



TISSUE LEVEL OF ORGANIZATION


**Subject : Human Anatomy &
Physiology-I
Code : BP101TP**

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INTRODUCTION

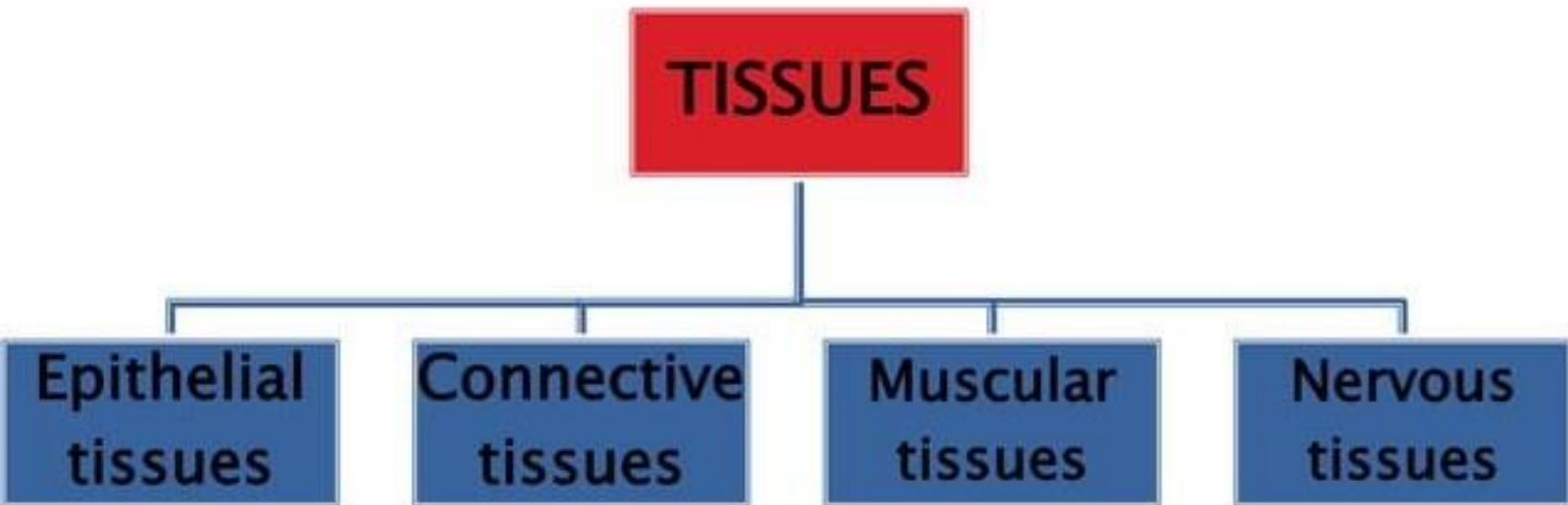
- ▶ Cells are the body's smallest functional units they are grouped together to form **tissues**, each of which has specialized functions, e.g. blood, muscle
- ▶ Study of tissues is called **histology**.

- ▶ Tissues are grouped together to form **organs** e.g heart, stomach ,brain.
 - ▶ Organs are grouped together to form **system**,each of which performs a particular functions.eg digestive system
- 

TISSUES

- ▶ **DEFINITION:**
- ▶ Tissue is a collection of cells which have similar structure and perform relatively common functions.

TYPES OF TISSUES



Four types of tissue



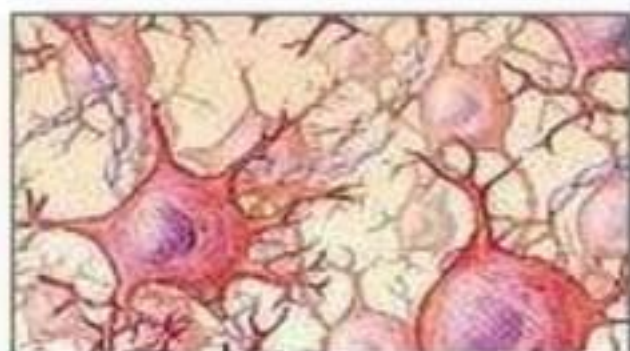
Connective tissue



Epithelial tissue



Muscle tissue



Nervous tissue

EPITHELIAL TISSUES

CHARACTERISTICS

- ▶ Cells are closely packed without any intercellular spaces
- ▶ Lie on basement membrane

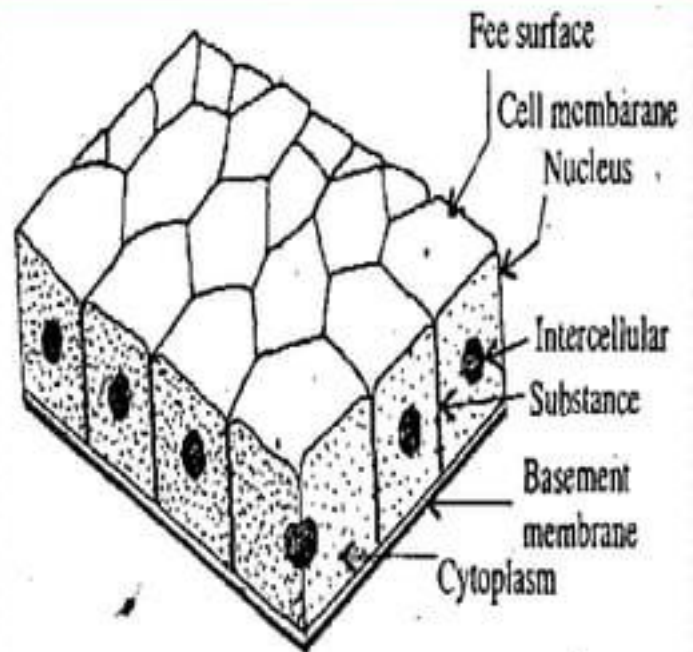


Fig. 10.1 General Structure of Epithelia

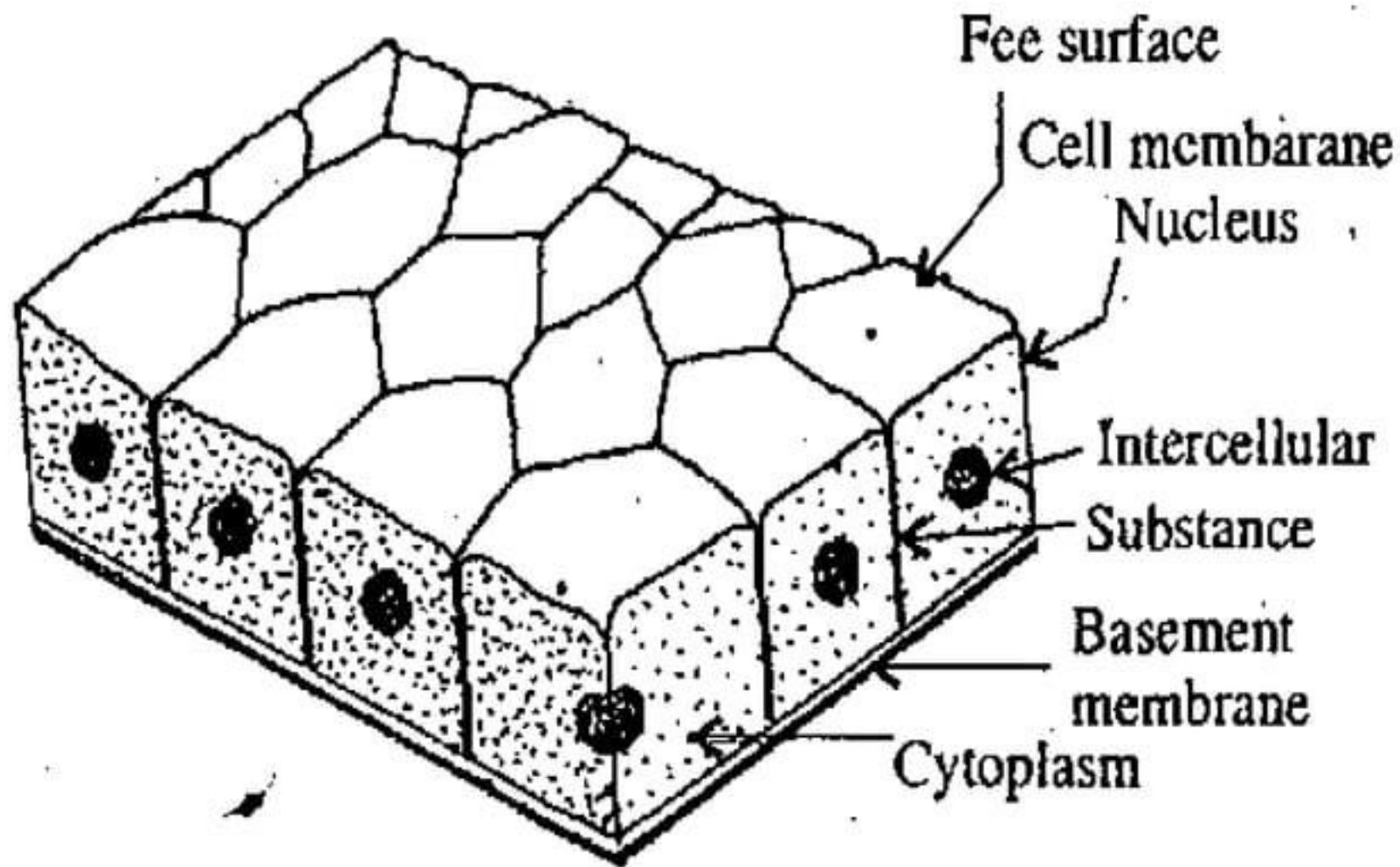
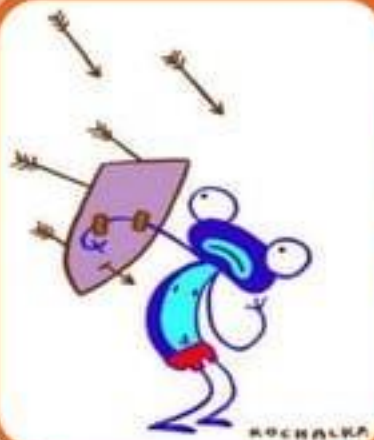


Fig. 10.1 General Structure of Epithelia

LOCATION

- ▶ Found covering the body and lining cavities and tubes. Outer and inner lining of most of the body organs such as gastrointestinal tract(GIT), urinary tract , blood vessels, heart chambers uterus.
- ▶ Found on the entire exposed surface of the body such as skin.
- ▶ Also found in glands

FUNCTIONS OF EPITHELIAL TISSUES



Role of defense and protect body organs



Secret gastric juice in stomach.

FUNCTIONS CONT....



Absorb digested food in intestine.



Removes waste as sweat in skin.

EPITHELIAL TISSUE

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graph TD; A[EPITHELIAL TISSUE] --> B[SIMPLE EPITHELIUM]; A --> C[STRATIFIED EPITHELIUM];
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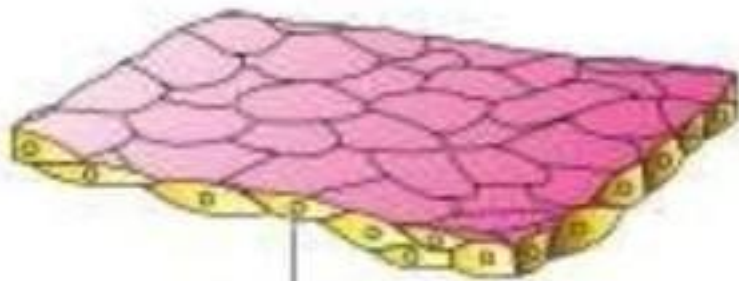
SIMPLE EPITHELIUM

STRATIFIED
EPITHELIUM

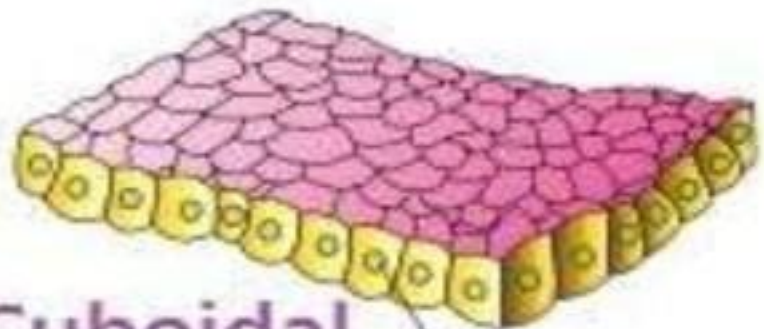
SIMPLE EPITHELIAL TISSUE

- ▶ Consists of a single layer of identical cells
- ▶ Found on absorptive or secretory surfaces
- ▶ Divided into three main types.

