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XAVIER INTERNATIONAL COLLEGE

Subject: Biology

2 Science Management Humanities Law

Section ‘B’ Zoology

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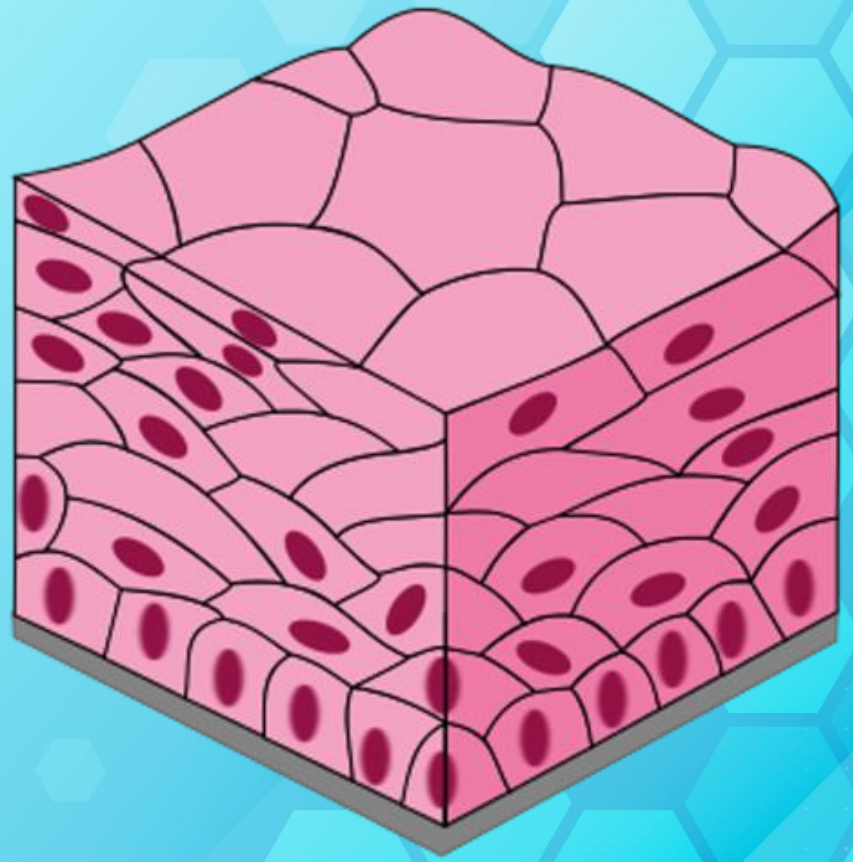
Animal Tissue

Epithelium

Compound/Stratified Epithelium:

- More than two layers of epithelial tissue
- Only the innermost layer of tissue is rest upon basement membrane
- Innermost layer: Germinative layer which is able to divide into other layers of tissues

Compound epithelium



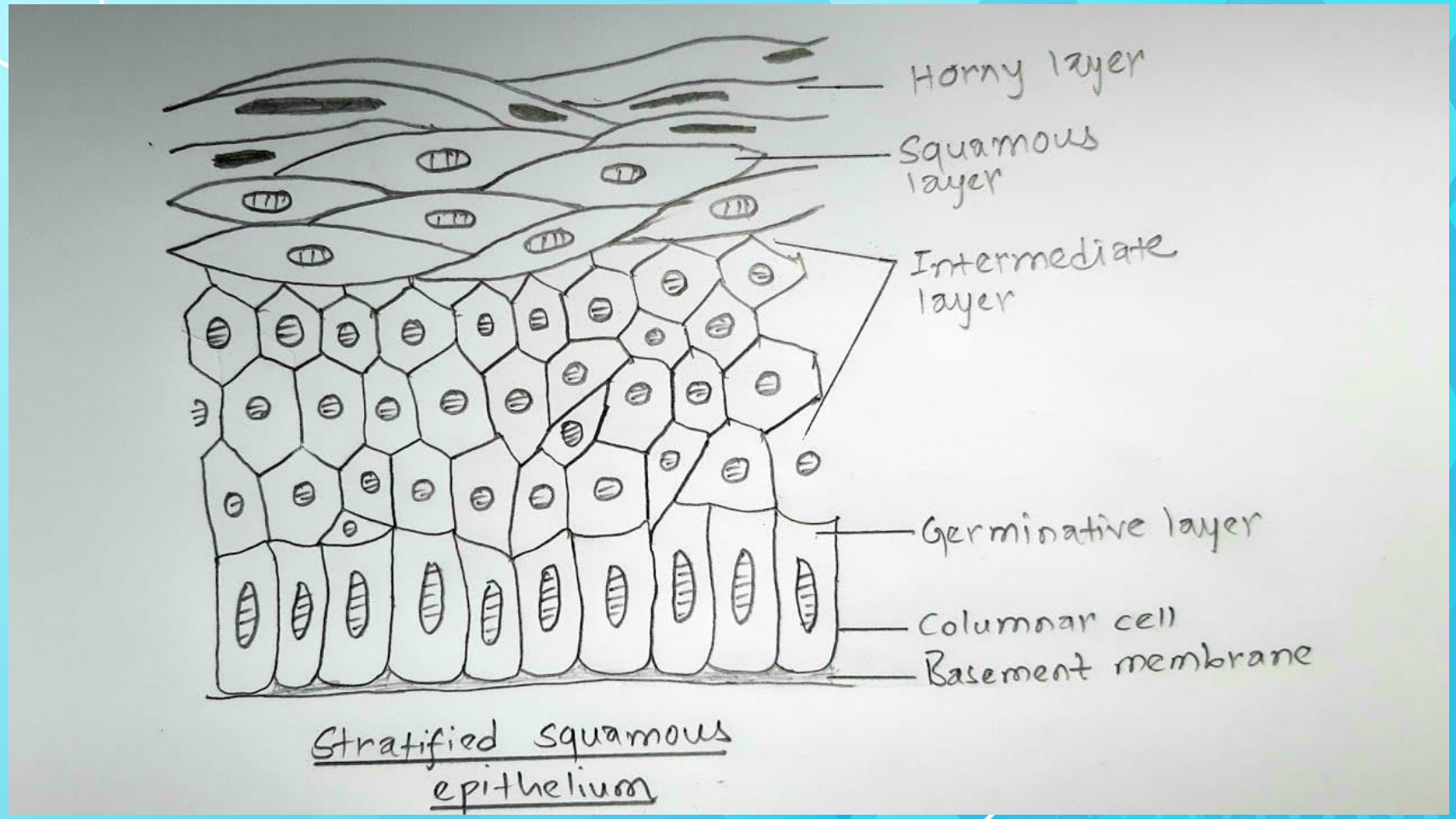
Types of Stratified epithelial tissues

1) Stratified Squamous Epithelium

Upper layers are made of polygonal cells and flat squamous cells

Lower germinative layers may be either cuboidal or columnar cells

Stratified squamous epithelium



Types of Stratified Squamous Epithelium

Upper Squamous cells layer is deposited by thick layer of Keratin protein

Location:				
Nail	Horn	Scales	Epidermis of skin	Hair

Functions

Protection

Impermeable to water

B) Non-keratinized Epithelium

- Absence of keratin protein
- The layer becomes wet

Location:

- Tongue
- Pharynx
- Oesophagus
- Vagina

Functions:

- Protection
- Conduction

2) Stratified Cuboidal Epithelium

Outermost layer or the upper layer is made of cuboidal cells

Lower germinative cells are either columnar or squamous cells

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Stratified cuboidal Epithelium

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Location:

- Duct of sweat gland,salivary gland and pancreatic gland
- Scales of fishes
- Tail of Urodela
- Urodela: tailed amphibians(salamander, Necturus)

Functions:

- Conduction
- Protection

Stratified Columnar Epithelium

Outermost layer consists of columnar cells

Lower layer consists of cuboidal cells

Locations:

- Duct of mammary gland
- In a part of urethra
- Vasa differentia
- Trachea and bronchi

