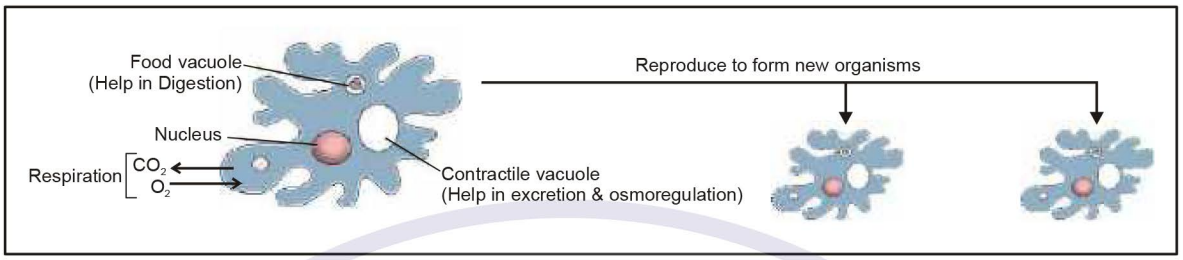
ANIMAL TISSUE

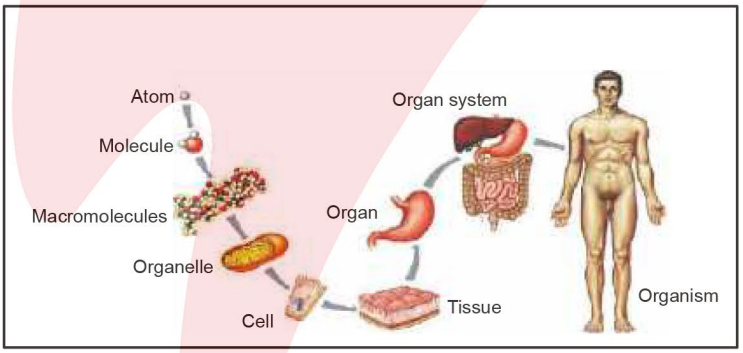
In unicellular organisms, all functions like digestion, respiration and reproduction are performed by a single cell.



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.

Tissues : In multicellular animals, a group of similar cells alongwith intercellular substances perform a specific function. Such an organisation is called tissue. All complex animals consist of only four basic types of tissues. (I) Epithelial, (ii) Connective, (iii) Muscular and (iv) Neural.

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.



Atom → Molecule → Macromolecule → Organelle → Cell → Tissue → Organ → Organ System → Organism

On the basis of functions and structure tissues are of four types -

S.N.	Types of tissue	Functions	Origin
1.	Epithelial	Covering, protection, diffusion, secretion, absorption	Ectoderm, endoderm, mesoderm
2.	Connective	Connect structures, provide support the body, transport substances in the body	Mesoderm
3.	Muscular	Contraction and relaxation which help in movement and locomotion	Mesoderm
4.	Nervous	To generate and conduct impulses in body	Ectoderm

EPITHELIAL TISSUE

PROPERTIES OF EPITHELIAL TISSUES

Word epithelium is composed of two words.

Epi – Upon

Thelia – growth

A tissue which grows upon another tissue is called Epithelium.

It always rest upon underlaying connective tissue. Epithelium cells are closely packed with each other so there is very little inter cellular space.

Due to absence of/less 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 underlaying connective tissue.

During embryonic development epithelium orginates first.

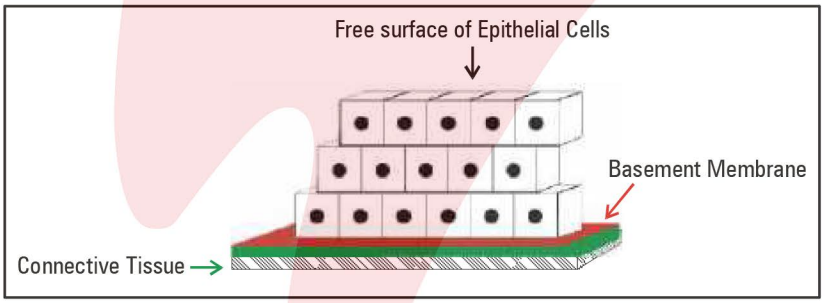
Power of regeneration is high in this tissue.