TYPES OF SIMPLE EPITHELIUM TISSUE

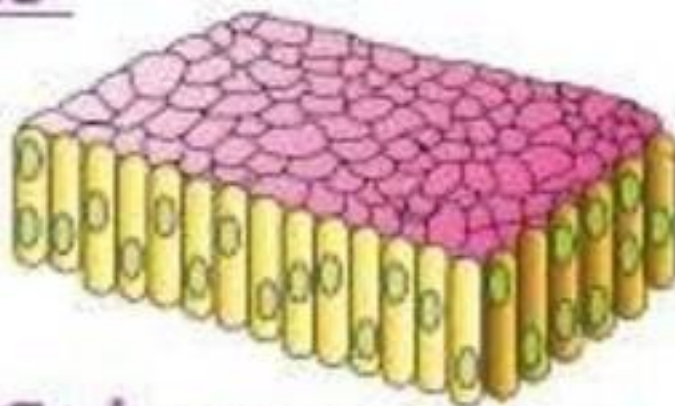


Flattened cell
Squamous



Cuboidal

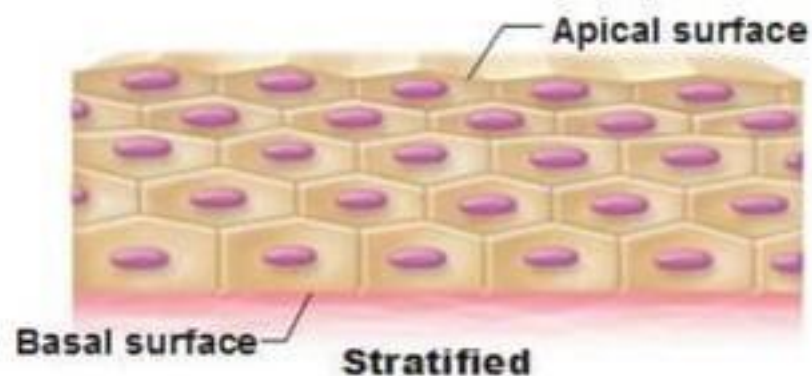
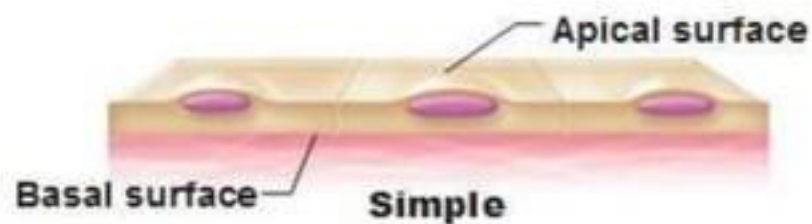
Cube-like cell



Tall cell

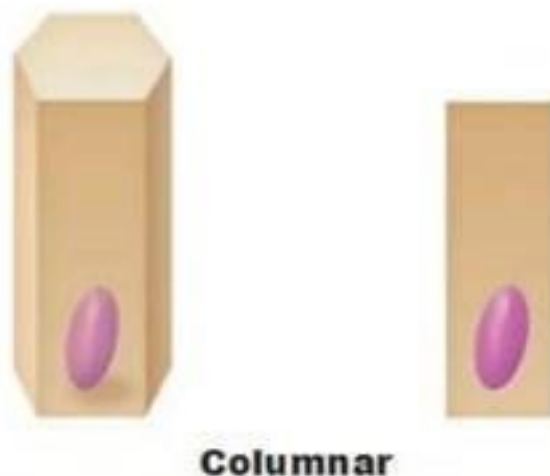
Columnar

Classifications of Epithelia




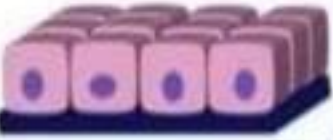

(a) Classification based on number of cell layers

Note that basal cells regenerate; as apical cells slough off, they are replaced by basal cells



(b) Classification based on cell shape

DIFFERENT TYPES OF SIMPLE EPITHELIUM TISSUE

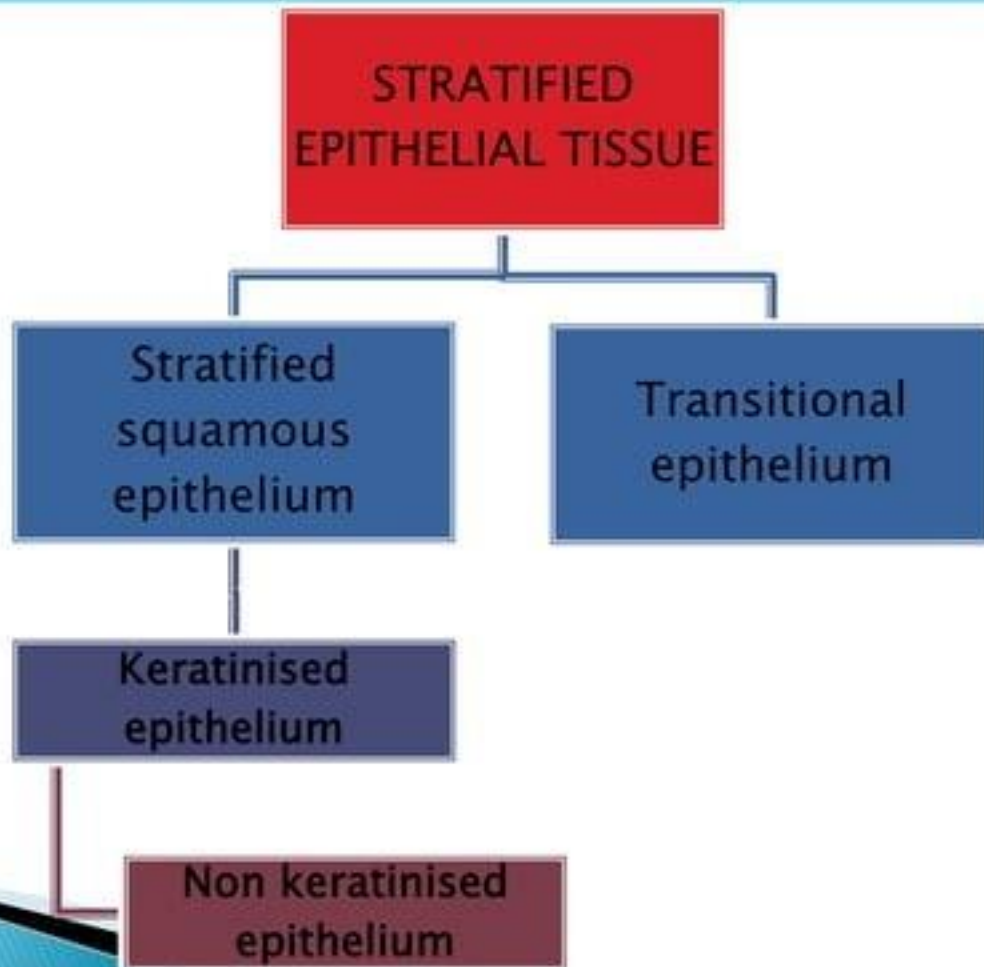
| Type of Epithelium | Structure | Location in the body | Function |
|---|--|--|---|
| Squamous epithelium  | Cells are thin, flat, irregular cells which fit like floor tiles to form delicate lining called PAVEMENT EPITHELIUM Nuclei in centre | Oesophagus, lining of mouth, alveoli of the lungs, blood vessels | Protects the underlying tissue from injury, grems Exchange of gases in lungs and materials between cells and blood |
| Cuboidal epithelium  | Cells are cuboidal with round nucleus in centre Nuclei in centre | Kidney tubules, duct of salivary glands | Gives mechanical support At times the epithelial tissue folds, forms a gland that secretes substances. Such epithelium is called GLANDULAR EPITHELIUM |
| Columnar epithelium  | Cells are more tall and less wide (PILLAR LIKE), placed side by side. Nucleus is situated near the base. (Rectangular shape) Nuclei near base | Inner lining of intestine, In respiratory tract, cells have cilia (hair like) that move and push the mucous to clear it. Such epithelium is called CILIATED COLUMNAR EPITHELIUM | Helps in absorption excretion and secretion |

STRATIFIED EPITHELIAL TISSUE

Characteristics

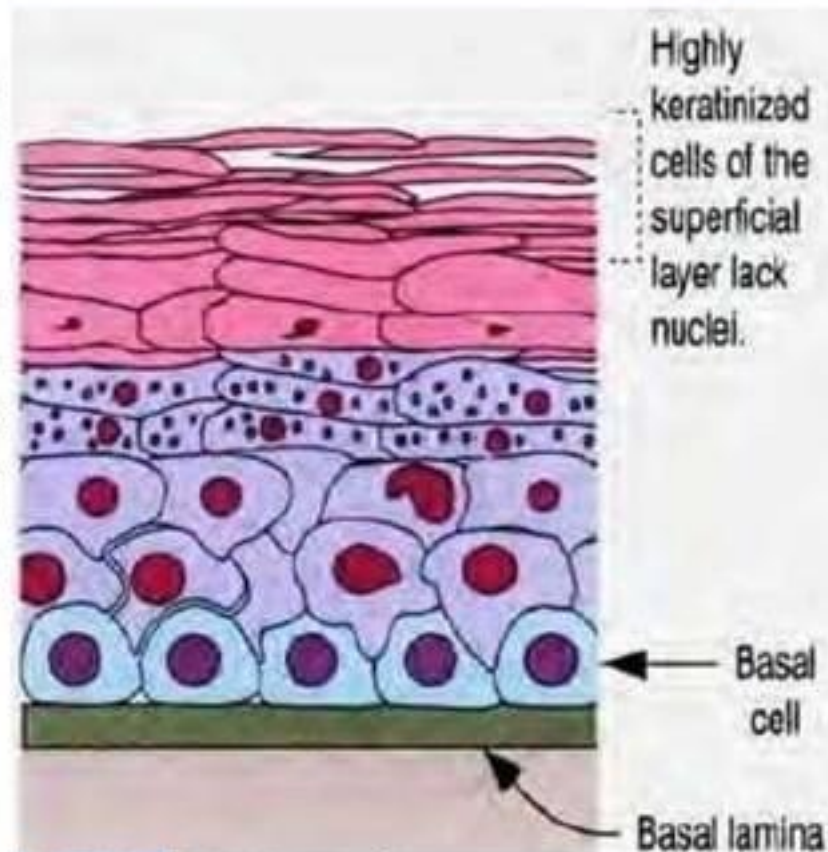
- ▶ Consists of several layers of cells of various shapes.
- ▶ Continual cell division in the lower layers pushes cells above nearer and nearer to the surface where they are shed.
- ▶ Basement membrane are usually absent.
- ▶ Main function is to protect underlying structure from mechanical wear and tear.