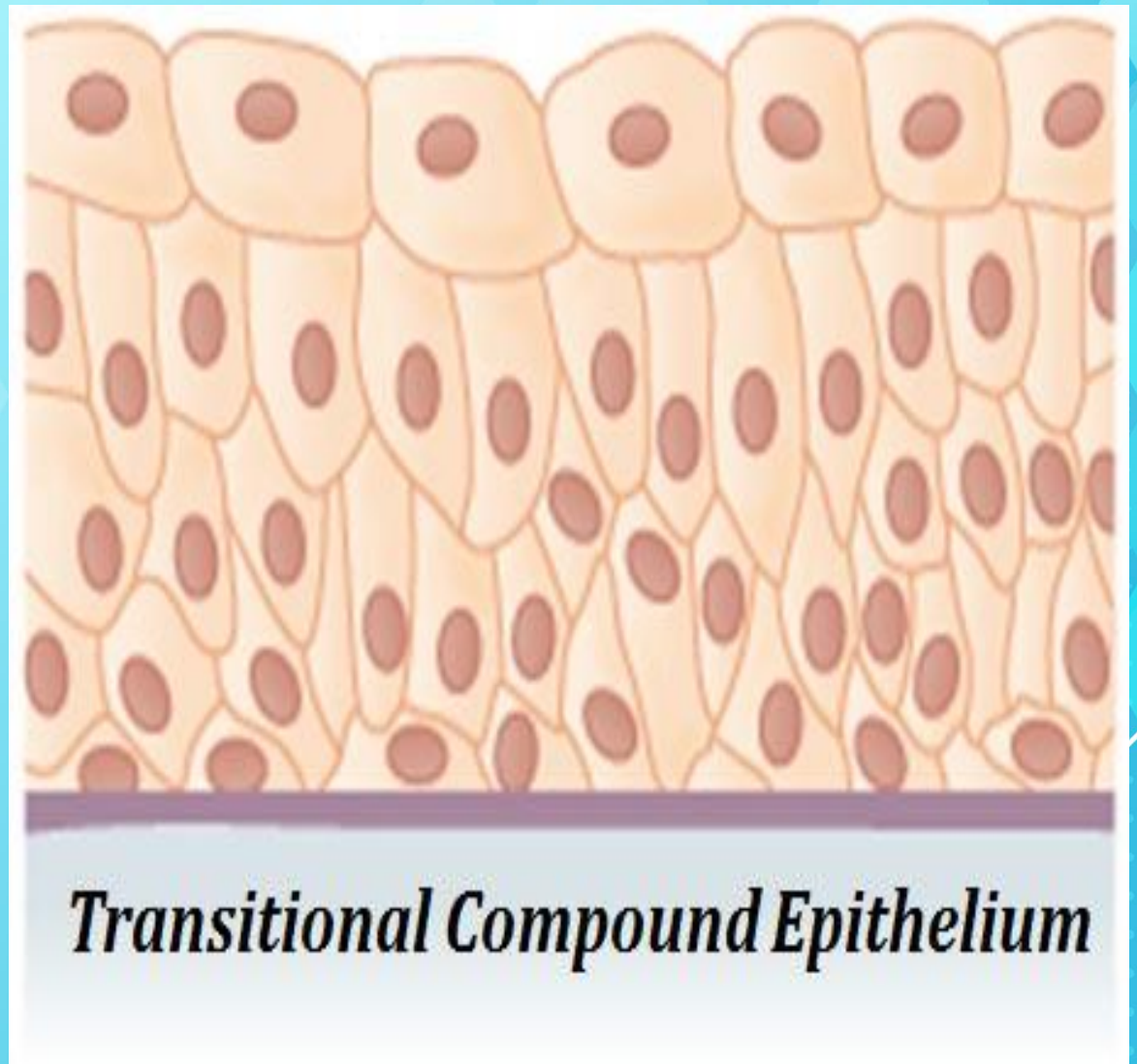
Function:

- Protection
- Conduction

4) Transitional epithelium

- Upper layer is made of polyhedral cells and squamous cell at the topmost layer
- Lower layer or the germinative layer has columnar cells
- Absence of basement membrane. So connected to other kind of tissue or connective tissue
- Also known as Urothelium
- Elastic in nature

Transitional epithelium



Location:

- Renal pelvis
- Ureter
- Urinary Bladder

Functions:

- Conduction
- Storage
- Filtration

Specialized/Modified Epithelium

Ciliated Epithelium: Modified form of columnar or cuboidal cells bearing cilia at the free surface.

Location:

- Oviduct and sperm duct
- Trachea and bronchi

Function:

- Conduction and filtration

Sensory Epithelium

Modified columnar cells where cells are connected to nerve or sensory fibre and are sensitive in nature

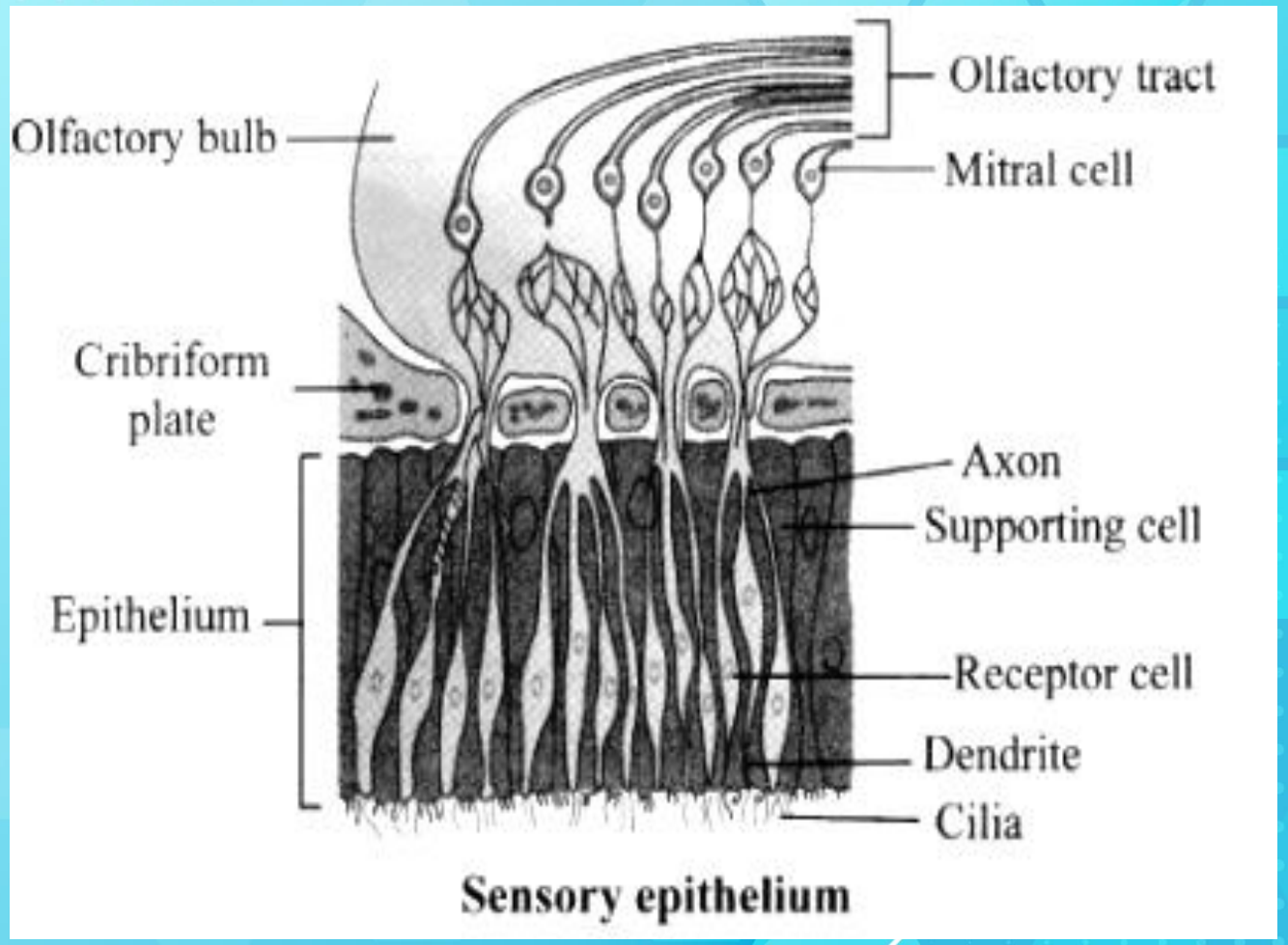
Location:

- Sense Organs
- Organs of corti
- Olfactory chamber
- Taste buds(lining of the tongue)

Function:

- Receive sensitivity

Sensory epithelium



Germinal Epithelium

Modified form of cuboidal cells

Found in the lining of testis and ovary

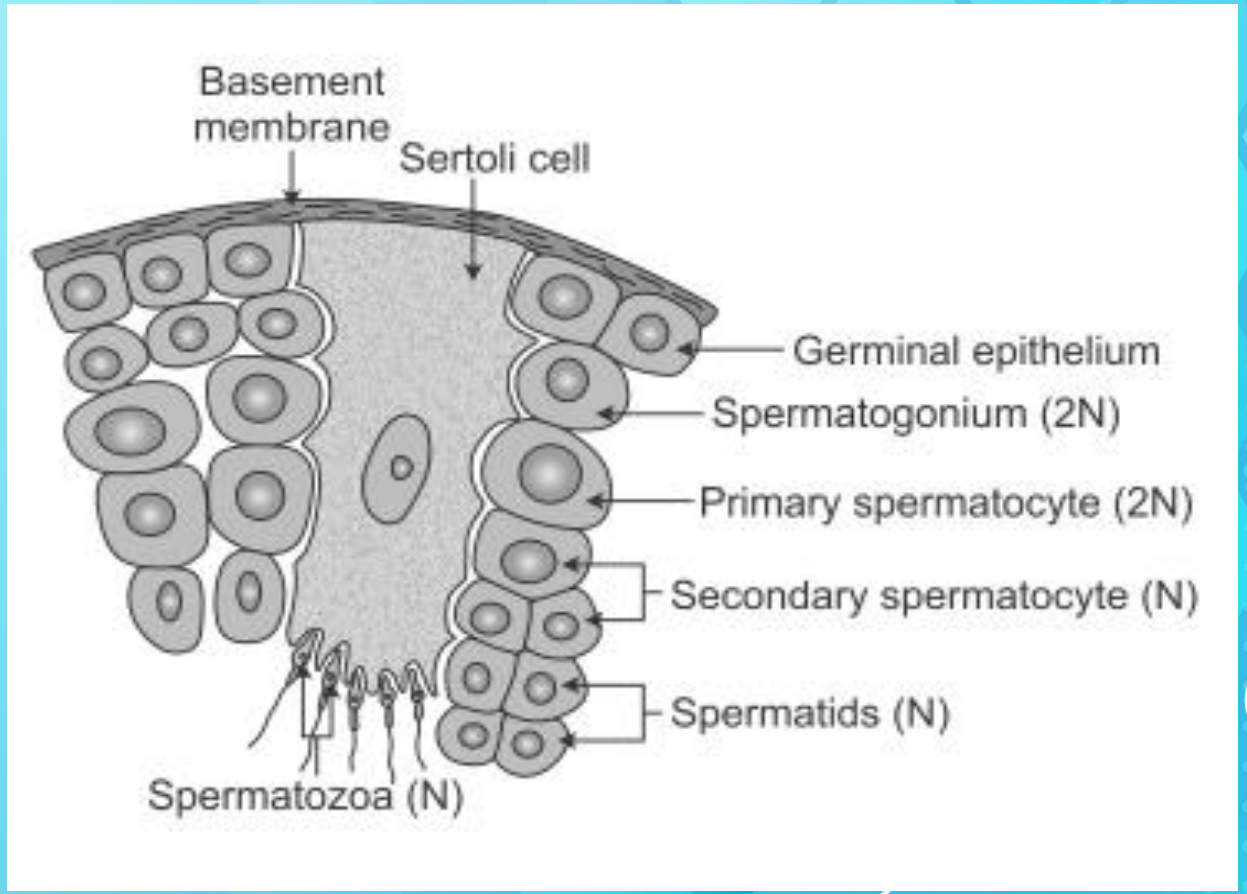
Able to divide and develop into gametes by meiosis