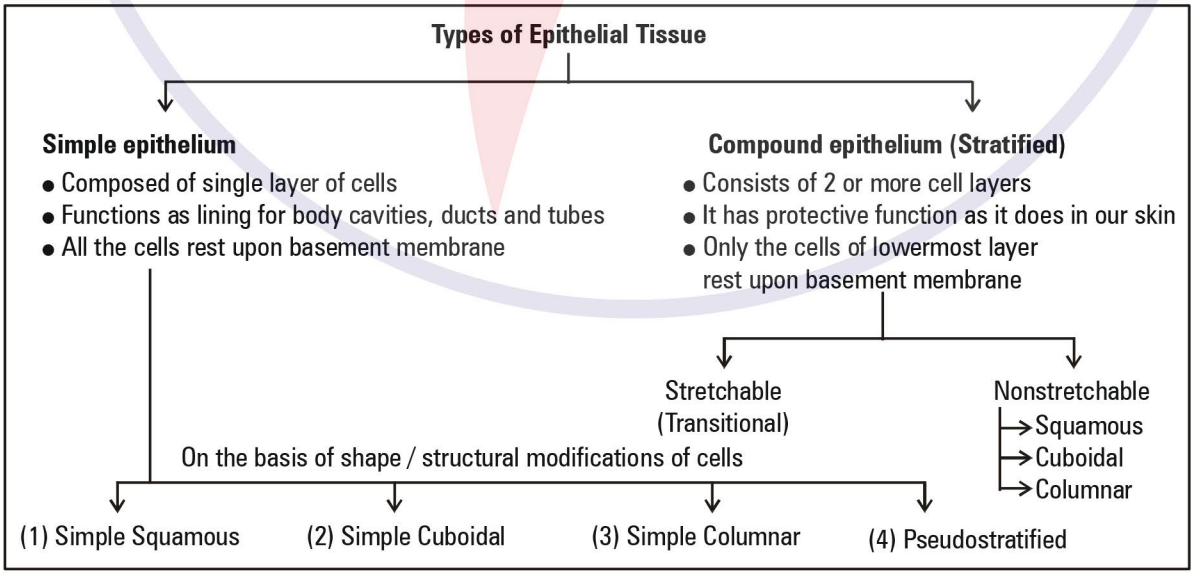
Between epithelium and connective tissue, a thin non living non-cellular basement membrane is present which is selectively permeable.

Basement membrane is secreted by both epithelium and connective tissue and made up of glycoproteins, mucopolysaccharides & protein fibres.

In nearly all animal tissues, specialised junctions provide both structural & functional links between its individual cells.

This tissue has a free surface, which faces either a body fluid or the outside environment and thus provides a covering or a lining for some part of the body.





CELL JUNCTIONS

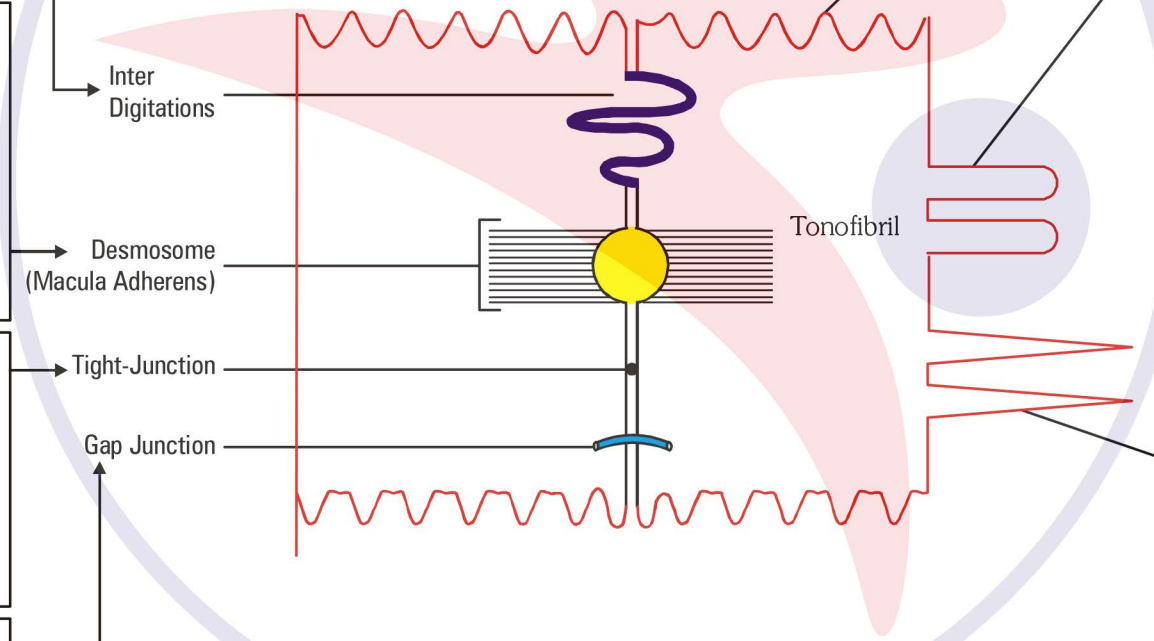
All cells in epithelium are held together with little intercellular material. In nearly all animal tissues, specialised junctions provide both structural and functional links between its individual cells. Three types of cell junctions are found in the epithelium and other tissues.

Interdigitation – Finger like processes of plasma membrane which enter into cytoplasm of adjacent cell. These structures are mainly found in transitional epithelium.

Desmosomes – This type of (Adhering junction) junction consists of disc - like protein plate with intermediate fibre known as tonofibrils These structures provide mechanical support to stratified epithelium perfom cementing to keep the neighbouring cells together.