TYPES OF STRATIFIED EPITHELIAL TISSUES



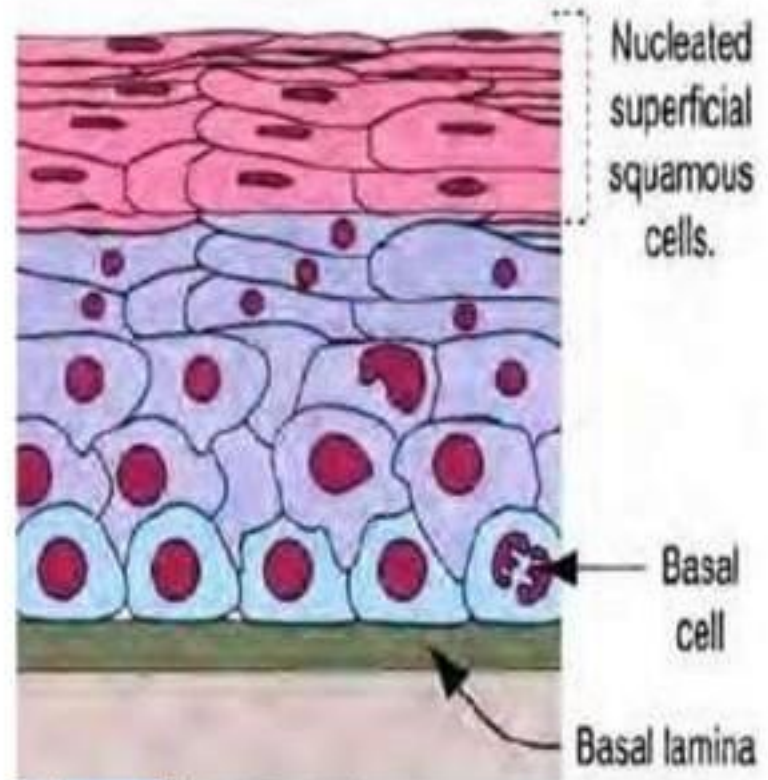
KERITINISED SQUAMOUS EPITHELIUM

- ▶ Found on dry surfaces subjected to wear and tear.
- ▶ Consists of dead epithelial cells that have lost their nuclei and contain the protein keratin.
- ▶ Sites
Skin, hairs and nails



NON-KERATINISED EPITHELIUM

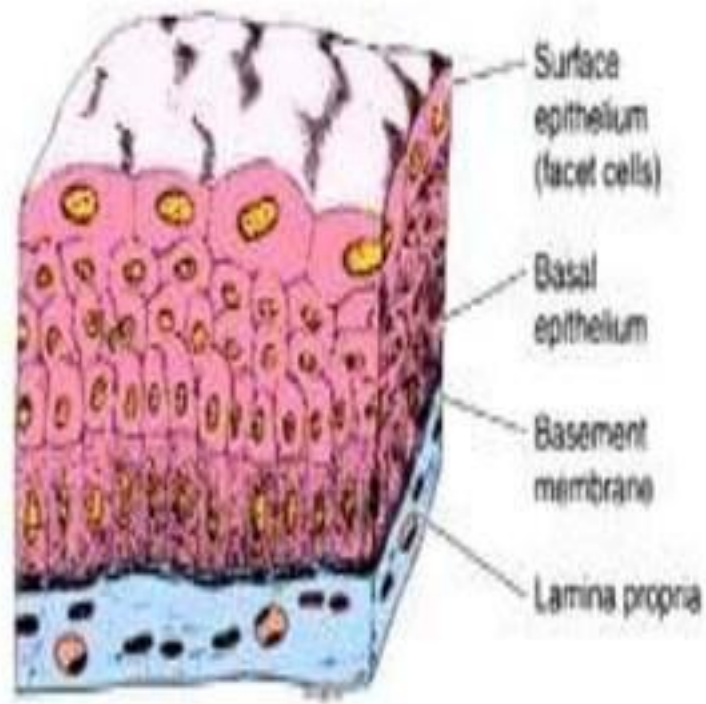
- ▶ Protects moist surfaces subjected to wear and tear and prevents them from drying out.
- ▶ Sites
- ▶ Conjunctiva of the eyes, the lining of the mouth, the vagina.



TRANSITIONAL EPITHELIUM

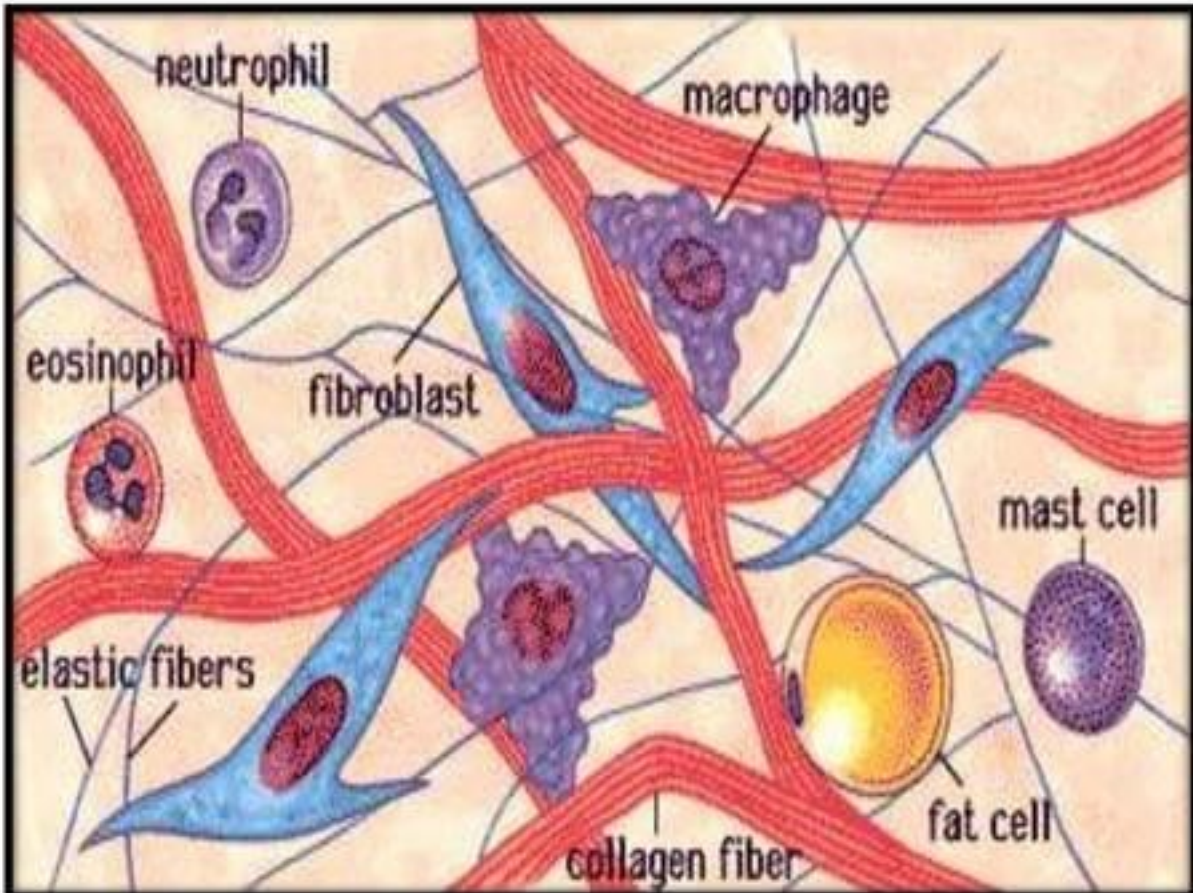
- ▶ Composed of several layers of pear shaped cells which are very elastic and have the capacity of dividing themselves.
- ▶ Sites
- ▶ Lines several parts of the urinary tract including the bladder.

B Transitional epithelium



CONNECTIVE TISSUES

- ▶ It is most abundant tissue in the body
- ▶ Connective tissues cells are more widely separated from each other than in epithelial tissues and intercellular substance (matrix) is present in larger amount
- ▶ Made up of cells like fibroblast, fat cells, macrophages, leukocytes and mast cells.



FUNCTIONS OF CONNECTIVE TISSUES

- ▶ Provide support
- ▶ Transport materials from one part of the body to another
- ▶ Store energy.
- ▶ Protection
- ▶ Insulation

▶ Cells in connective tissues



Fibroblast



Fat globule

Adipose cell



Plasma cell




Mast cell



**Macrophage or
histocyte**

FIBROBLASTS

- ▶ They are large cells with irregular processes
Manufacture collagen and elastic fibres and a matrix of extracellular material.
 - ▶ Functions
 - ▶ Active in tissue repair
- 

- ▶ FAT CELLS

- ▶ Also known as adipocytes
- ▶ These cells occur singly or in groups in many types of connective tissues and are especially abundant in adipose tissue.

▶ MACROPHAGES

- ▶ These are large irregular shaped cells with granules in the cytoplasm.
- ▶ Important part of the body defence mechanism because they are actively phagocytic, engulfing and digesting cell debris, bacteria and other foreign bodies.

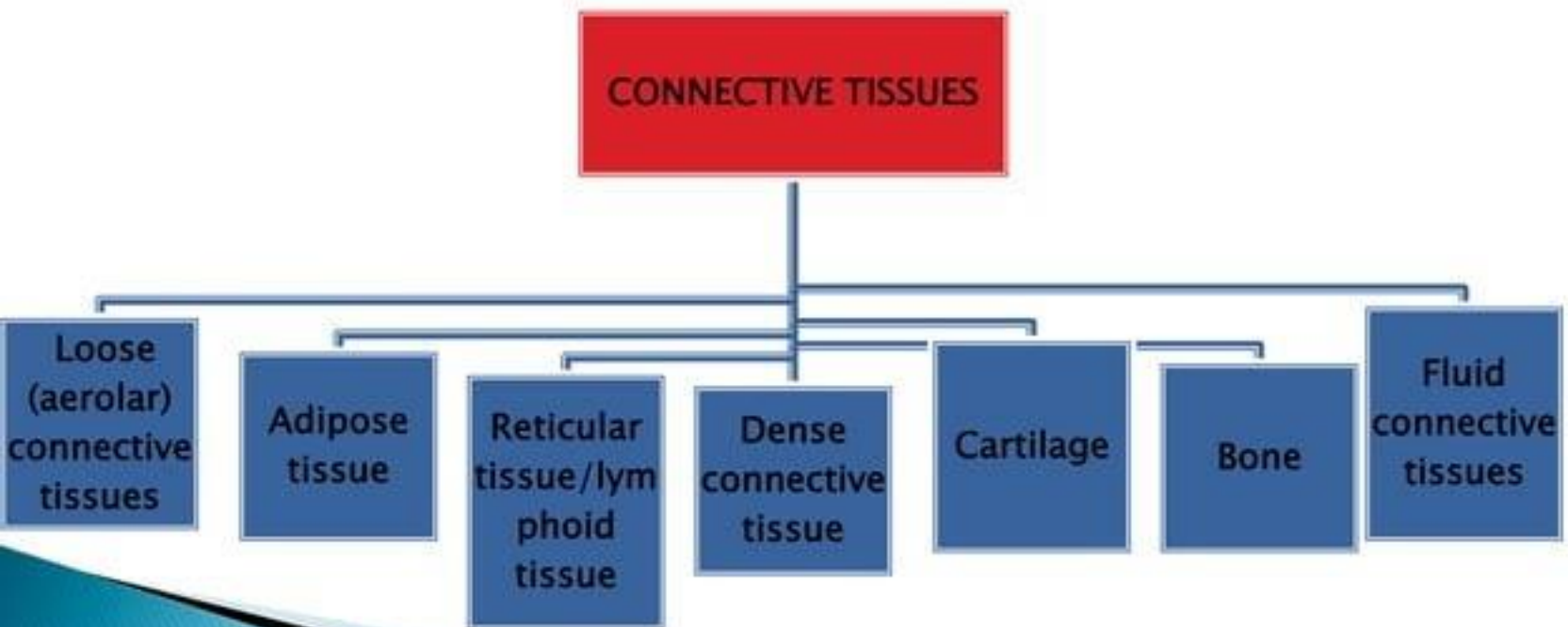
▶ LEUCOCYTES

- ▶ White blood cells are normally found in small numbers in healthy connective tissues.
- ▶ Synthesis and secret specific defensive antibodies into the blood and tissue

▶ MAST CELLS

- ▶ Similar to basophilic leukocytes
- ▶ Found in loose connective tissues, under the fibrous capsules of some organs.eg.liver and spleen.