Location:

- Seminiferous tubule of testis and lining of ovary

Function: Gamete formation

Germinal Epithelium



Glandular Epithelium:

- Modified columnar or cuboidal cells specialized for manufacture and secretion of chemical substances
- Forms gland

Types of Glands

- **A) Based on the no. of cells present**
  - Unicellular glands- if only one cell represents a gland and scattered in the columnar cells. Eg: Goblet cells
  - Multicellular glands- if many cells represent a gland. Eg: Sweat gland, thyroid gland, salivary gland

On the basis of presence or absence of duct or the type of secretion

1)**Exocrine gland**: Synthesize and then secrete their product

- Directly(mucous glands)
- Via a Duct
- Secrete enzymes and hydrolases

2)**Endocrine Glands:** Synthesize and the secrete their product directly into the intracellular space(blood)

- Secrete hormones

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Types of exocrine glands

On the basis of presence of no. Of ducts in a gland

A) **Simple gland:** Having only one duct

TYPES

I)**Simple tubular glands:** Having a duct with straight tubular secretory parts.

Eg: Crypts of Lieberkuhn of intestine

II) **Simple branched tubular glands:** Having a duct with branched tubular secretory parts.
Eg: Gastric gland, Brunner's glands of intestine

III) **Simple coiled tubular glands:** Coiled secretory Parts. Eg: Sweat glands

IV) **Simple Alveolar gland:** Having a duct with alveoli like structure or round bottom flask in appearance. Eg: Sweat glands

V) **Simple branched alveolar gland:** having a duct with number of alveoli like secretory parts. Eg: sebaceous gland

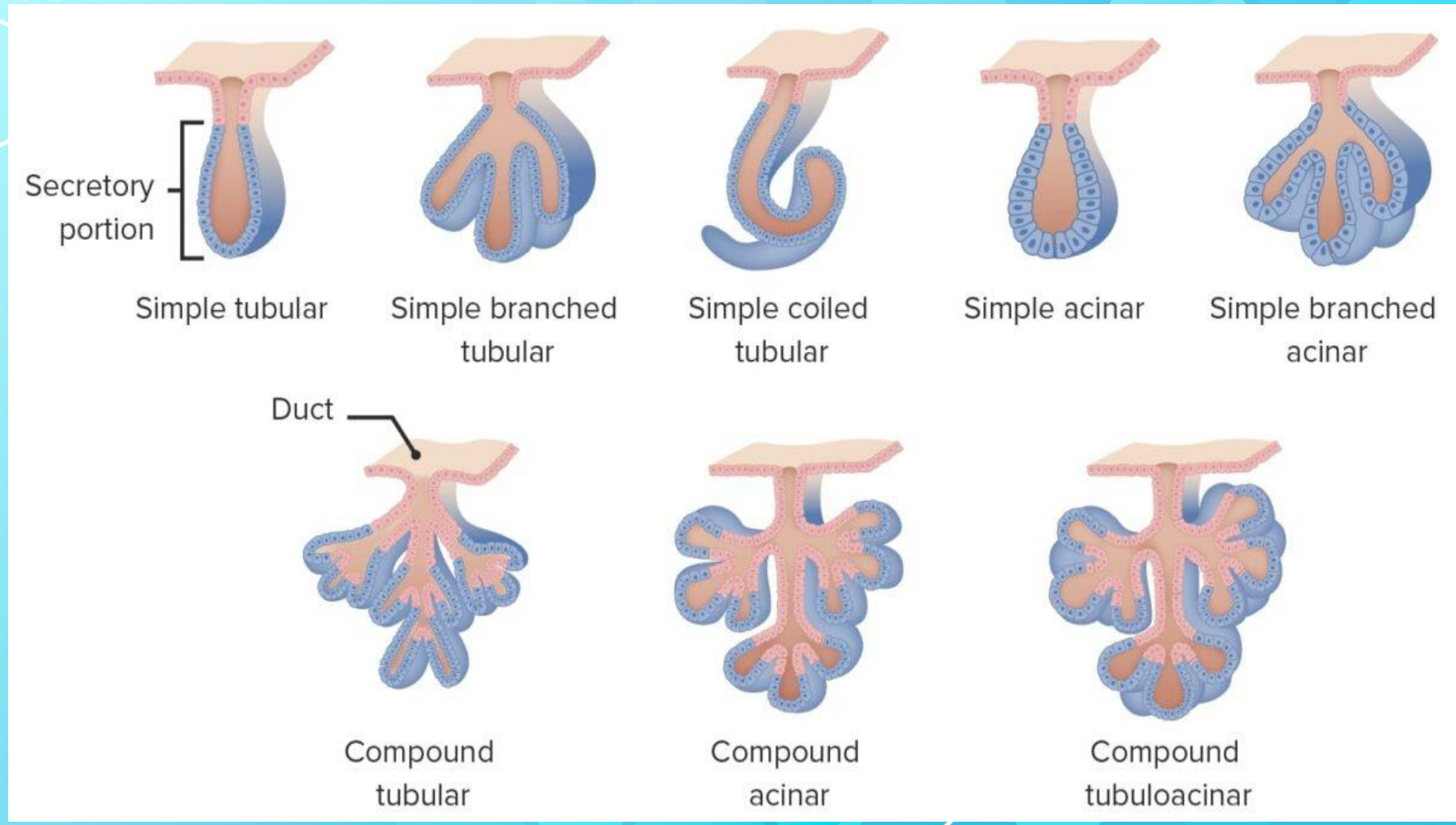
B) Compound glands: Having more than 1 ducts

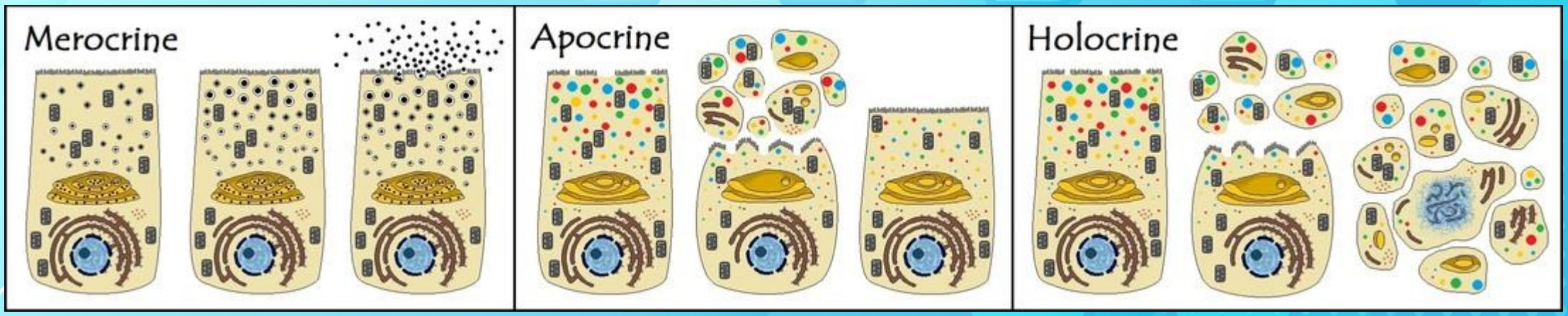
TYPES

I) Compound tubular glands: Salivary glands

II) Compound tubulo-alveolar gland: Cowper's gland, Bartholin's gland

III) Compound alveolar gland: Mammary gland, Pancreatic gland





On the basis of nature of secretion

I) mucous gland:

- Secretes the mucus
- Also khnwn as mucocytes or mucous cells
- Found in goblet cells in the intestine

II) Serous gland:

- Secretes a clear watery fluid
- Termed as serocytes
- Found in intestinal gland, sweat gland, salivary gland

III) Mixed gland:

- Made of both mucocytes and serocytes. So produced both kinds of secretion
- Found in gastric glands, pancreatic gland

Connective tissue

- Group of tissues that maintain the organs and body form of the body and provide cohesion and internal support
- Mesodermal in origin with large intracellular space
- 3 compounds

1) Cells
2) Matrix(ground tissue)- liquid, semisolid or solid
3) Fibers- Thread like made from protein

Cells of Connective tissue

1) Fibroblast and fibrocytes:

-Are large sized, flat and spindle-shaped with long protoplasmic processes

- Large prominent nucleus
- **Osteoblast** & **Chondrioblast** cells to produce bone & cartilage
- Produce protein fibres and secrete matrix

2) Macrophages/Histocytes:

- Are large irregular shaped long-lived cells
- Presence of oval and kidney-shaped nucleus along with granules, endocytic vesicles and abundant lysosomes
- Phagocytic nature- engulfs foreign bodies, damaged cell tissues and microbes