Tight Junctions – At some places plasma membrane of adjacent cells become fused to form tight junction. They stop substances from leaking across a tissue.These structures are mostly found in columnar epithelium.

Gap Junctions – Facilitate the cells to communicate with each other by connecting cytoplasm of adjoining cells for rapid transfer of ions, small molecules and sometimes big molecules.



PLASMA MEMEBRANE OF FREE END GET MODIFIED TO FORM 3 TYPES OF FUNCTIONAL STRUCTURES.

Microvilli

- These are minute protoplasmic process which are non motile, non contractile.
- They mainly help in absorption and secretion.
- They increase surface area more than 20 times.
- These are present in the wall of Intestine, Gall bladder, Proximal convoluted tubule etc.

Cilia or Kinocilia

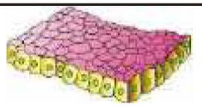
- Motile and contractile protoplasmic process.
- Diameter of cilia is same from base to apex.
- Movement of cilia is in uniform direction and their function is to move particles or mucus in a specific direction over the epithelium.
- These are found in
  e.g. – Fallopian tube, Uterus.
  – Trachea.
  – Ependymal epithelium

Steriocilia

- Non motile, non contractile cytoplasmic process.
- Base of stereocilia is broad and apical part is narrow so they are conical in shape.
- They increase surface area and found in
  eg. – Epididymis
  – Vasadeferens

SIMPLE EPITHELIUM

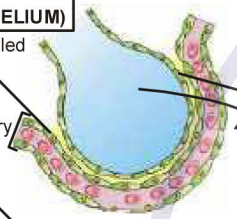
Simple epithelium is composed of a single layer of cells and functions as a lining for body cavities, ducts, and tubes. The squamous epithelium is made of a single thin layer of flattened cells with irregular boundaries. The cuboidal epithelium is composed of a single layer of cube-like cells. The columnar epithelium is composed of a single layer of tall and slender cells. Their nuclei are located at the base.



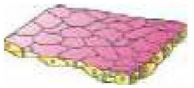
SIMPLE CUBOIDAL EPITHELIUM (Iris, Choroid Ciliary body) ← Eye

SIMPLE SQUAMOUS EPITHELIUM (ENDOTHELIUM)
with irregular margins called Tesselated epithelium

Blood capillary



A L V E O L I



(SIMPLE SQUAMOUS EPITHELIUM)

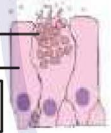
Micro Villi

(SIMPLE COLUMNAR BRUSH BORDER EPITHELIUM)

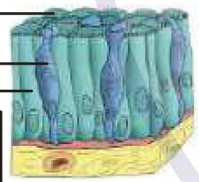
(SIMPLE COLUMNAR EPITHELIUM)

GALL BLADDER

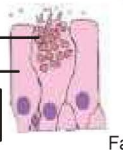
Goblet cells
Tall Columnar cells
(SIMPLE COLUMNAR GLANDULAR EPITHELIUM)

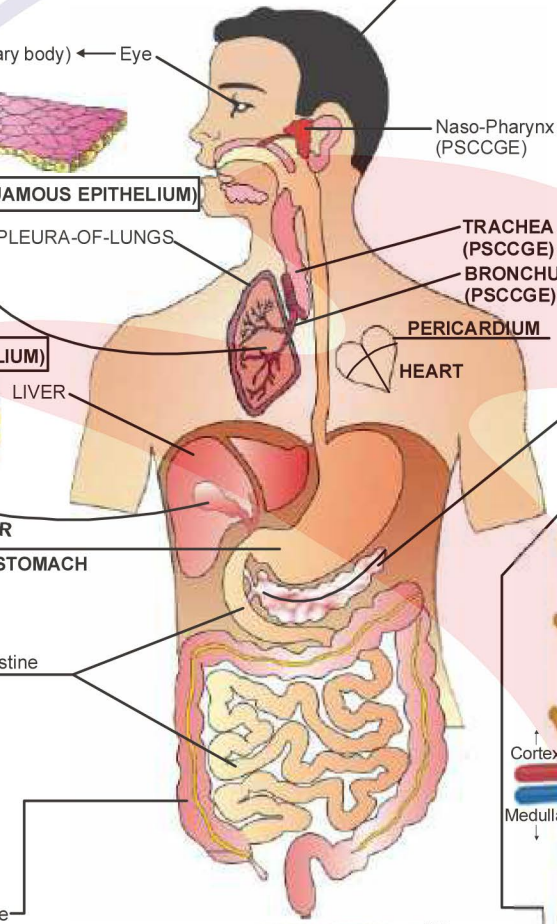


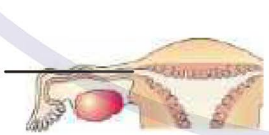
Micro Villi
Goblet cells
Tall Columnar cells
(SIMPLE COLUMNAR BRUSH BORDER GLANDULAR EPITHELIUM)