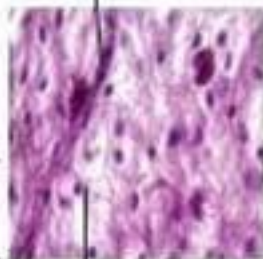
TYPES OF CONNECTIVE TISSUES



Connective Tissue

Loose connective tissue

Collagenous fiber



120 μm

Elastic fiber

Fibrous connective tissue



30 μm

Nuclei

Bone

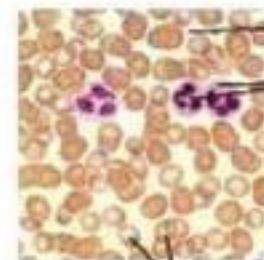


700 μm

Central canal

Osteon

Blood



Plasma

White blood cells

55 μm

Red blood cells

Cartilage



Chondrocytes

100 μm

Chondroitin sulfate

Adipose tissue

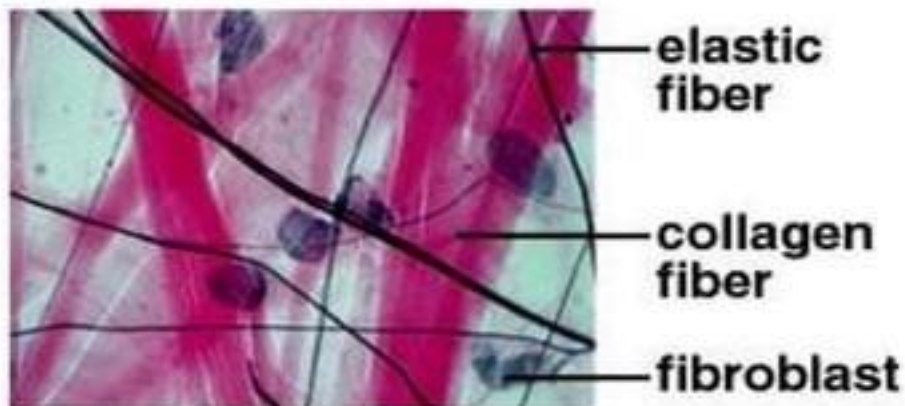


Fat droplets

150 μm

LOOSE AEROLAR CONNECTIVE TISSUES

- ▶ Most generalized type of connective tissues
- ▶ Matrix is semisolid with many fibroblasts and some fat cells (adipocytes), mast cells and macrophages widely separated by elastic and collagen fibres.



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50 μm

**Loose fibrous
connective tissue**

LOOSE AEROLAR CONNECTIVE TISSUE CONTD....

- ▶ Found in almost part of the body, providing elasticity and tensile strength.
- ▶ It connects and supports other tissues, for eg. under the skin, between muscles, supporting blood vessels and and nerves, in the alimentary canal, in gland supporting secretory cells.

ADIPOSE TISSUE

- ▶ Consists of fat cells(adipocytes), containing large fat globules, in a matrix .

TYPES OF ADIPOSE TISSUES

ADIPOSE
TISSUES

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graph LR; A[ADIPOSE TISSUES] --- B[White adipose tissue]; A --- C[Brown adipose tissue]
```

White adipose
tissue

Brown
adipose tissue

WHITE ADIPOSE TISSUE

- ▶ More present in obesity and in less in those who are underweight
- ▶ Found in between muscle fibres and under the skin, where it acts as a thermal insulator and energy store.
- ▶ Sites
- ▶ Deeper layer of skin, buttocks, breast and around kidneys

BROWN ADIPOSE TISSUE

- ▶ Present in the newborn
- ▶ **Has a more extensive capillary network than white adipose tissue.**
- ▶ Produces less energy and more heat than other fat contributing to the maintenance of body temperature.

LYMPHOID/RETICULAR TISSUES

- ▶ Has a semisolid matrix with fine branching reticulin fibres.
- ▶ **Contains reticular cells and white blood cells**
- ▶ Found in all lymph nodes and all organs of lymphatic system.

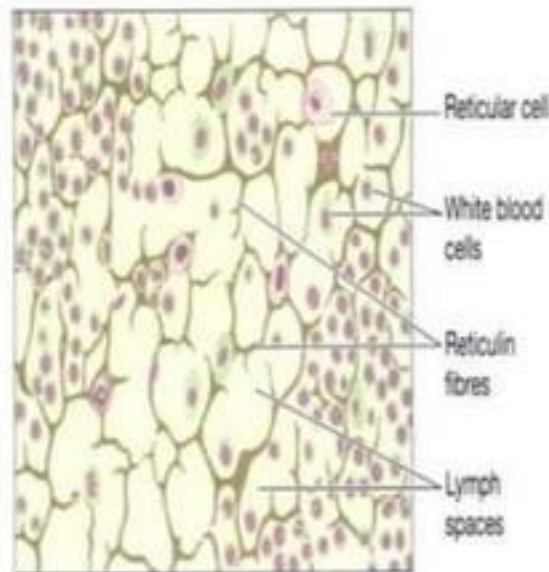


Figure 3.18 Lymphoid tissue.

DENSE CONNECTIVE TISSUE

- ▶ These contains more collagen fibers and fewer cells than loose connective tissues.

TYPES OF DENSE CONNECTIVE TISSUE

DENSE
CONNECTIVE
TISSUES

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graph TD; A[DENSE CONNECTIVE TISSUES] --> B[Fibrous tissue]; A --> C[Elastic tissue]
```

Fibrous tissue

Elastic tissue

FIBROUS TISSUE

- ▶ Made up of mainly of closely packed bundles of collagen fibres with very little matrix and few fibrocytes.
- ▶ Found in Ligament, tendon, fasciae

ELASTIC TISSUE

- ▶ Capable of considerable extension and recoil. There are few cells and the matrix **consists mainly of masses and of elastic fibres secreted by fibroblasts.**
- ▶ Sites
- ▶ Large blood vessel walls, the trachea and bronchi and the lung.

TYPES OF CARTILAGE

Hyaline cartilage

Fibrocartilage

**Elastic
fibrocartilage**

HYALINE CARTILAGE

- ▶ It is a smooth bluish white tissues. The **chondrocytes** are arranged in small groups within cell nests and matrix is solid and smooth.

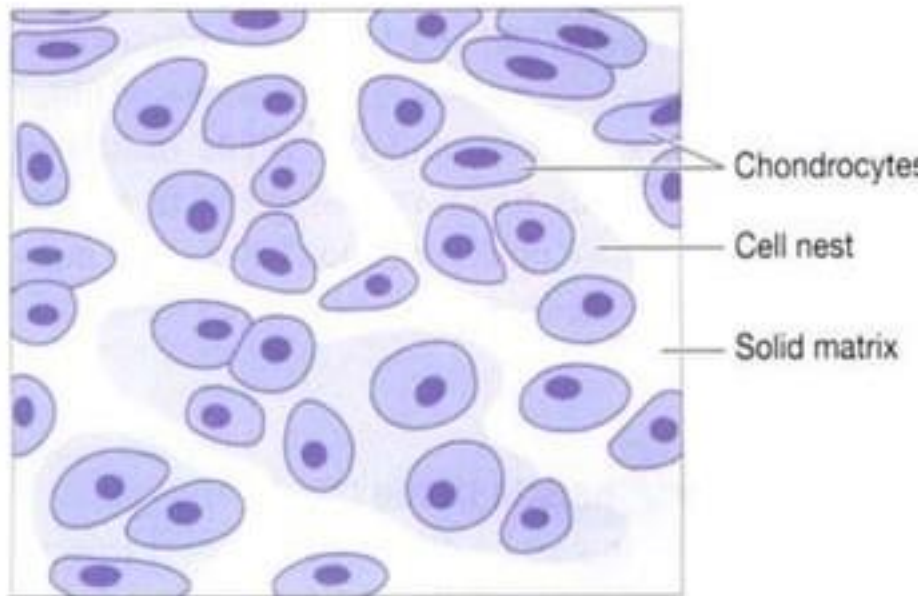


Figure 3.19 Hyaline cartilage.

HYALINE CARTILAGE CONTD..

- ▶ **Function:**
- ▶ Provides flexibility, support and smooth surfaces for movements at joints.

- ▶ **Sites**
- ▶ Ends of long bones
- ▶ Forming the parts of larynx, trachea and bronchi

FIBROCARILAGE

- ▶ Consists of dense masses of white collagen fibres in a matrix similar to that of hyaline cartilage with the cells widely dispersed.

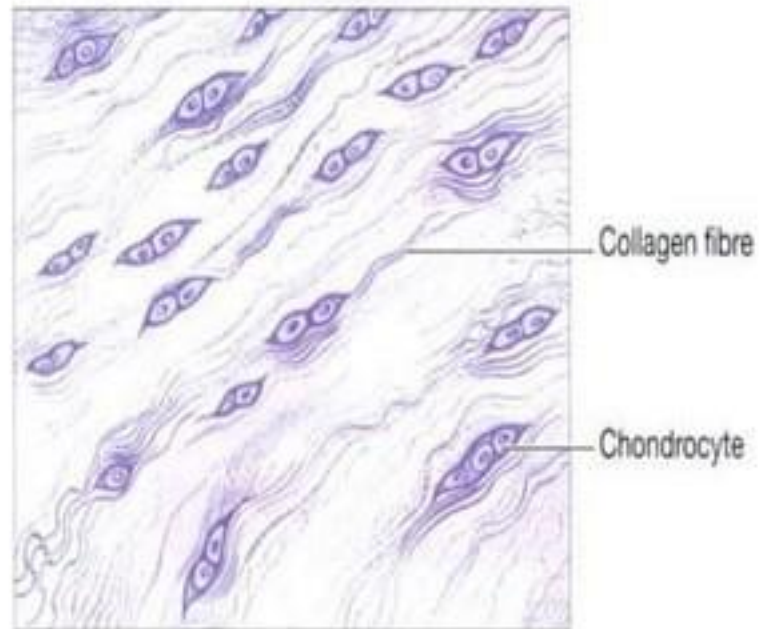


Figure 3.20 Fibrocartilage.

FIBROCARILAGE CONTD..

- ▶ It is a tough, slightly flexible, supporting tissue.
- ▶ Sites
- ▶ Pads between intervertebral disc
- ▶ Between pubic bones(symphysis pubis)

ELASTIC FIBROCARILAGE

- ▶ Contains large amount of elastin fibres in the chondrin .

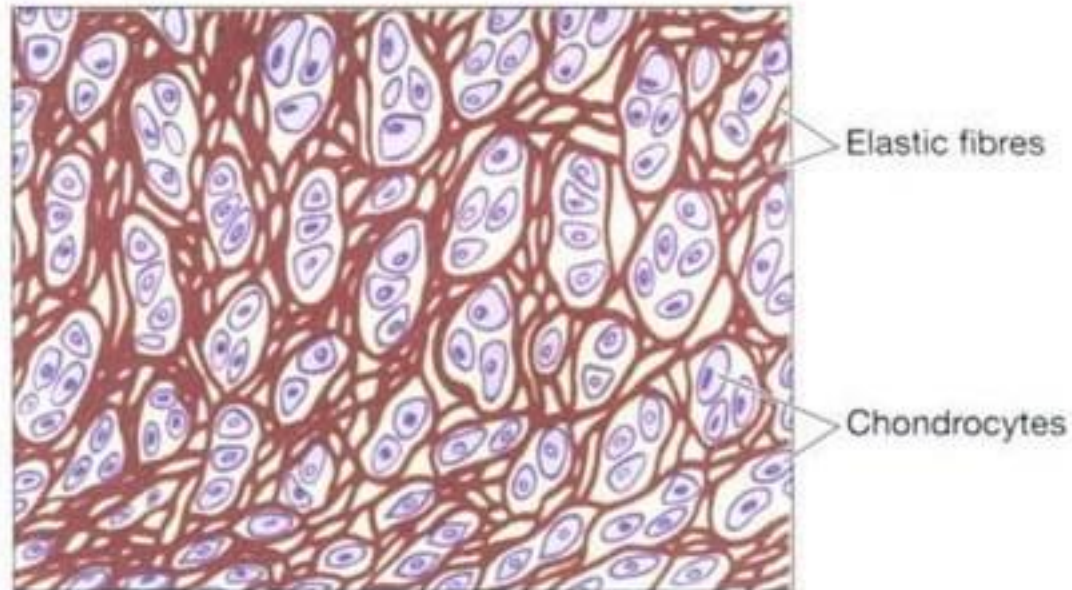
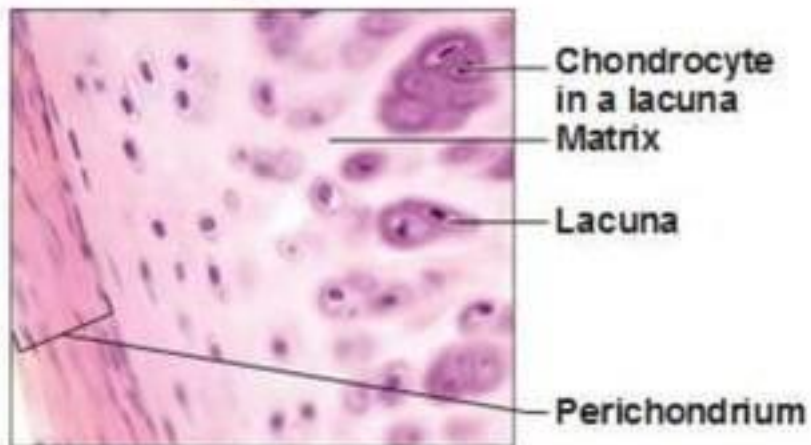


Figure 3.21 Elastic fibrocartilage.