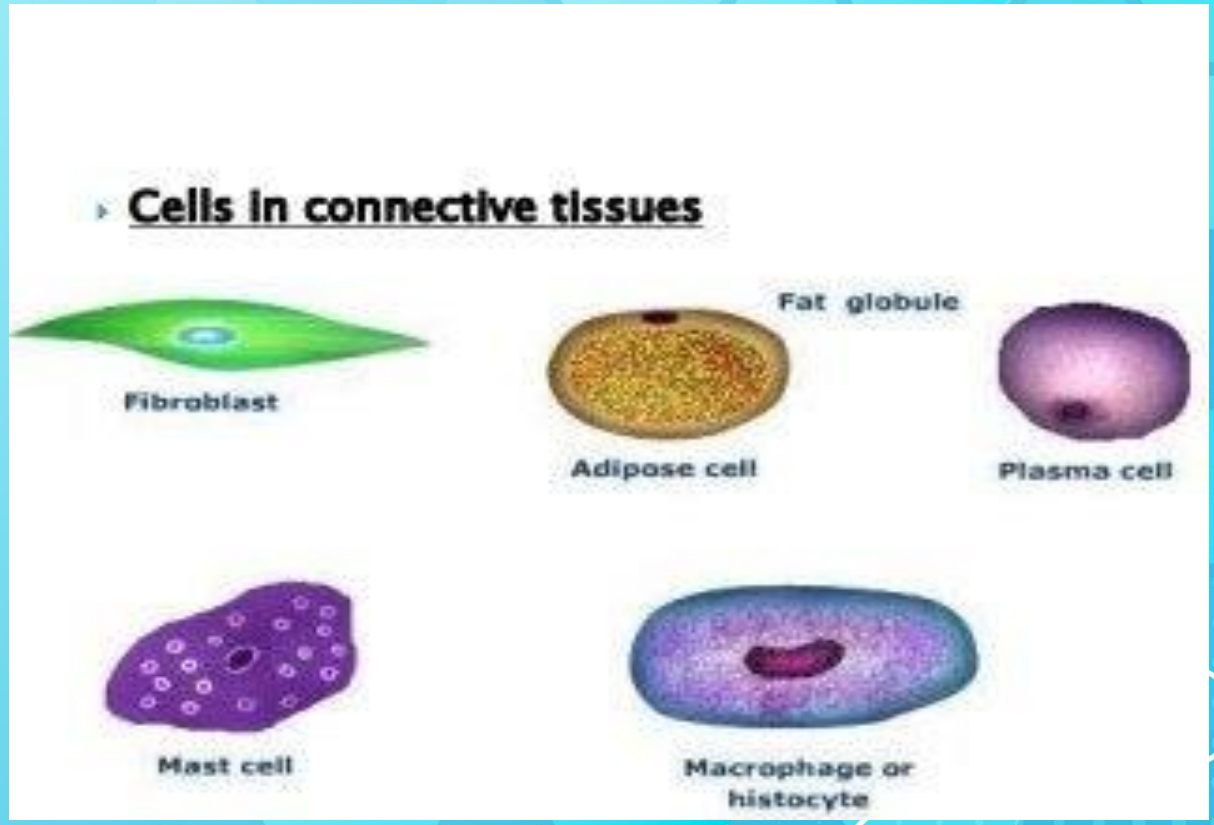
3) Mast cells:

- Oval shaped cells with centrally placed oval nucleus
- Modification of basophils(types of WBC)
- Secrete heparin(checks the clotting of blood into the blood vessels), histamine(cause inflammatory or allergic reaction to antigens) and serotonin(vasoconstrictor)

4) Plasma Cells:

- Small, round or irregular shaped cells with an eccentric round nucleus
- Are modified B-lymphocytes
- Produce antibodies for defense

Other kinds of cells : Adipocytes, lymphocytes, chromatophores, reticular cells and mesenchyme



Matrix

- Non-living, transparent fluid or semisolid intercellular substance
- Contains various organic and inorganic substances

Fibres of Connective tissues

1) White collagen fibres:

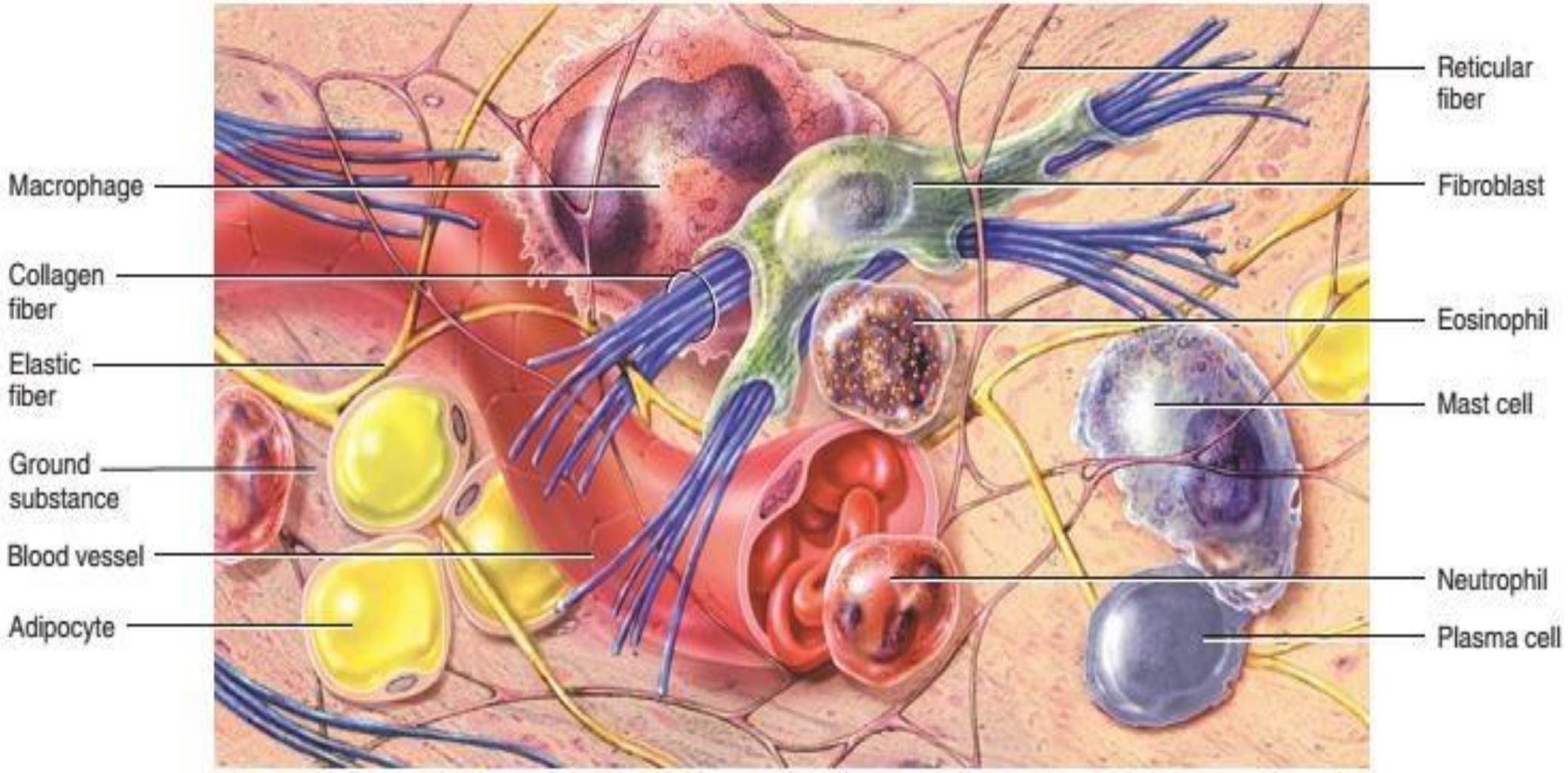
- Long unbranched, inelastic white fibres containing collagen protein
- \Flexible but inelastic
- Provides structural strength and tissue repairment