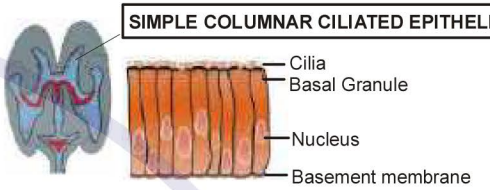
Goblet cells
Tall Columnar cells
(SIMPLE COLUMNAR GLANDULAR EPITHELIUM)

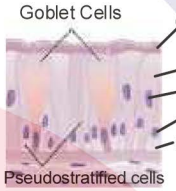






SIMPLE COLUMNAR CILIATED EPITHELIUM

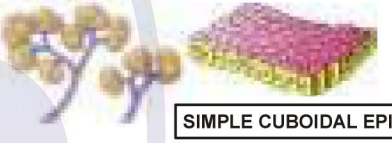




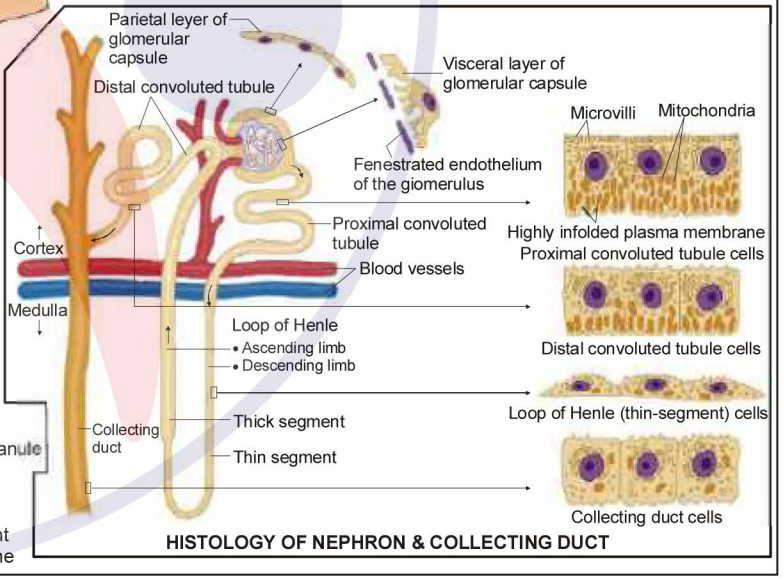
PSEUDOSTRATIFIED COLUMNAR CILIATED GLANDULAR EPITHELIUM

(SIMPLE SQUAMOUS EPITHELIUM)

ACINI OF PANCREAS



SIMPLE CUBOIDAL EPITHELIUM

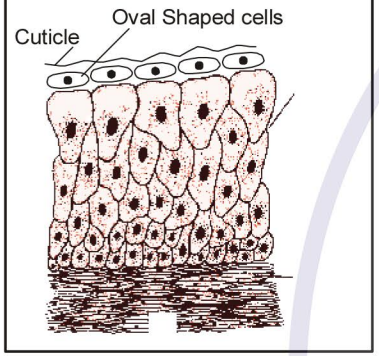


HISTOLOGY OF NEPHRON & COLLECTING DUCT

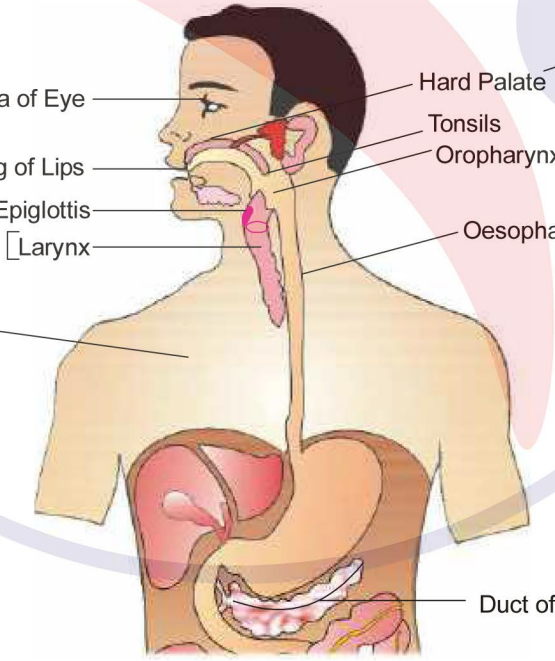
COMPOUND EPITHELIUM

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

Transitional Epithelium



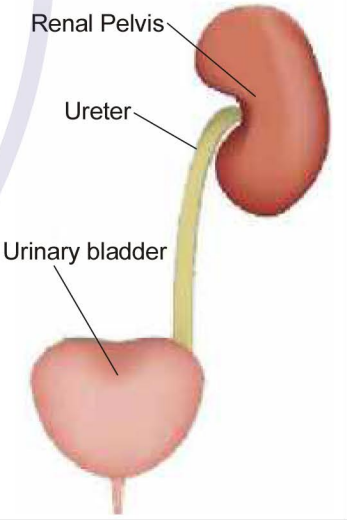
	Squamous Nonkeratinised	Squamous Keratinised	Cuboidal	Columnar Ciliated	Columnar Non-Ciliated
Top most-layer Middle 2 to 4 Layers of pear shaped cells Inner most layer of cells are cube like	Living nucleated flat cells	Keratin Dead non nucleated flat cells	Cuboidal cells		