ELASTIC FIBROCARILAGE CONTD..

- ▶ It's highly flexible.
- ▶ **Sites**
- ▶ The pinna or lobe of ear, epiglottis

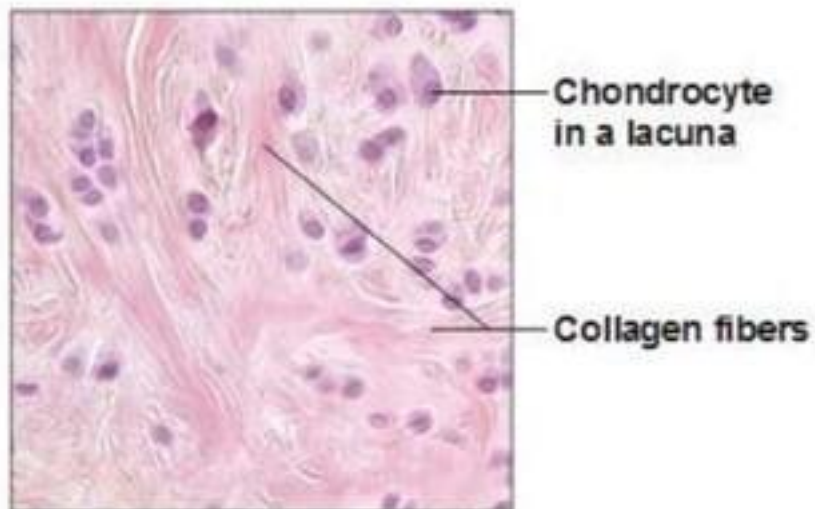
Cartilages in the Adult Body



(a) Hyaline cartilage (180 \times)



(b) Elastic cartilage (470 \times)



(c) Fibrocartilage (285 \times)

BONE

- ▶ These have a diaphysis or shaft and two epiphyses or extremities.
- ▶ The diaphysis is composed of compact bone with a central medullary canal, containing fatty yellow bone marrow.
- ▶ The epiphyses consist of an outer covering of compact bone with cancellous bone inside.

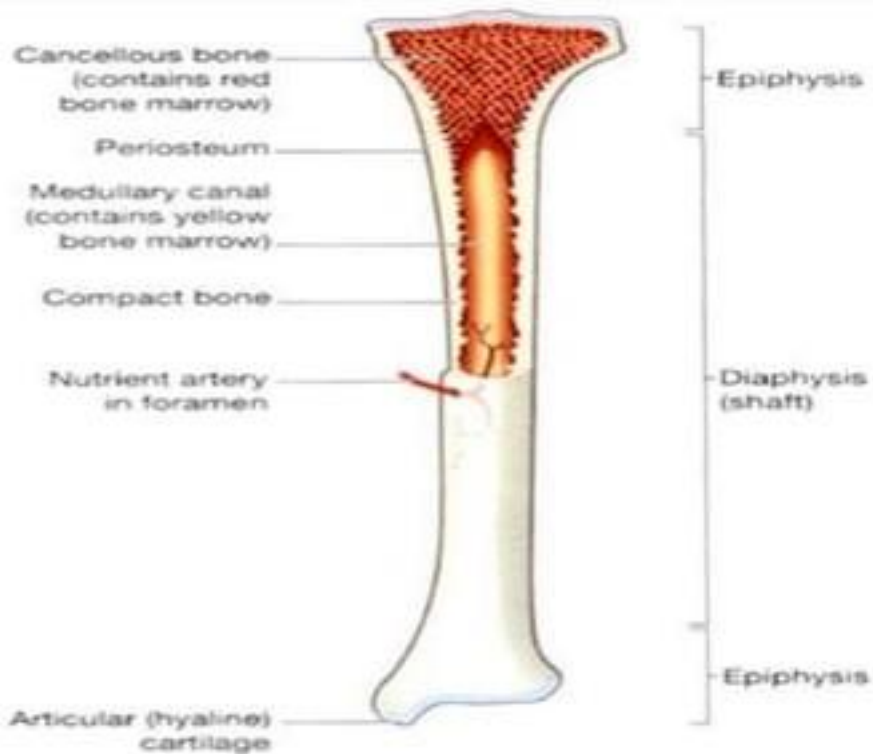

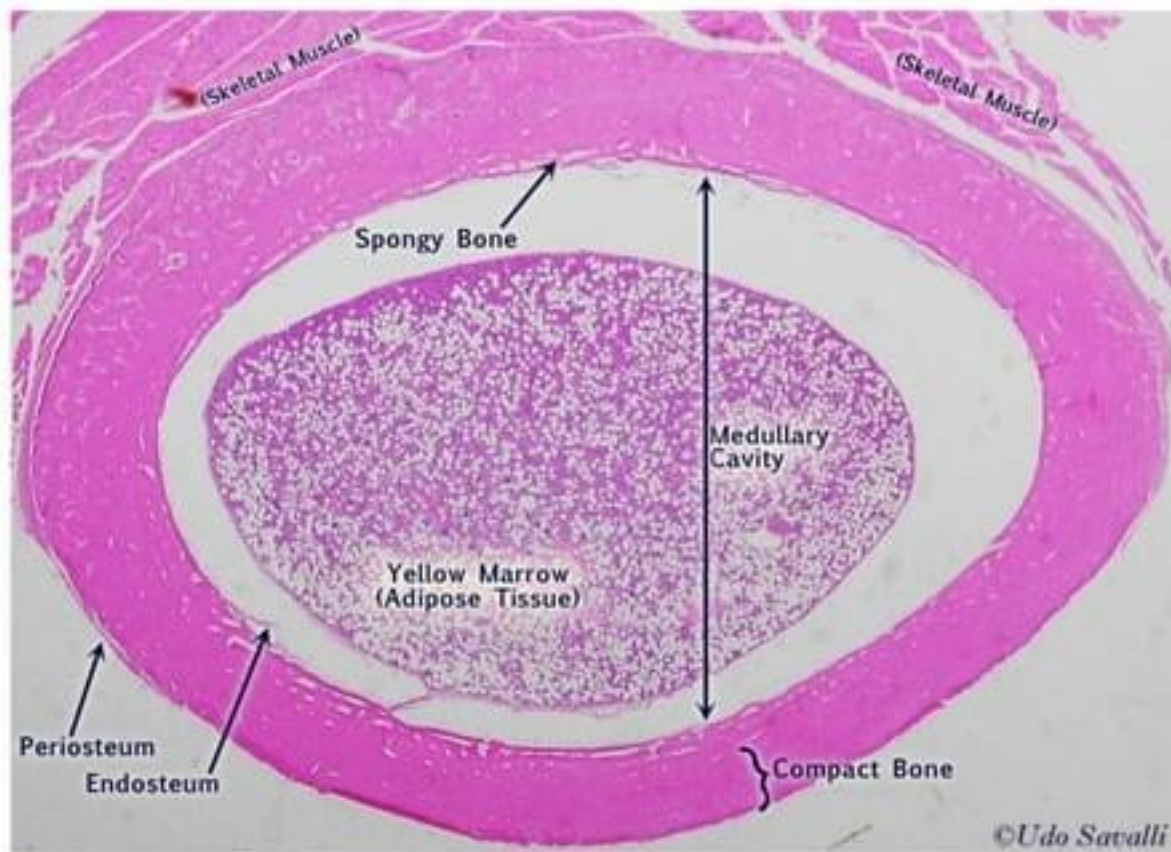
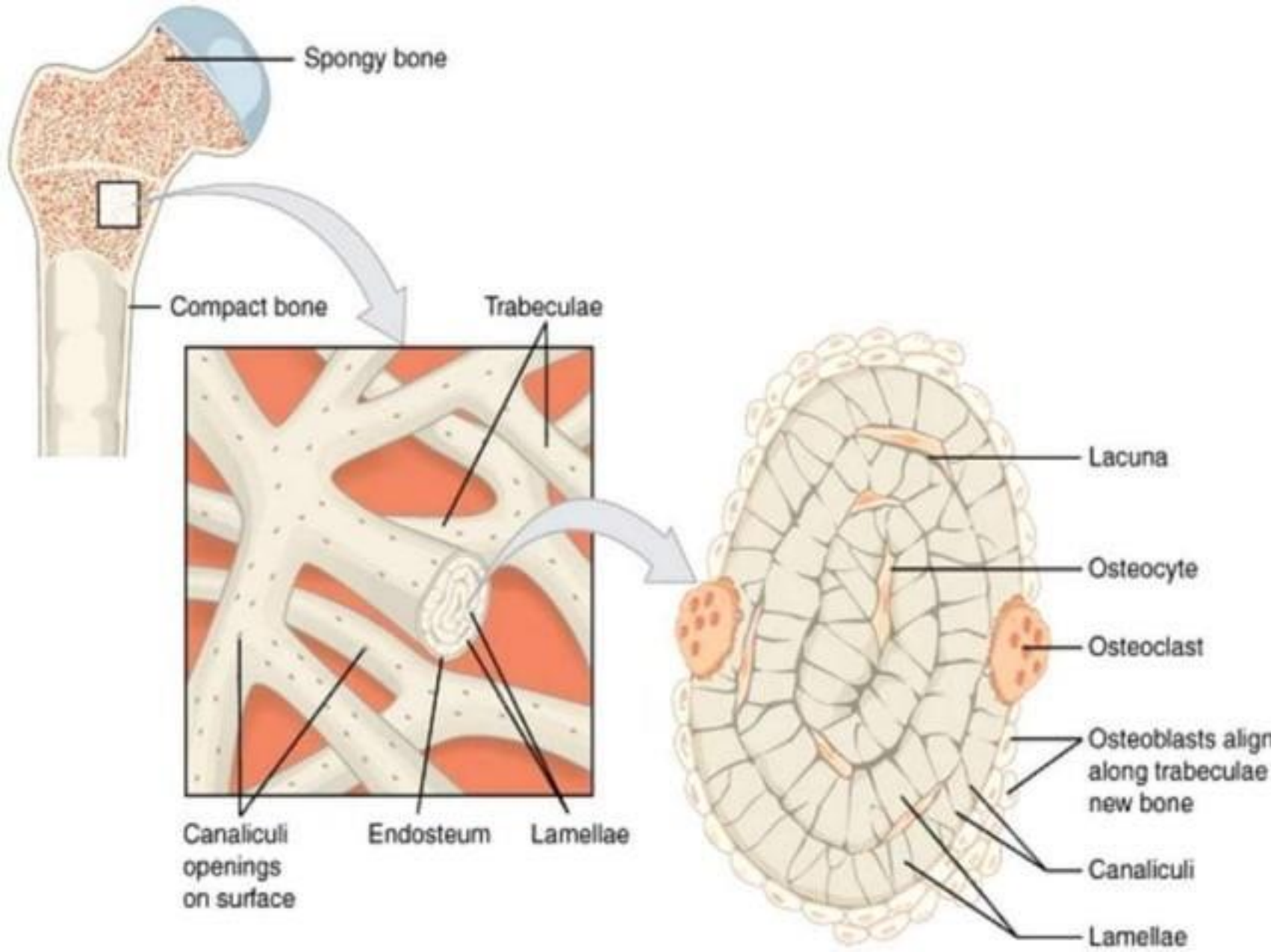


Figure 16.1 A mature long bone – partially sectioned.