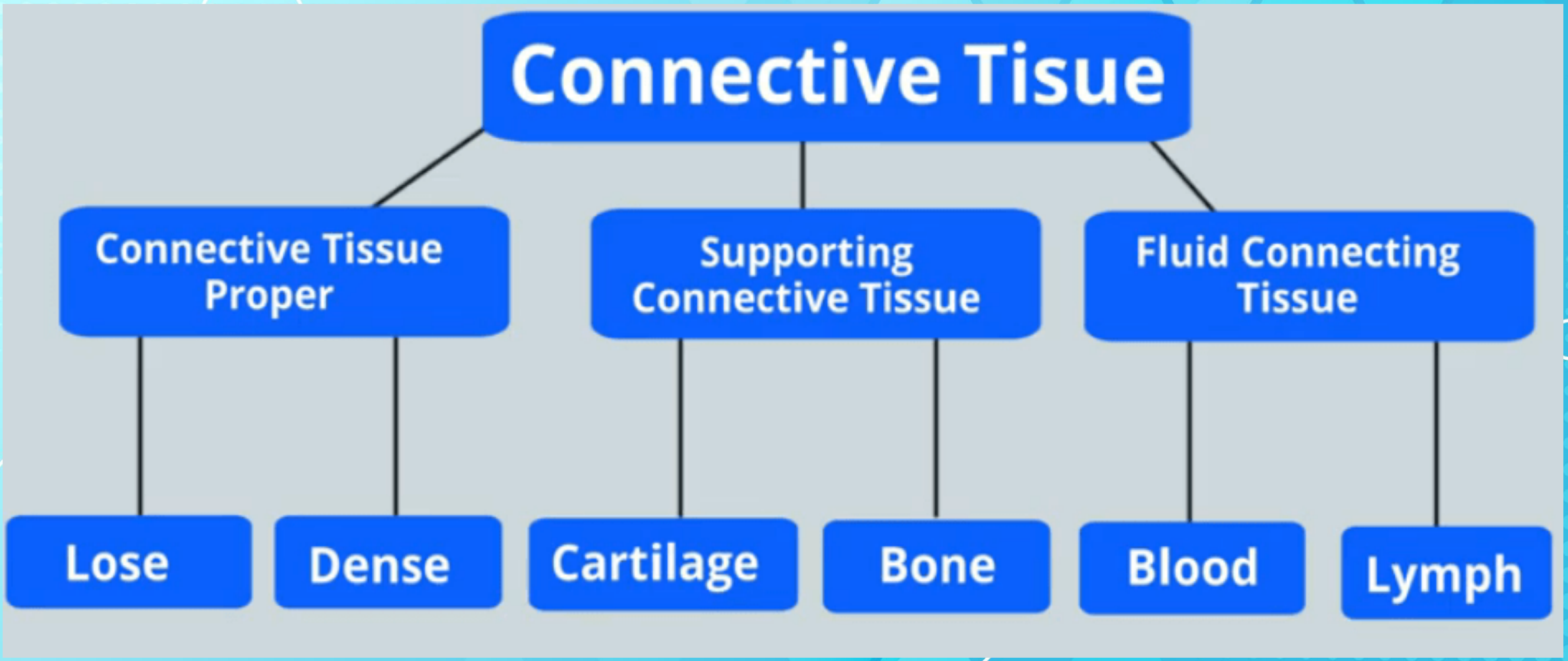
2) Yellow elastic fibres:

- Long branched, elastic and straight fibre found singly
- Formed from elastin protein
- Flexible and elastic

3) Reticular fibres:

- Fine and highly branched fibres forming networks
- Do not form bundles
- Contains reticulin protein
- Form supporting network of spleen, bone marrow and lymph nodes




Connective Tisue
Connective Tissue Proper
Supporting Connective Tissue
Fluid Connecting Tissue
Lose
Dense
Cartilage
Bone
Blood
Lymph

A) Connective Tissue proper

- Connective tissue proper includes those types of connective tissues that exhibit a variable mixture of both connective tissue cell types and extracellular protein fibers suspended within a viscous ground substance.

- connective tissue types differ with respect to their numbers and types of cells and the relative properties and proportions of their fibers and ground substance.

- Its main function is to bind cells and tissues into organ and organ system

Loose connective tissue

- Distributed throughout the body as a binding and packing material
- The protein fibers loosely arranged rather than tightly packed together.
- Contains relatively fewer cells and protein fibers than dense connective tissue but has more ground substance.
- The cells are predominantly fibroblasts, with collagen and elastic fibers dispersed throughout the ground substance
- Occupies the spaces between and around organs.

- It binds the skin to the underlying muscles and is highly vascular, providing nutrients to the skin. Loose connective tissue that binds skin to underlying muscles is known as fascia .
- Surrounds blood vessels and nerves, where it provides both protection and nourishment.
- The irregular arrangement of this tissue provides flexibility, yet strength, in any direction

- There are two types of loose connective tissue:
  - areolar connective tissue
  - adipose connective tissue

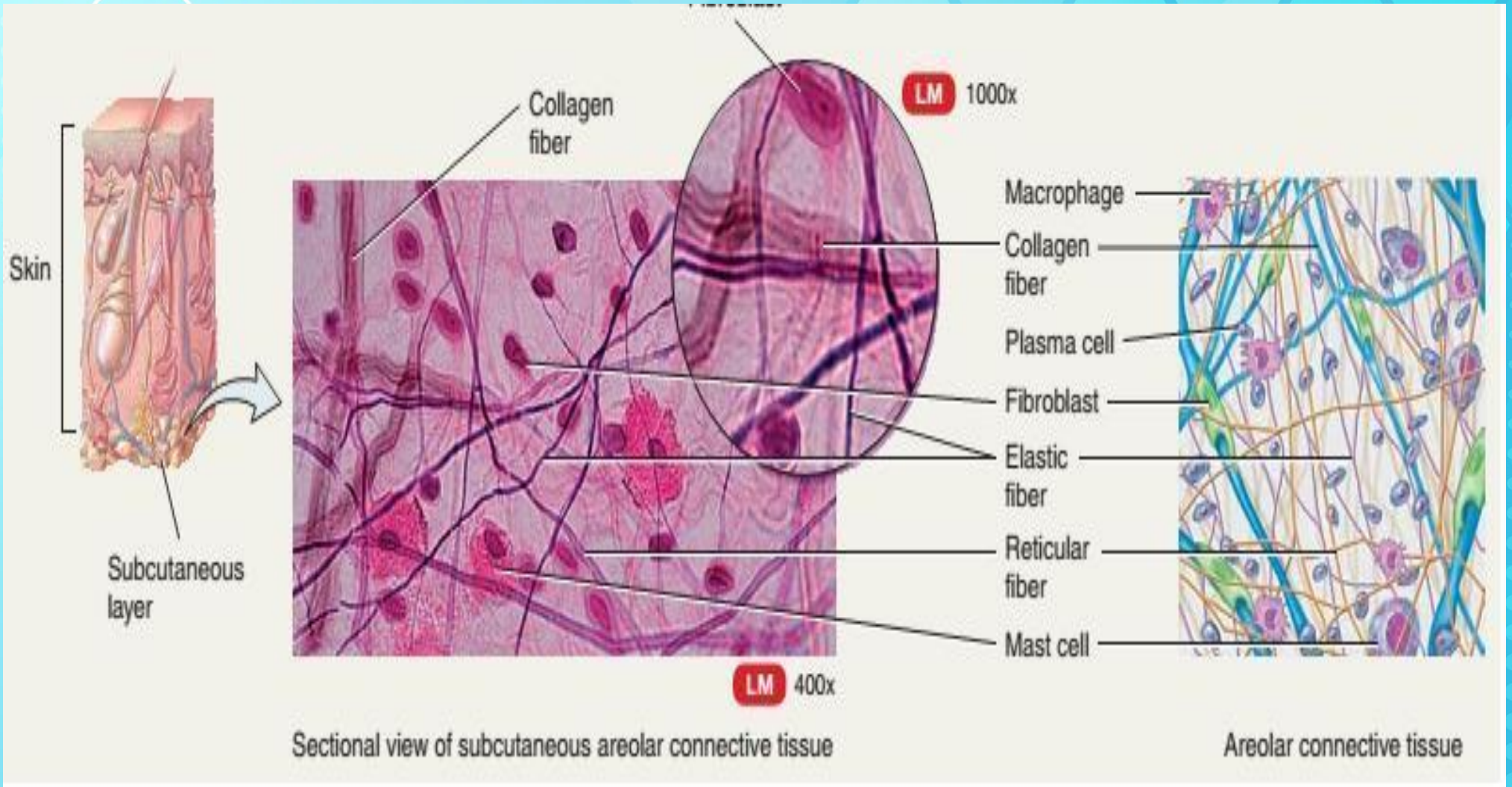
Areolar connective tissue

- Areolar connective tissue is highly variable in appearance and most widely distributed tissue in the body.
- It has a loosely organized array of collagen and elastic fibers and an abundant distribution of blood vessels.
- consists of
  - fibers (collagen, elastic) arranged randomly
  - several kinds of cells (fibroblasts, macrophages, plasma cells, mast cell)
  - semifluid ground substance (hyaluronic acid, chondroitin sulfate, dermatan sulfate, and keratan sulfate).
- irregular arrangement of bundle of collagen fibres due to which many gaps are present. These spaces called **Areolae.**

- The elastic fibers ensure independent movement.

LOCATION: Present everywhere in body including subcutaneous layer deep to skin, superficial region of dermis of skin, mucous membranes, around blood vessels, nerves, and body organs.

FUNCTION: strength, elasticity, support, protection, enhance natural immunity



Sectional view of subcutaneous areolar connective tissue

Areolar connective tissue

2. Areolar connective tissue is often considered the prototype of connective tissue proper because of its variety of cell types and fibers. Figure 4.3 shows most of these elements. Identify all structures or cell types provided with leader lines. Color the diagram as your fancy strikes you.

