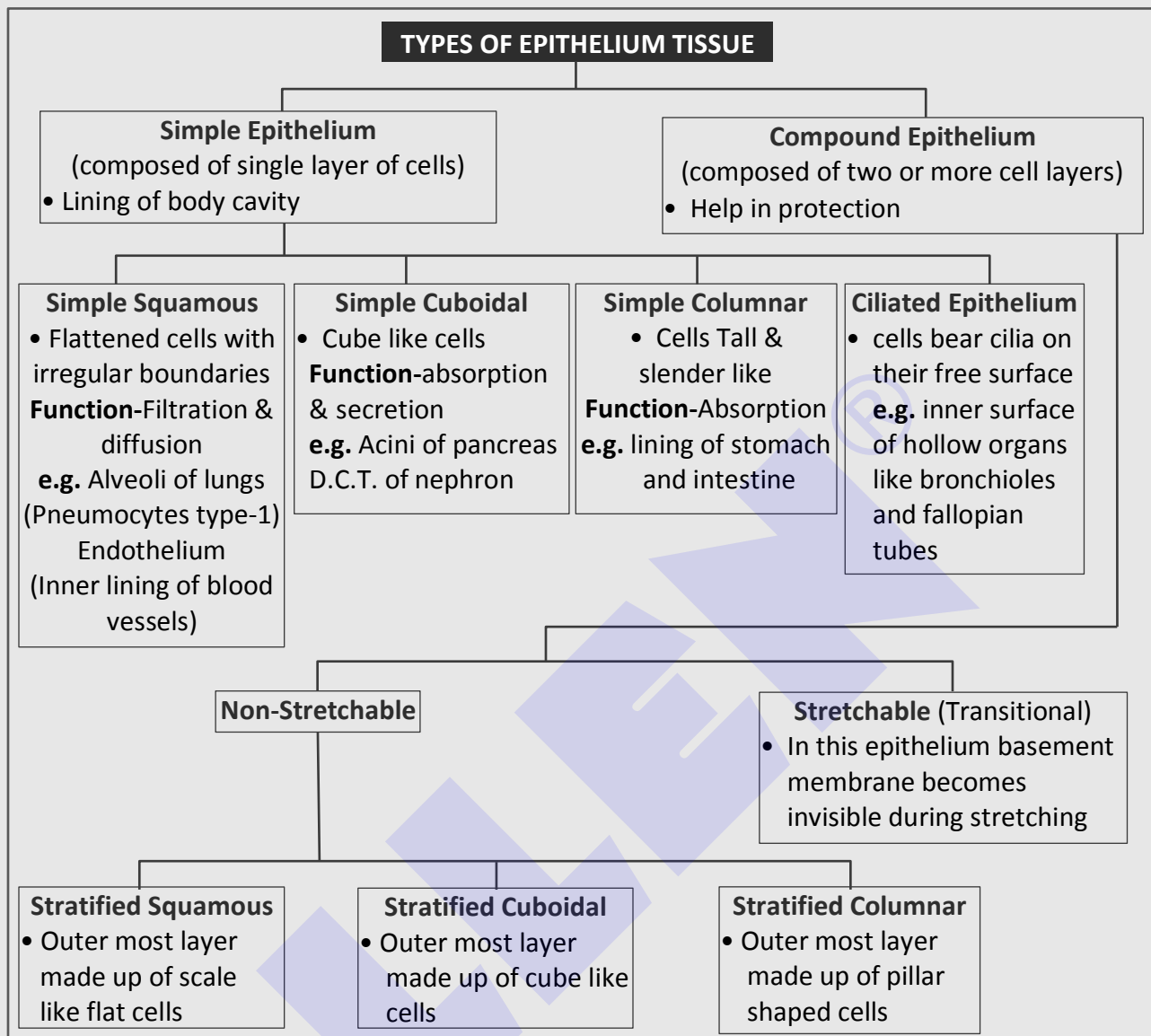


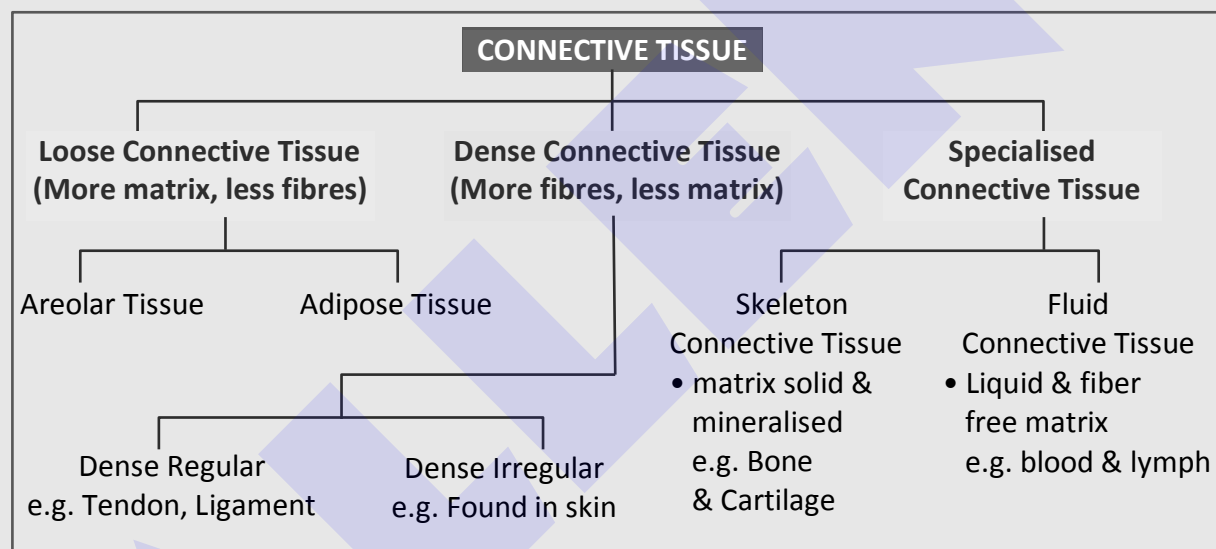
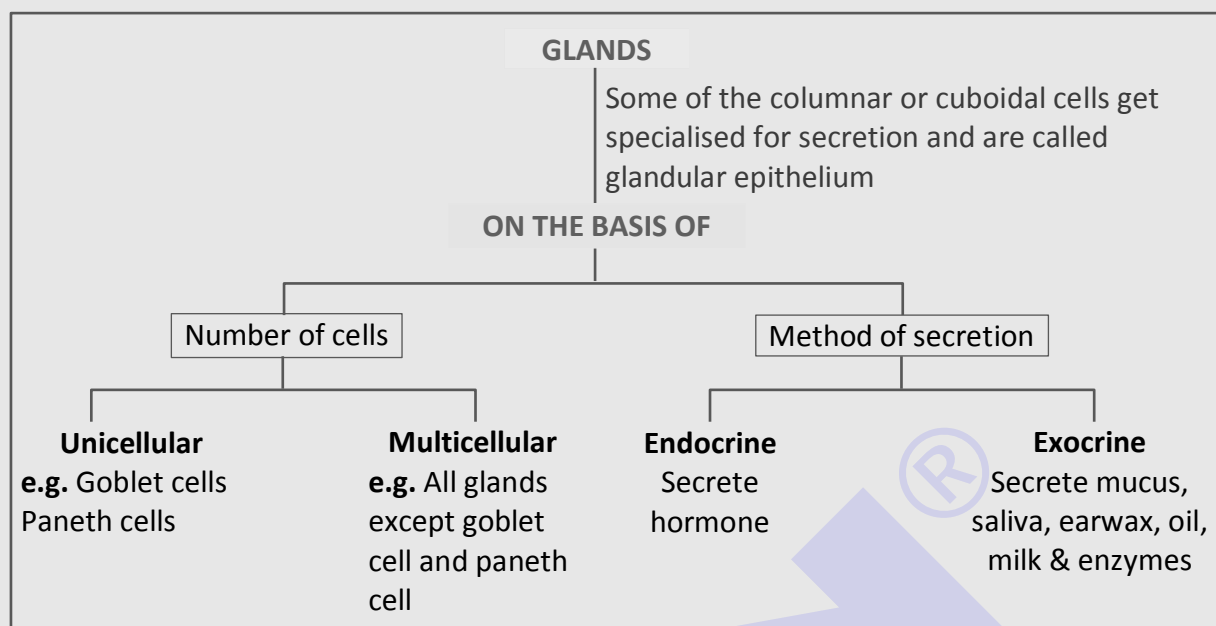
#### INTERCELLULAR JUNCTION



#### MODIFICATION OF PLASMA MEMBRANE







### DO YOU KNOW ??

- Macrophages/phagocytic cells of
  - Liver – Kupffer cells
  - Spleen – Reticulo-endothelial cells
  - Brain – Microglial cells
  - Lung – Dust cells
- Examples of anticoagulant
 

- EDTA (Ethylene diamine tetra acetic acid)
  - Sodium citrate and sodium oxalate
  - Hirudin (natural)

Artificial