- ▶ Long bones are almost completely covered by a vascular membrane, the periosteum.
- ▶ The outer layer is fibrous and the inner layer is osteogenic containing osteoblasts (bone-forming cells) and osteoclasts (bone-destroying cells), which are involved in maintenance and remodelling of bones.
- ▶ Have a yellow central cavity which is filled with cells called bone marrow.
- ▶ Around the bone marrow cavity is layer of osteoblasts called endosteum

- ▶ **Types of bone:**
 - ▶ Spongy bone–spongy or fine honey comb appearance
 - ▶ Compact bone–solid or dense appearance
- 



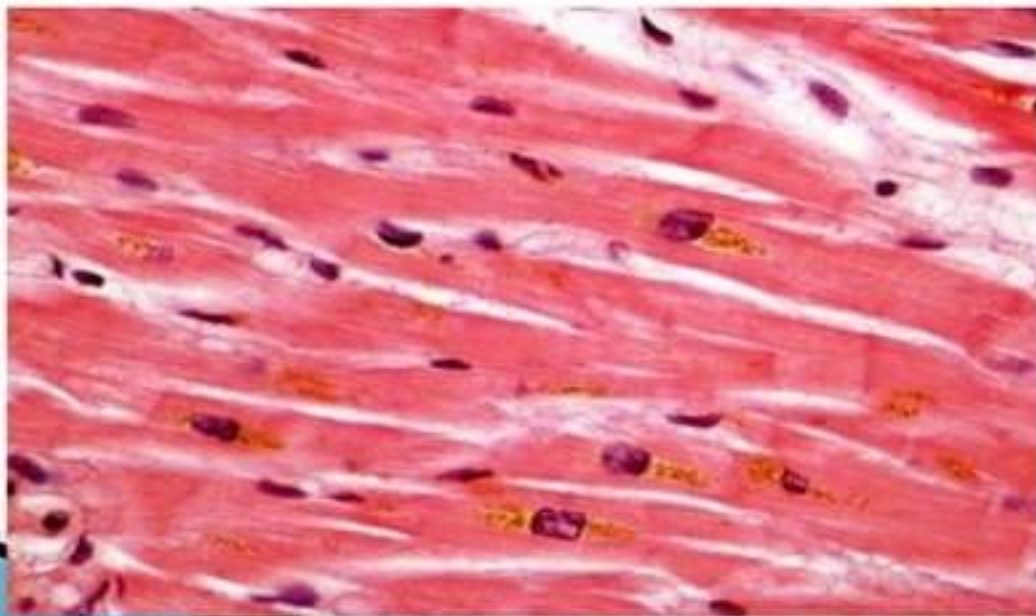


FLUID CONNECTIVE TISSUES

- ▶ They have a large number of different types of cells suspended in a fluid found substance (matrix).
- ▶ They are blood and lymph.

MUSCULAR TISSUES

- ▶ It is made up of muscle cells(muscle fibers) which unite to form muscle.
- ▶ It contracts and relaxes rhythmically.



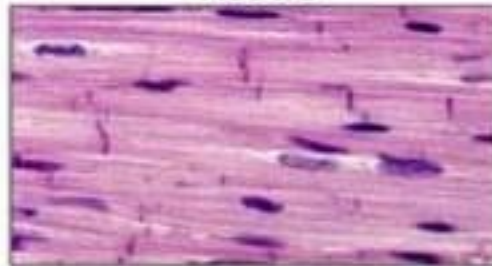
TYPES OF MUSCULAR TISSUES

Smooth Muscle
Tissue



Involuntary
Control

Cardiac Muscle
Tissue




Involuntary
Control

Skeletal Muscle
Tissue



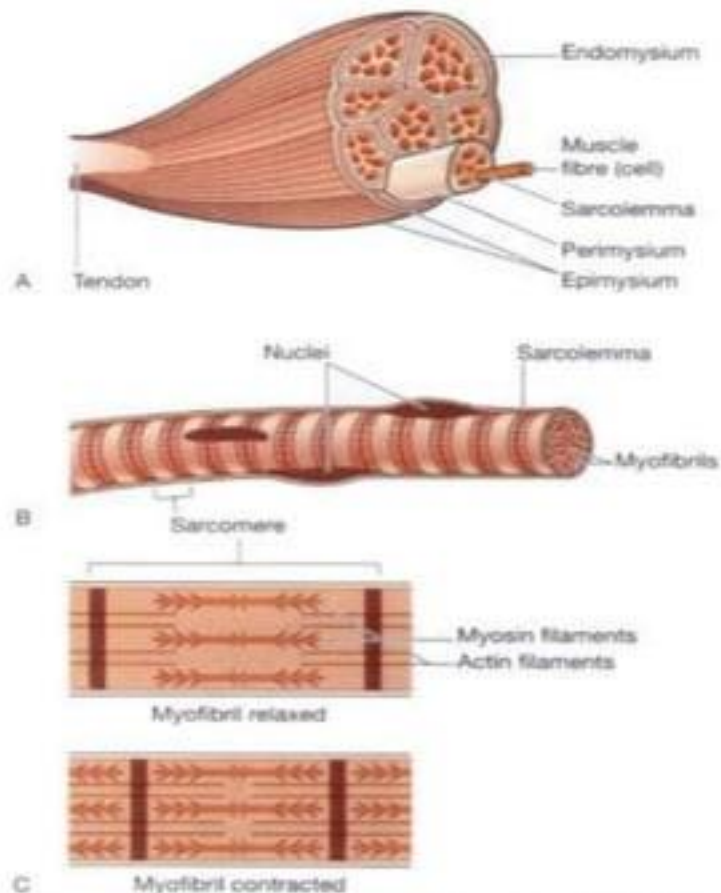
Voluntary
Control

Skeletal muscle tissue

- ▶ Also called as **skeletal, striated, striped or voluntary muscle**.
 - ▶ It is called voluntary because contraction is under conscious control.
 - ▶ Microscopically the cells are found to be roughly **cylindrical in shape** and may be as long as 35 cm.
- 

Structure of skeletal muscle tissue

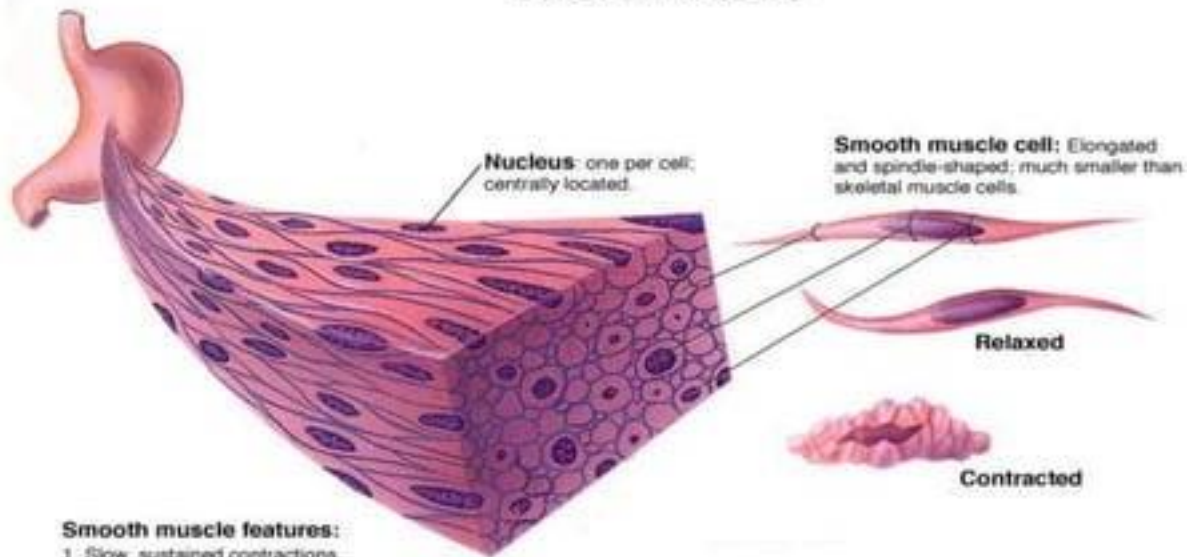
- ▶ Each cell, commonly called a fibre, has several nuclei situated just under the sarcolemma or cell membrane
- ▶ The muscle fibres lie parallel to one another and, when viewed under the microscope, they show well-marked transverse dark and light bands, hence the name striated or striped muscle.



Smooth muscle tissue

- ▶ Smooth muscle may also be described as **non-striated or involuntary**.
- ▶ It is not under conscious control.
- ▶ It is found in the walls of hollow organs:
- ▶ When examined under a microscope, the cells are seen to be **spindle shaped with only one central nucleus**.
- ▶ There is **no distinct sarcolemma** but a very fine membrane surrounds each fiber.

Smooth Muscle



Smooth muscle features:

1. Slow, sustained contractions
 2. Under autonomous (non-voluntary) control.
 3. Contain actin and myosin filaments but lack sarcomeres.
- Prominent locations:
1. Wall of GI tract.
 2. Walls of arteries and veins.
 3. Around glands.

CARDIAC MUSCLE TISSUE

Cardiac muscle tissue

- ▶ Found exclusively in **the wall of the heart**.
- ▶ Cardiac muscle has cross striations formed by rotating segments of thick and thin protein filaments.
- ▶ Each fibre (cell) has a nucleus and one or more branches.

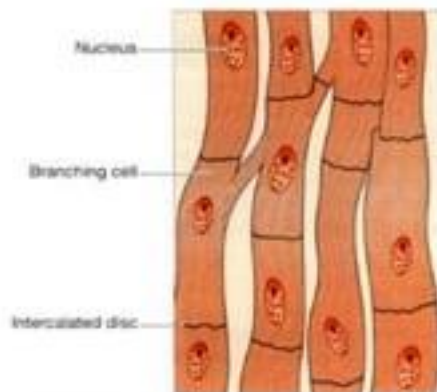





Figure 3.24 Cardiac muscle fibres.

Structure of cardiac muscle tissue

- ▶ Microscopically these 'joints', or **intercalated discs**, can be seen as lines which are thicker and darker than the ordinary cross-stripes.
- ▶ A wave of contraction spreads from cell to cell across the intercalated discs which means that cells do not need to be stimulated individually

COMPARISON OF MUSCULAR TISSUES

| | SMOOTH | CARDIAC | SKELETAL |
|----------------------|--|--|---|
| Location | Wall of hollow organs, vessels, respiratory passageways | Wall of heart | Attached to bones |
| Cell characteristics | Tapered at each end, branching networks, nonstriated | Branching networks; special membranes (intercalated disks) between cells; single nucleus; lightly striated | Long and cylindrical; multinucleated; heavily striated |
| |  |  |  |
| Control Action | Involuntary Produces peristalsis; contracts and relaxes slowly; may sustain contraction | Involuntary Pumps blood out of heart; self-excitatory but influenced by nervous system and hormones | Voluntary Produces movement at joints; stimulated by nervous system; contracts and relaxes rapidly |

Compare muscle tissue

| Skeletal | Cardiac | Smooth |
|---|---------------------------------------|------------------------|
| Striation: striated | somewhat striated | non-striated |
| Cells: straight cylindrical parallel, non-branching | tapered cylinders parallel & branched | spindle shape |
| Nucleus: multi-nuclei, peripheral | mostly uni-nucleus most peripheral | uni-nucleus central |
| Discs: none | intercalated | none |
| Location: attach bones | cardiac wall | hollow organs |
| Control: voluntary | involuntary | involuntary |
| Function: body movement | heart contraction | visceral & circulatory |
| Speed of contraction: fastest | intermediate | slowest |

NERVOUS TISSUE

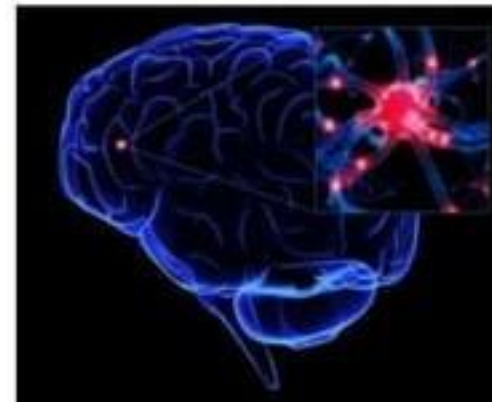
- ▶ These types of tissues are found in nervous system.
- ▶ Types
- ▶ Excitable cells–neurones
- ▶ Non excitable cells– Neuroglia



NERVOUS TISSUE CONTD...