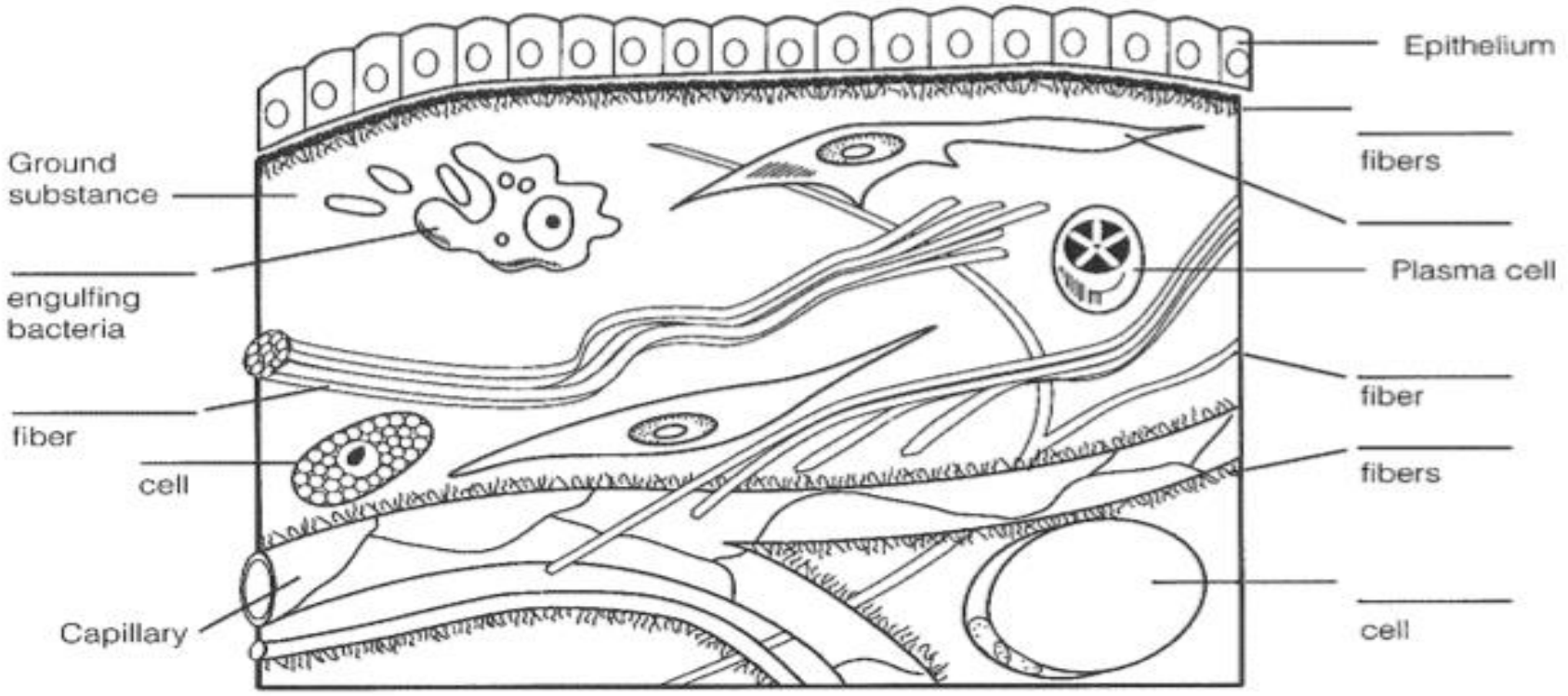


Figure 4.3

Adipose connective tissue (fat laden tissue)

- Made up of adipocytes that are specialized for storage of triglycerides (fats) as a large, centrally located droplet.
- Blood vascular system is also present in this tissue.
- Cell fills up with a single or multiple large triglyceride droplet, and cytoplasm and nucleus are pushed to periphery of cell.
- It has two types: **White adipose tissue-** composed of single large triglyceride droplet present in adults and has less blood supply

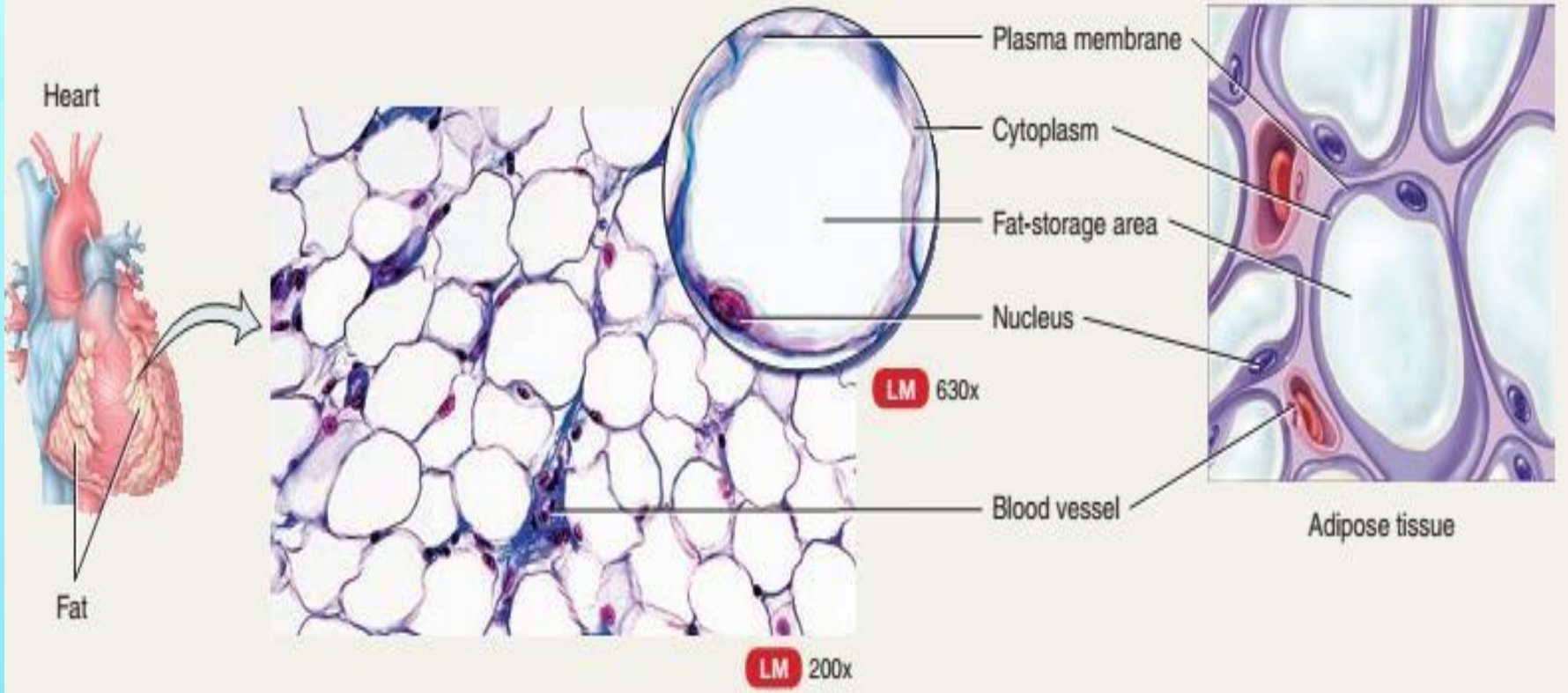
Brown adipose tissue-composed of more than one or multiple no of triglyceride droplets present in infants and hibernating animals and have extensive blood supply.

LOCATION: Around visceral organs, subcutaneous layer, blubbers(a layer of fat present under the skin of aquatic animals),hump of camel,

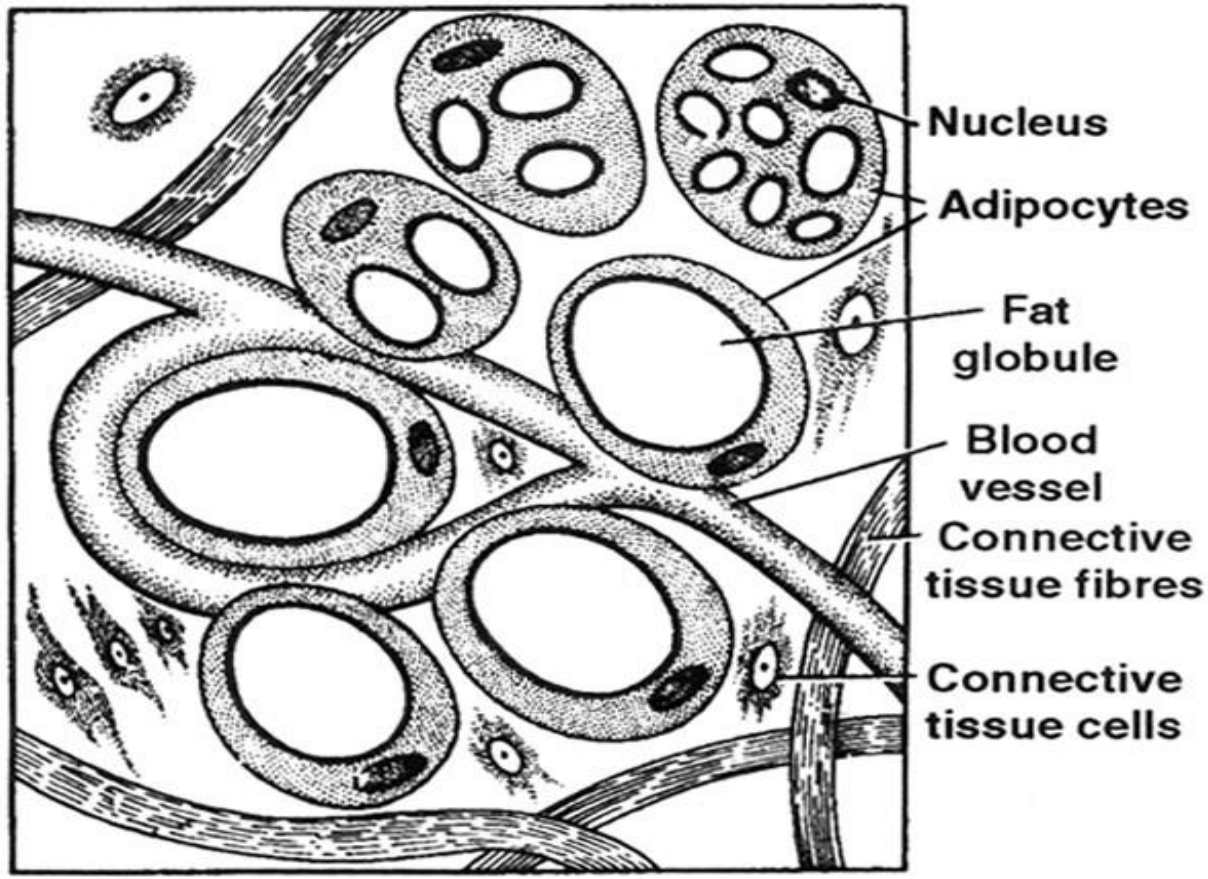
FUNCTION: primary function: synthesize storage and utilization of fats

- Reduces heat loss through skin,
- serves as an energy reserve,
- supports and protects organs.
- In newborns, BAT generates heat to maintain proper body temperature.

body temperature.