Stratified squamous keratinised epithelium is found in epidermis of skin, Nails, Scales, Horns, Hooves, Feathers

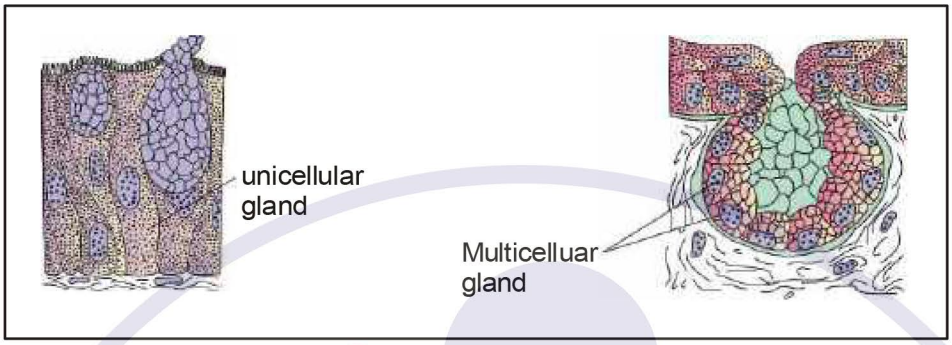
Stratified cuboidal epithelium also found in lining of Vagina

Transitional Epithelium



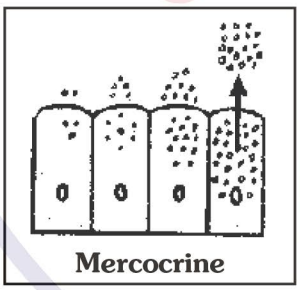
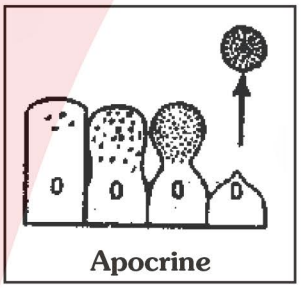
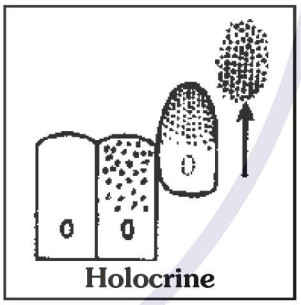
GLANDS

Some of the columnar or cuboidal cells get specialised for secretion and are called glandular epithelium. They are mainly of two types: unicellular, consisting of isolated glandular cells (goblet cells of the alimentary canal), and multicellular, consisting of cluster of cells (salivary gland).



On the basis of the mode of pouring of their secretions, glands are divided into two categories namely exocrine and endocrine glands. Exocrine glands secrete mucus, saliva, earwax, oil, milk, digestive enzymes and other cell products. These products are released through ducts or tubes. In contrast, endocrine glands do not have ducts. Their products called hormones are secreted directly into the fluid bathing the gland.

<u>On the basis of nature of secretion</u> **:-** 3 types of glands are there.

Gland	Acrine/Merocrine	Apocrine	Holocrine
Definition	In these glands secretory cells secrete substances by simple diffusion (Exocytosis). No part of cytoplasm is destroyed and secretes a watery fluid.	In this type of glands secretory products are collected in apical part of secretory cell and apical portion is also shed alongwith secretory matter.	The production or secretion is shed with whole cell leading to its destruction, Secretory matter is more concentrated.
Diagram	 Mercocrine	 Apocrine	 Holocrine
Examples	Maximum sweat glands of humans, Goblet cells, Salivary gland, Tear gland, Intestinal glands, Mucous gland.	Mammary glands. Sweat gland of arm pit, pubic region, skin around anus, lips, nipples etc.	Sebaceous, meibomian & Zeis gland

On the basis of number of cells

(a) Unicellular glands
Eg. Goblet cells, Paneth cells

(b) Multicellular glands
Eg. All glands except Goblet cells and Paneth cells

CELLS AND FIBRES OF CONNECTIVE TISSUE PROPER

(YELLOW-FIBRES)

ELASTIC FIBRES

- Composed of elastin proteins
- Branched but arranged singly
- Maximum elasticity is present
- Highly resistant to chemicals

FIBROBLAST

- Largest cells of connective tissue proper
- Maximum in number
- Irregular in shape due to long cytoplasmic processes
- Cytoplasm is rich in rough ER
- Primary function is to produce protein fibres
- Secrete matrix of connective tissue (Chief matrix producing cells)