▶ Functions

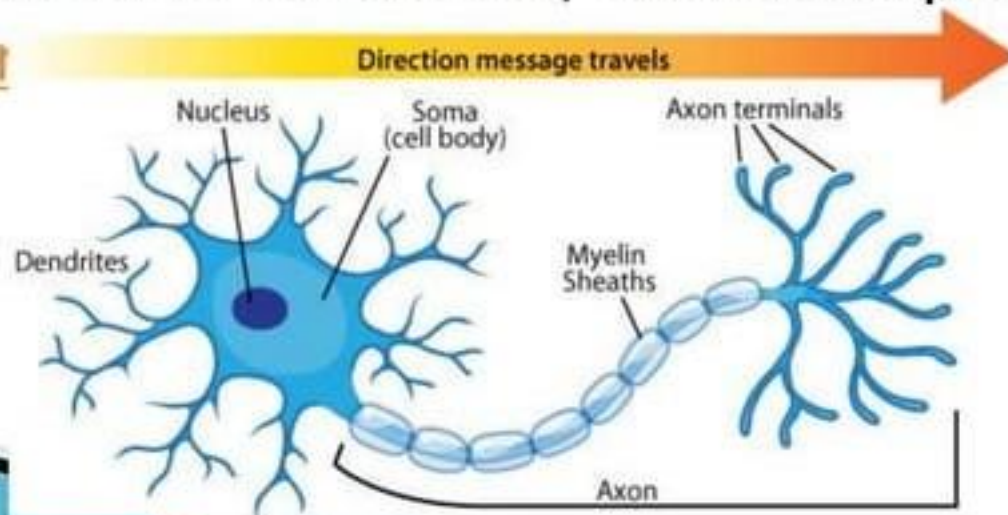
- ▶ Irritability – the capacity to react to various physical and chemical agents.
- ▶ Conductivity– the ability to transmit the resulting reaction from one point to another.



▶ Neuron

- ▶ also known as a **neurone** or **nerve cell**) is an electrically excitable cell that receives, processes, and transmits information through electrical and chemical signals.
- ▶ It is the working unit of nervous system
- ▶ Consists of cell body with cytoplasmic extensions—dendrites, axon and pole

▶ Scier



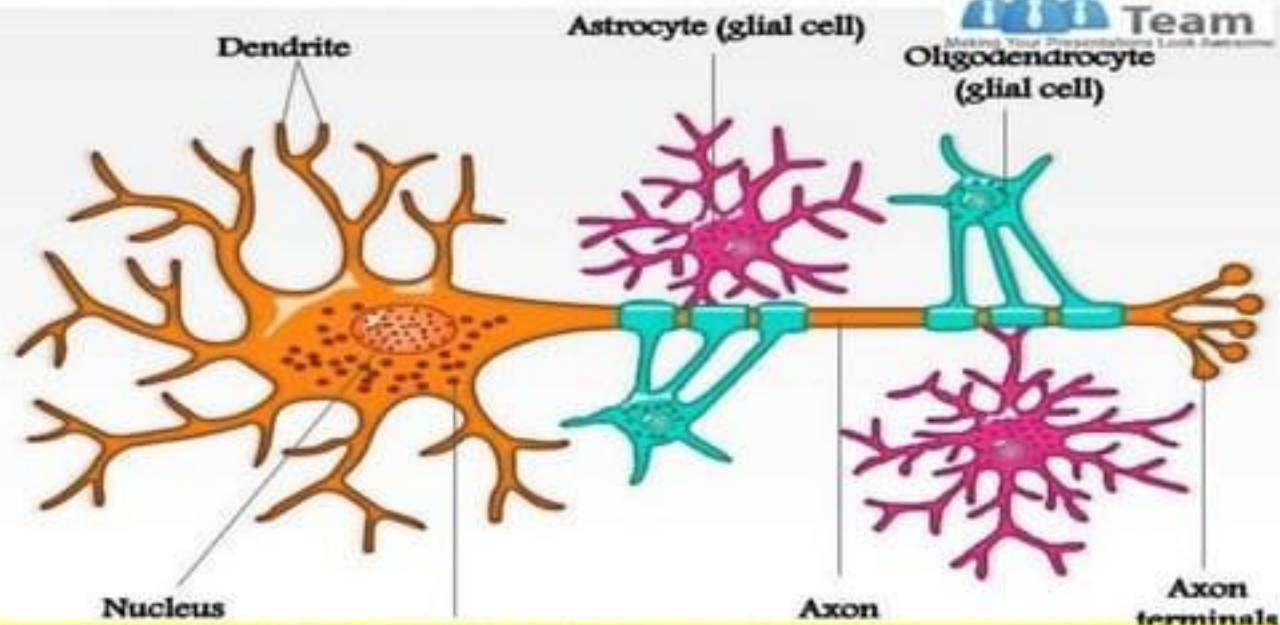
- ▶ Neuroglia
- ▶ Neuroglia form the support structure of nervous tissues, insulating and protecting neurons.
- ▶ They are astrocytes, oligodendrocytes, microglia and ependymal cells.



Neuroglial Cells - Astrocyte




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Tissue regeneration



- ▶ The extent to which regeneration is possible depends on the **normal rate of physiological turnover of particular types of cell**. Those with a rapid turnover regenerate most effectively.
 - ▶ Types :
 - ▶ Labile cells
 - ▶ Stable cells
 - ▶ Permanent cells
- 

- ▶ **Labile cells** : Labile cells are those in which replication is normally a continuous process. They include cells in:
 - ❖ epithelium of e.g. skin, mucous membrane, secretory glands, ducts, uterus lining
 - ❖ **bone marrow**
 - ❖ **blood**
 - ❖ **spleen and lymphoid tissue.**

- ▶ **Stable cells** :Stable cells have retained the ability to replicate but do so infrequently. They include:
 - ▶ liver, kidney and pancreatic cells
 - ▶ fibroblasts
 - ▶ smooth muscle cells
 - ▶ osteoblasts and osteoclasts in bone


- ▶ **Permanent cells:** Permanent cells are unable to replicate after normal growth is complete. They include:
 - ▶ nerve cells (neurones)
 - ▶ skeletal and cardiac muscle
- 

MEMBRANE

MEMBRANE

- ▶ Membranes are sheets of epithelial tissue and their supporting connective tissue that cover or line internal structures or cavities

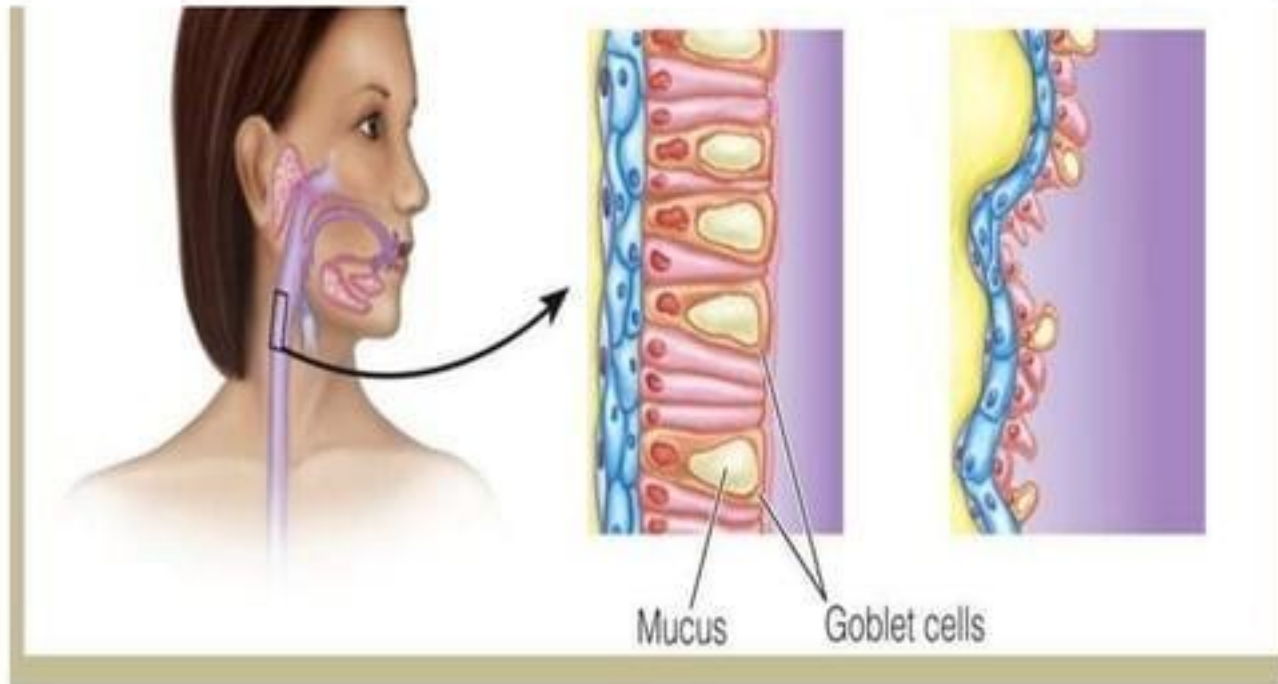
- ▶ The main membranes are:
 - ❖ mucous
 - ❖ serous
 - ❖ synovial
 - ❖ Cutaneous

- ▶ **Mucous membrane**
 - ▶ Moist lining of the alimentary tract, respiratory tract and genitourinary tracts and is sometimes referred to as the mucosa
 - ▶ Membrane consists of epithelial cells, some of which produce a secretion called mucus, a slimy tenacious fluid.
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Mucous mem contd..

- ▶ The cells fill up with mucus they have the appearance of a goblet or flask and are known as goblet cells
- ▶ Organs lined by mucous membrane have a moist slippery surface.
- ▶ Mucus protects the lining membrane from mechanical and chemical injury and in the respiratory tract it traps inhaled foreign particles, preventing them from entering the alveoli of the lungs.


Mucous membrane



Serous membrane

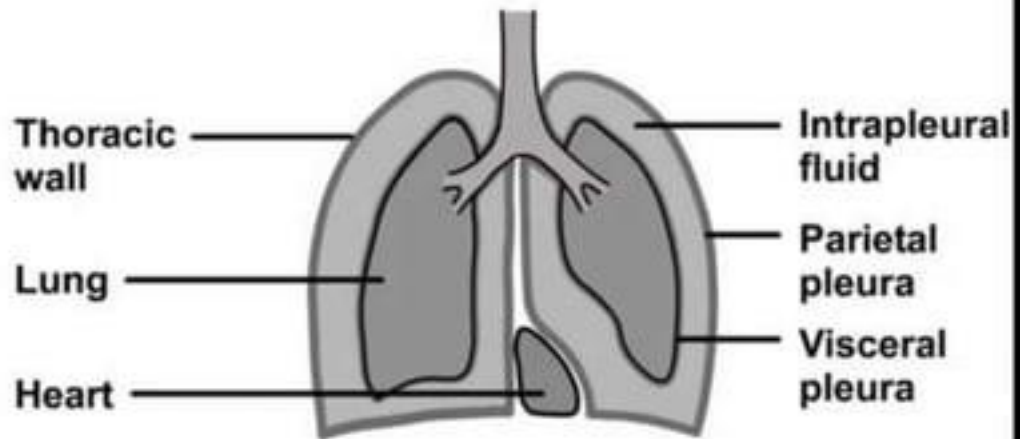
- ▶ Serous membranes, or serosa **secrete serous watery fluid.**
- ▶ They consist of a double layer of loose areolar connective tissue lined by simple squamous epithelium.
- ▶ The **parietal layer lines a cavity** and the **visceral layer surrounds organs** within the cavity.
- ▶ The two layers are separated by serous fluid secreted by the epithelium.

Contd..