Sectional view of adipose tissue showing adipocytes of white fat and details of an adipocyte



Adipose connective tissue

Dense connective tissue

- **Dense connective tissue** consists of densely packed fibers with relatively little space between the fibers.

- Has proportionately high **protein fiber** than ground substance.

Further divided into two categories:

A) White fibrous tissue

B) Yellow fibrous tissue

C) reticular connective tissue

A)White fibrous tissue(tendons)

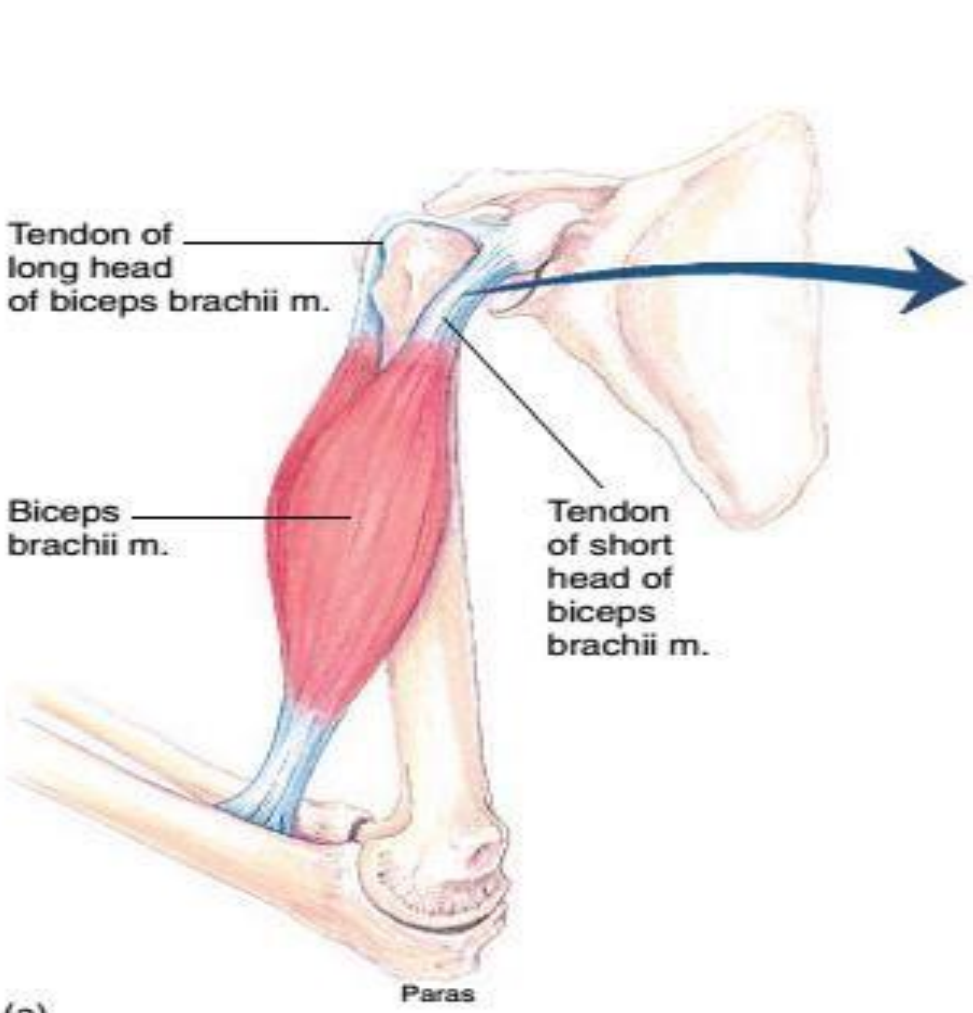
- Has densely packed white collagen fibers in the extracellular matrix and Modified form of areolar tissue
- Occurs where strong, flexible support is needed
- Has few blood vessels which is reason behind its slow healing properties.
- Matrix contains fibroblast cells only cells present and lie in rows between the bundle of white fibres

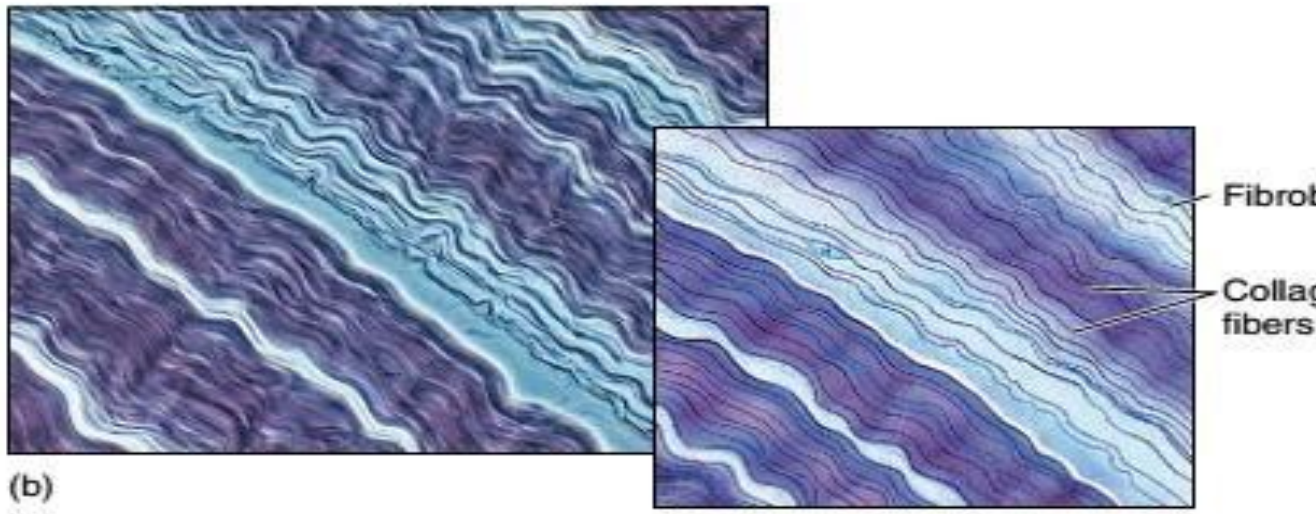
- **F**orm tendons which are parallel running fibres with cord-like structures that helps to connect the skeletal muscles to the bones

LOCATION:

- Pericardium of heart
- Dura mater
- Perichondrium
- Capsule of kidney
- Testes and spleen
- Coverings of cartilage and bone

FUNCTION: Mechanical support against stretch


Tendon of long head of biceps brachii m.
Biceps brachii m.
Tendon of short head of biceps brachii m.
(a)


(b)
Fibrob
Collag fibers
(c)

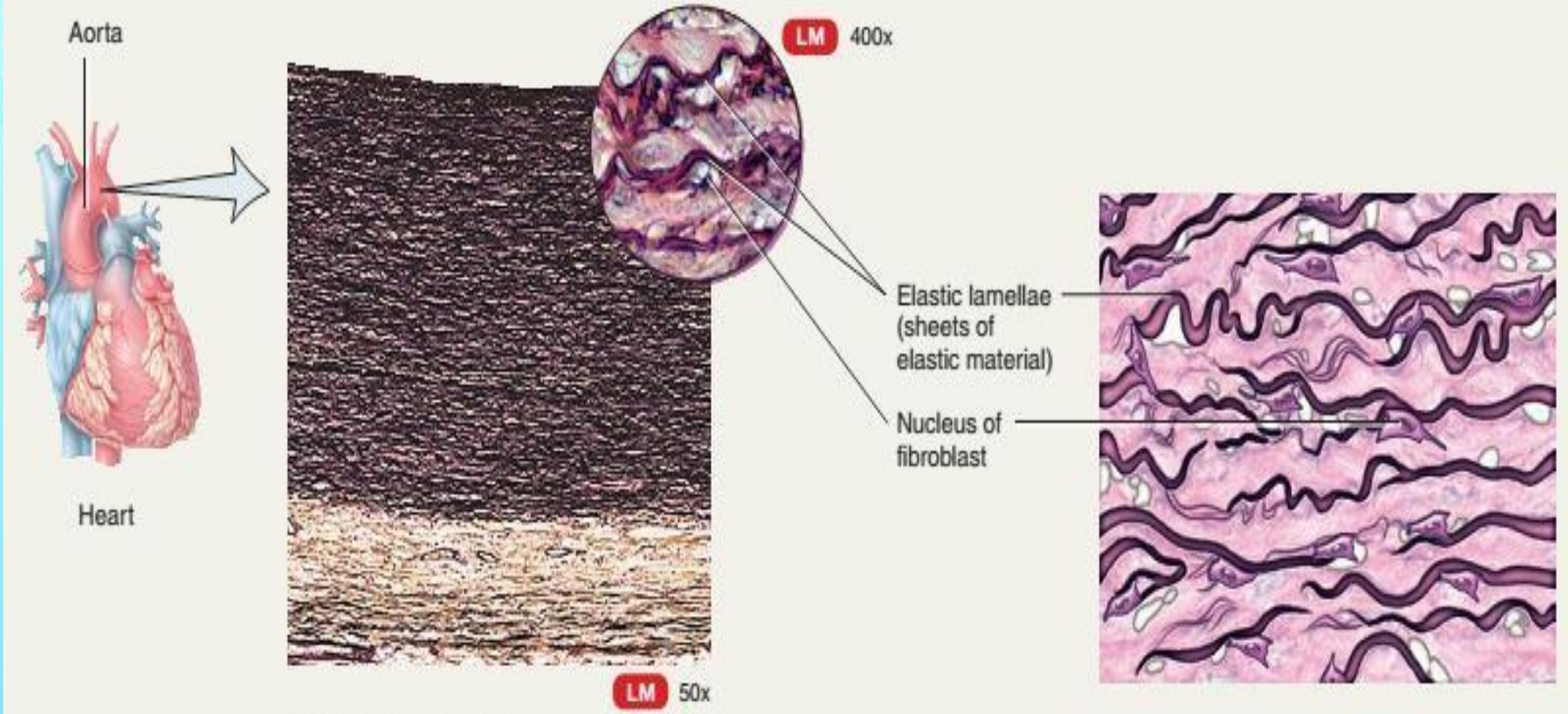
B) Yellow elastic tissue(ligament)

- Elastic connective tissue is composed primarily of elastic fibers and yellowish in color .
- They can be stretched to one and a half times their original lengths and will snap back to their former size.
- Has sparse ground substance. The elastic fiber is packed in parallel bundles

LOCATION:

- in the walls of large arteries
- in the vocal cords
- trachea and bronchial tubes of the lungs.