MESENCHYME-CELL

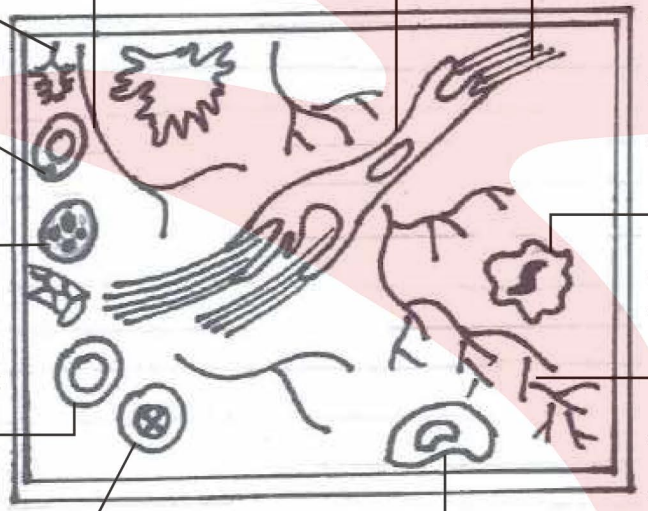
- Small sized pleuripotent cells of connective tissue proper

COLLAGEN FIBRES (WHITE-FIBRES)

- Made up of collagen protein (most abundant protein in animal kingdom)
- Wavy, inelastic, tough fibres arranged in the form of bundles (fascia)
- On boiling they yield gelatin

MONOLOCULAR-ADIPOCYTE

- Single large, central fat globule is present
- Cytoplasm and nucleus becomes peripheral
- Form white fat



MAST CELLS

- Small and amoeboid cells with S-shaped nucleus
- Secrete-histamine, serotonin, heparin and matrix of connective tissue proper

MULTILOCULAR-ADIPOCYTE

- Many, small, fat granules distributed in cytoplasm around nucleus
- Cytoplasm is more
- Form Brown fat

RETICULAR FIBRES

- Also called arzyrophil fibres as they can be stained with silver salts
- Composed of reticulin protein
- Highly branched fibres which always form dense network
- Delicate fibres
- Elasticity is completely absent
- Mainly found in lymphoid organs such as spleen, lymph nodes etc.

LYMPHOCYTES

- Centrally located large nucleus and cytoplasm is peripheral
- Key cells of immune system and involved in production of antibodies

divide to form

PLASMA CELLS

- Small amoeboid cells
- In these cells rounded nucleus is present in which chromatin material is arranged like spokes (radial rows) in wheel so they are also called as cart wheel cells
- Also called clones of lymphocytes as these are formed by division of lymphocytes
- Produce and transport antibodies

MACROPHAGES

- 2nd largest in size
- 2nd maximum in number
- Amoeboid cells, kidney shaped nuclues
- Cytoplasm is agranular but appears to be granular due to more number of lysosomes
- Phagocytic in nature
- Destroy bacteria and viruses by phagocytosis
- Also called scavengers of connective tissue because they destroy dead or damaged cells to clean connective tissues
- Also called histeocytes

CONNECTIVE TISSUE

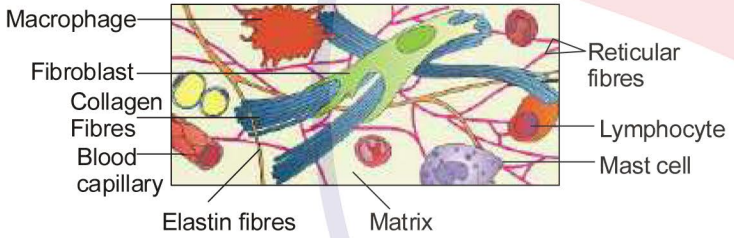
Connective Tissue :- Most abundant and widely distributed in the body of complex animals. They are named connective tissue because of their specialised function of linking and supporting other tissue/organs of the body.

TYPES OF CONNECTIVE TISSUES

LOOSE
(more matrix, less fibres)

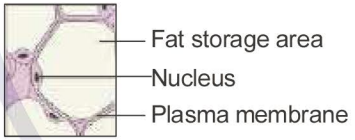
AREOLAR

- Also called loose or Spongy Connective tissue
- Most widely distributed tissue in the body
- Tissue with maximum intercellular spaces, these spaces are called Areolae
- It serves as a support frame work for epithelium



ADIPOSE

- Located mainly beneath the skin



- The cells of this tissue are specialised to store fats. The excess of nutrients which are not used immediately are converted into fats and are stored in this tissue.
- It is of two types (a) white fat (b) brown fat

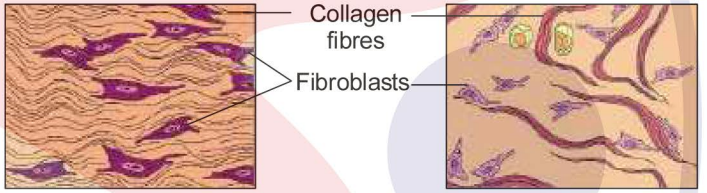
- White fat
  One large fat globule is present
  e.g Panniculas adiposus (hypodermis)
  Yellow bone marrow
- Brown fat
  Many small fat globules are present
  e.g. Cold resistance device in new born baby

DENSE
(more fibres, less matrix)

(Fibres and Fibroblasts are compactly packed)