- ▶ There are three sites where serous membranes are found
 - ▶ the **pleura** lining the thoracic cavity and surrounding the lungs
 - ▶ the **pericardium** lining the pericardial cavity and surrounding the heart
 - ▶ the **peritoneum** lining the abdominal cavity and surrounding abdominal organs
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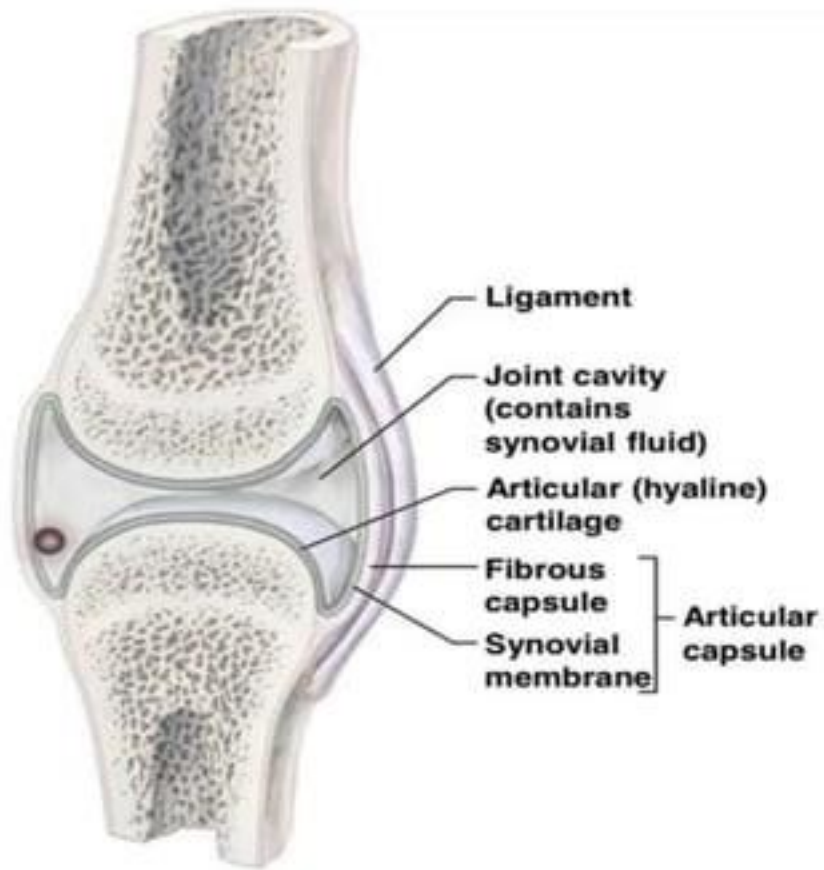
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- ▶ The serous fluid between the visceral and parietal layers enables an organ to glide freely within the cavity without being damaged by friction between it and adjacent organs.
- ▶ For example, the heart changes its shape and size during each beat and friction damage is prevented by the arrangement of pericardium and its serous fluid.

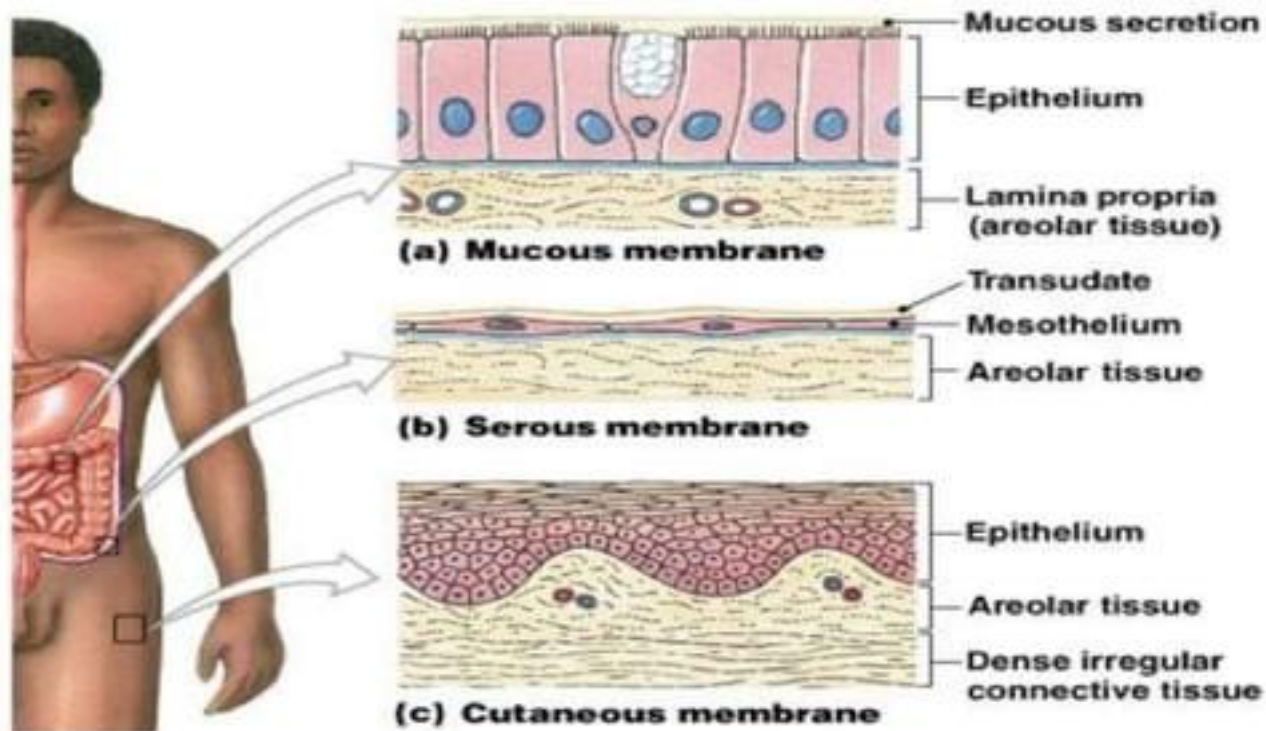


SYNOVIAL MEMBRANE


- ▶ **Synovial membrane:** This membrane is found lining the joint cavities and surrounding tendons, which could be injured by rubbing against bones, e.g. over the wrist joint.
- ▶ Made up of a layer of fine, flattened epithelial cells on a layer of delicate connective tissue.
- ▶ Synovial membrane **secretes clear, sticky, oily synovial fluid**, which acts as a lubricant to the joints and helps to maintain their stability




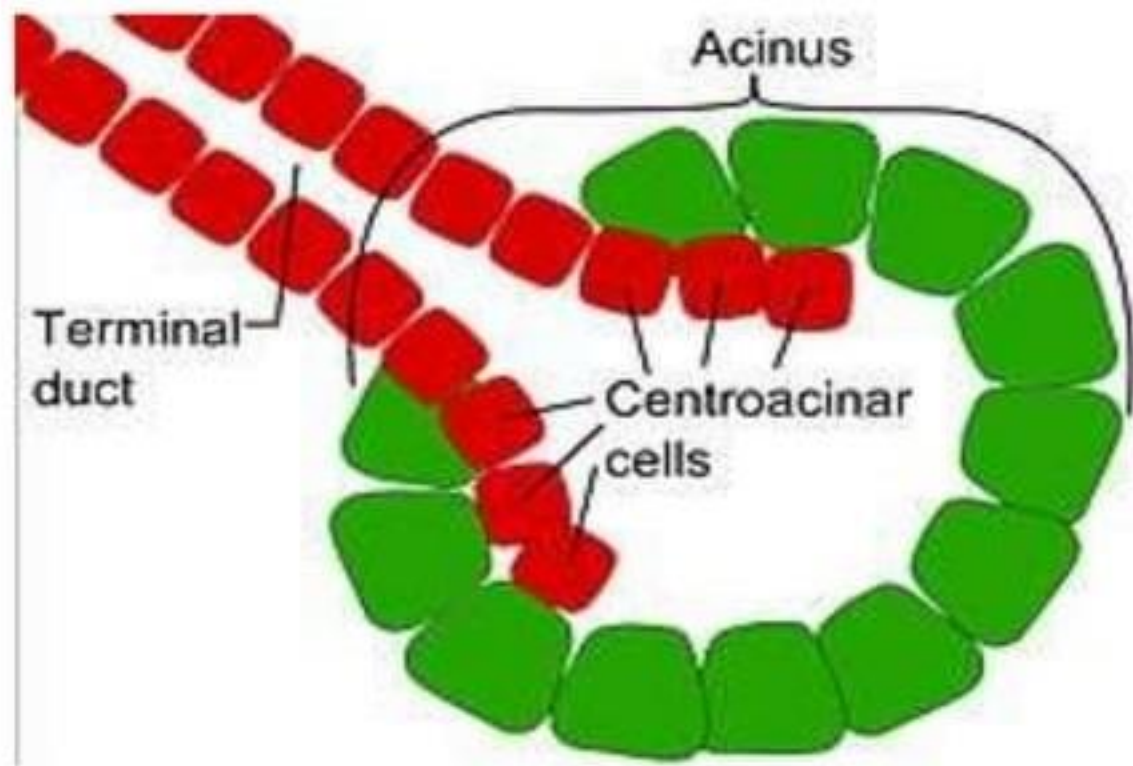
Cutaneous membrane- e.g Skin



GLANDS

- ▶ Glands are groups of epithelial cells which produce specialised secretions.
 - ▶ TYPES OF GLANDS
 - ▶ Exocrine and endocrine gland
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- ▶ **Exocrine glands** are glands that produce and secrete substances onto an epithelial surface **by way of a duct.**
 - ▶ Example: sweat, salivary, mammary, ceruminous, lacrimal, sebaceous, and mucous.
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Exocrine glands vary considerably in size, shape and complexity

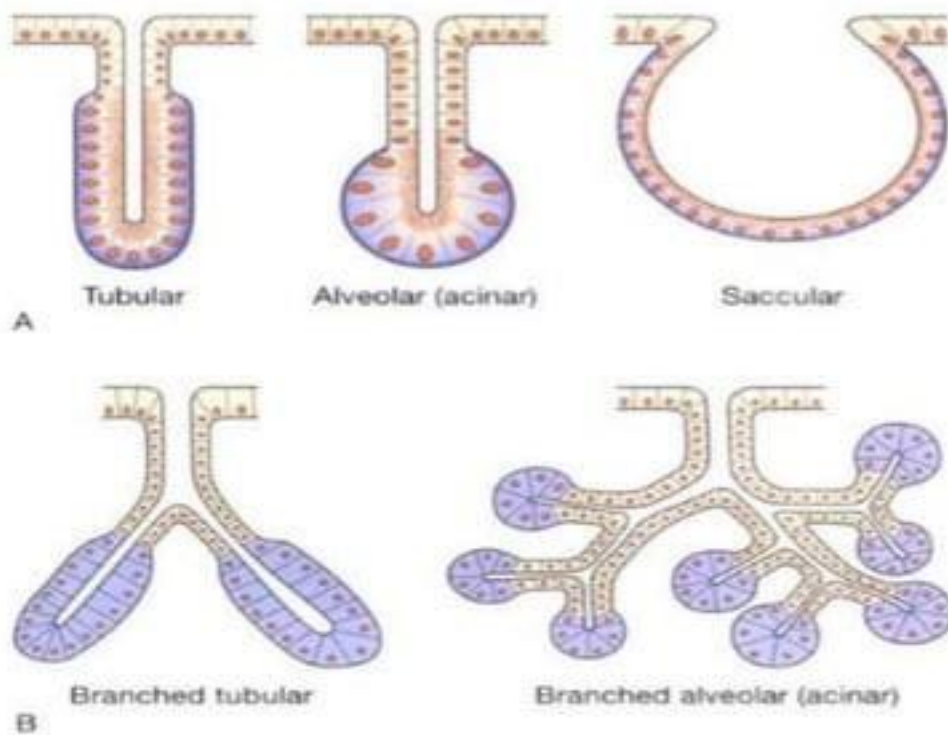


Figure 3.26 Exocrine glands: A. Simple glands. B. Compound (branching) glands.

- ▶ **Endocrine glands(ductless gland)** are glands of the endocrine system that secrete their products, *hormones*, **directly into the blood rather than through a duct.**
- ▶ E.g: the pineal gland, pituitary gland, pancreas, ovaries, testes, thyroid gland, parathyroid gland, hypothalamus and adrenal glands.