REGULAR
Bundles of collagen fibres and matrix are distributed in regular pattern

IRREGULAR
Bundles of collagen fibres and cells crisscross arranged



WHITE FIBROUS

- Collagen fibres are more
- Fibroblasts and mast cells are more

CORD
e.g. Tendon
(Connect bone with muscles)

SHEATH
e.g. This tissue is present in the skin, Pericardium, Periosteum, Perichondruim, Epimysium, Renal capsule, Duramater

YELLOW FIBROUS

- Elastic fibres are more
- Collagen fibres are less
- Reticular fibres are completely absent

CORD
e.g. Ligament
(Connect bone with bone)

SHEATH
e.g. walls of alveoli, small bronchioles, blood vessels, lymph vessels, true vocal cords

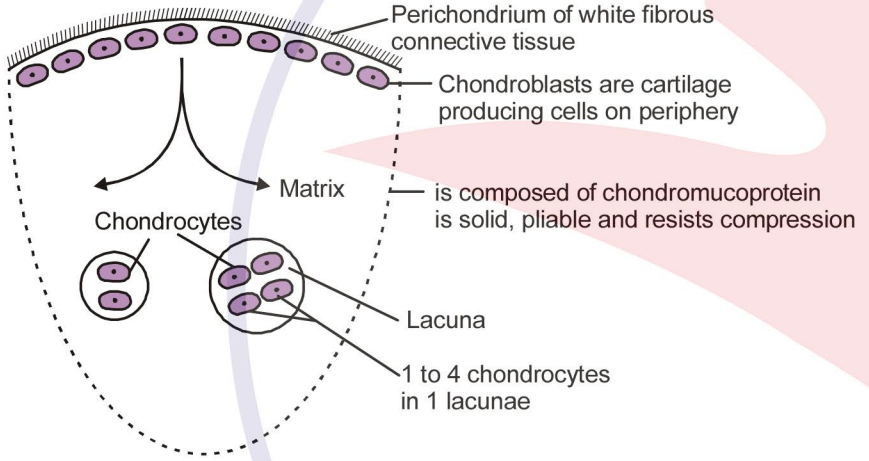
SPECIALISED

- **Skeleton Connective Tissue**
  - Cartilage
  - Bone
- **Blood**
  - Plasma
  - Corpuscles
    - RBC
    - WBC
    - Platelets

SKELETAL CONNECTIVE TISSUE

Matrix is dense and mineralised due to deposition of minerals it becomes hard. Also called supporting tissue, i.e. provide support to body. Skeletal connective tissue is of two types. (A) Cartilage (B) Bones

CARTILAGES



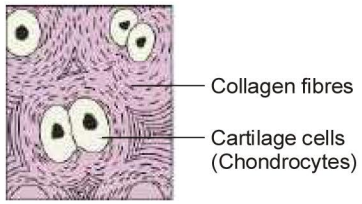
Blood circulation is absent in the matrix but supply present in perichondrium.

TYPES OF CARTILAGES

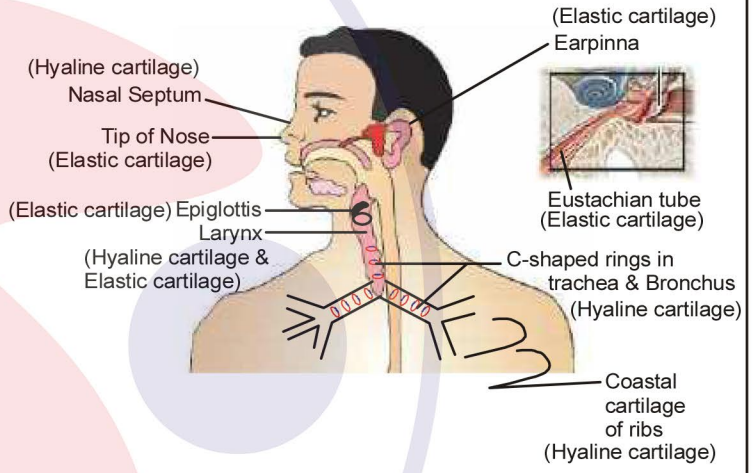
(1) HYALINE - Fibres are absent, matrix is semitransparent

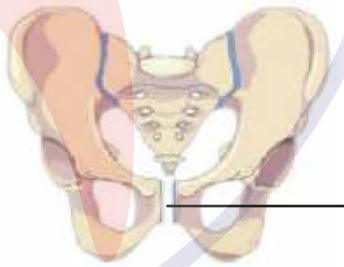
(2) FIBROUS - (A) Elastic (B) White Fibrous - Strongest cartilage

(3) CALCIFIED - Hardest cartilage.



EXAMPLES OF CARTILAGES





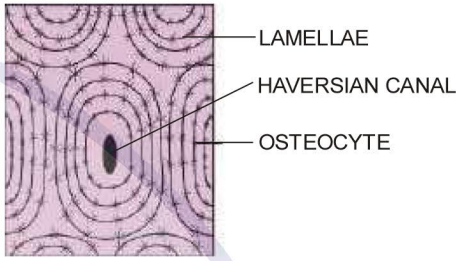
Pubic symphysis is made of white fibrous cartilage

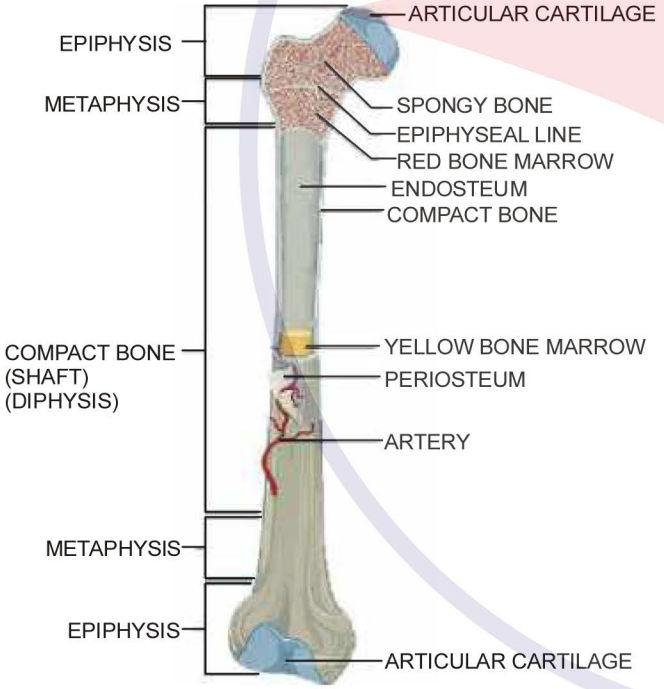
Ends of all long bones except femur and humerus are made of hyaline cartilage

Ends of femur and humerus are made of calcified cartilage

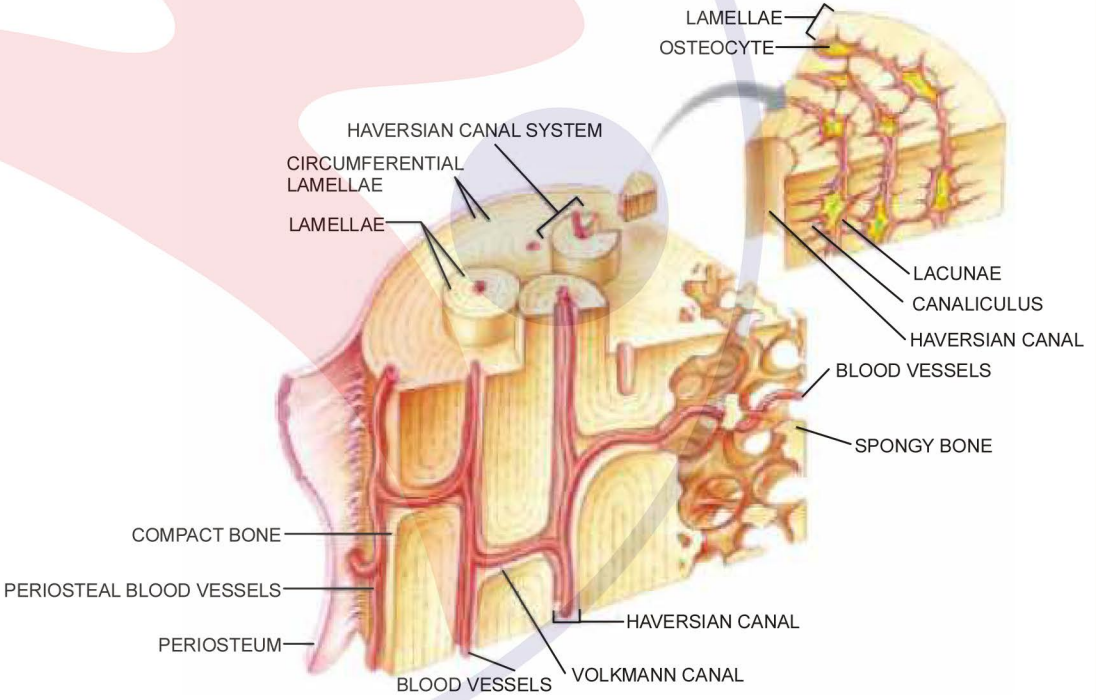
SKELETAL CONNECTIVE TISSUE (BONE)

- *Support and protect softer tissues and organs*
- *Process of formation of bone - OSSIFICATION*
- *Hardest tissue of our body.*
- *The bone marrow is some bones is the site of production of blood cells.*
- *Growth of bone is bidirectional.*
- *Matrix of bone is in the form of layers called lamellae.*
- *Protein present in bone is called ossein.*
- *Matrix is hard and nonpliable rich in Ca salts and collagen fibres.*
- *Mammalian long compact bone is characterised by the presence of Haversian canal system.*





L.S. OF LONG BONE



T.S. OF LONG BONE