FUNCTION: Provides stretch and elasticity

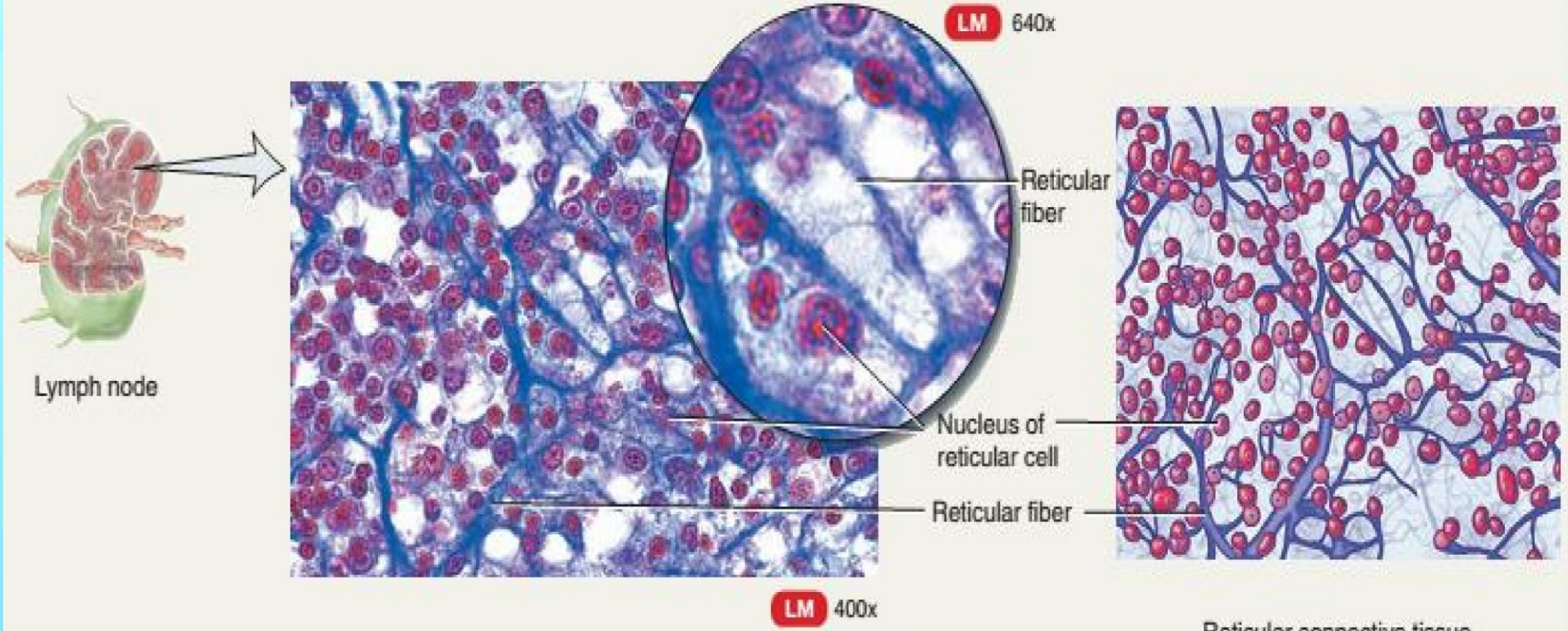


Sectional view of elastic connective tissue of aorta

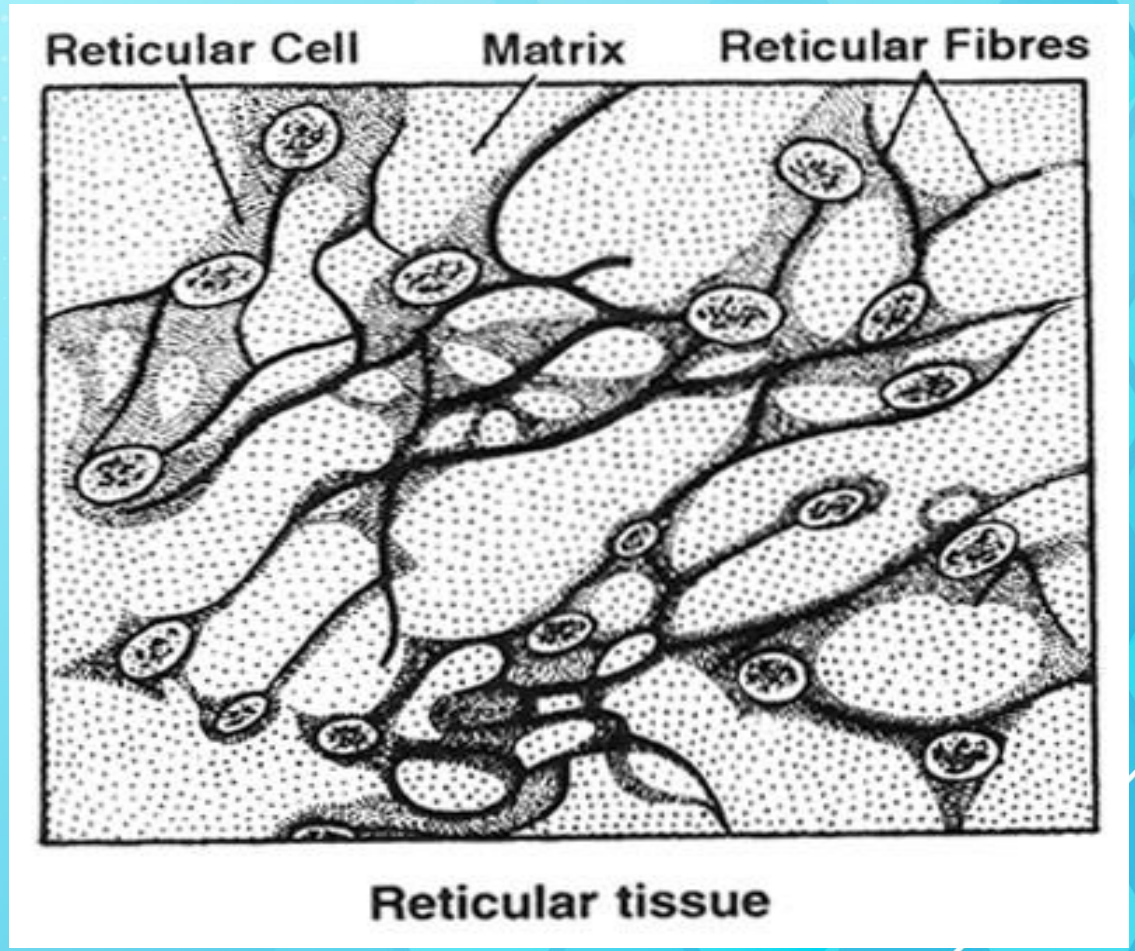
Elastic connective tissue

Reticular connective tissue

- Reticular connective tissue contains a meshwork of reticular fibers, on which fibroblast and leukocytes are suspended.
- Has very little ground substance.
- LOCATION: hematopoietic system; spleen, lymph nodes, bone marrow
- **FUNCTIONS:** filters and removes worn-out blood cells in spleen and microbes in lymph nodes



Sectional view of reticular connective tissue of a lymph node



Reticular tissue

Supporting connective tissue

CARTILAGE

- Outer most covering of cartilage is called **Perichondrium** which is composed of white fibres connective tissue.
- Cartilage producing cells are arranged on periphery known as **Chondrioblast.**
- These are active cell & divide to form chondriocytes, and synthesize the matrix of cartilage.
- Mature cells of cartilage are called **Chondriocytes.**
- They are found in vacuole like space in matrix called Lacuna. In which 2-3 Chondrocytes are present.
- Maxtrix of cartilage is called **Chondrin** composed of Chondromucoprotein having Chondroitin-6sulphate and Mucopolysaccharide (Hyaluronic acid)
- Matrix of cartilage provides rigidity & elasticity to cartilage.
- Blood circulation is absent in the matrix. Hence, heals slowly after trauma and injury.

- The collagen fibers give it strength.
- Makes most of the embryonic skeleton and gradually replaced by bones during embryonic development and after birth

- There are four types of cartilage:
  - Hyaline cartilage.
  - Elastic cartilage
  - Fibrocartilage
  - Calcified cartilage

Hyaline cartilage

- Matrix is semi-transparent in nature. So named for its clear, glassy microscopic appearance, which contains usually invisible fine collagen fibers
- Most abundant type of cartilage found in the body and flexible

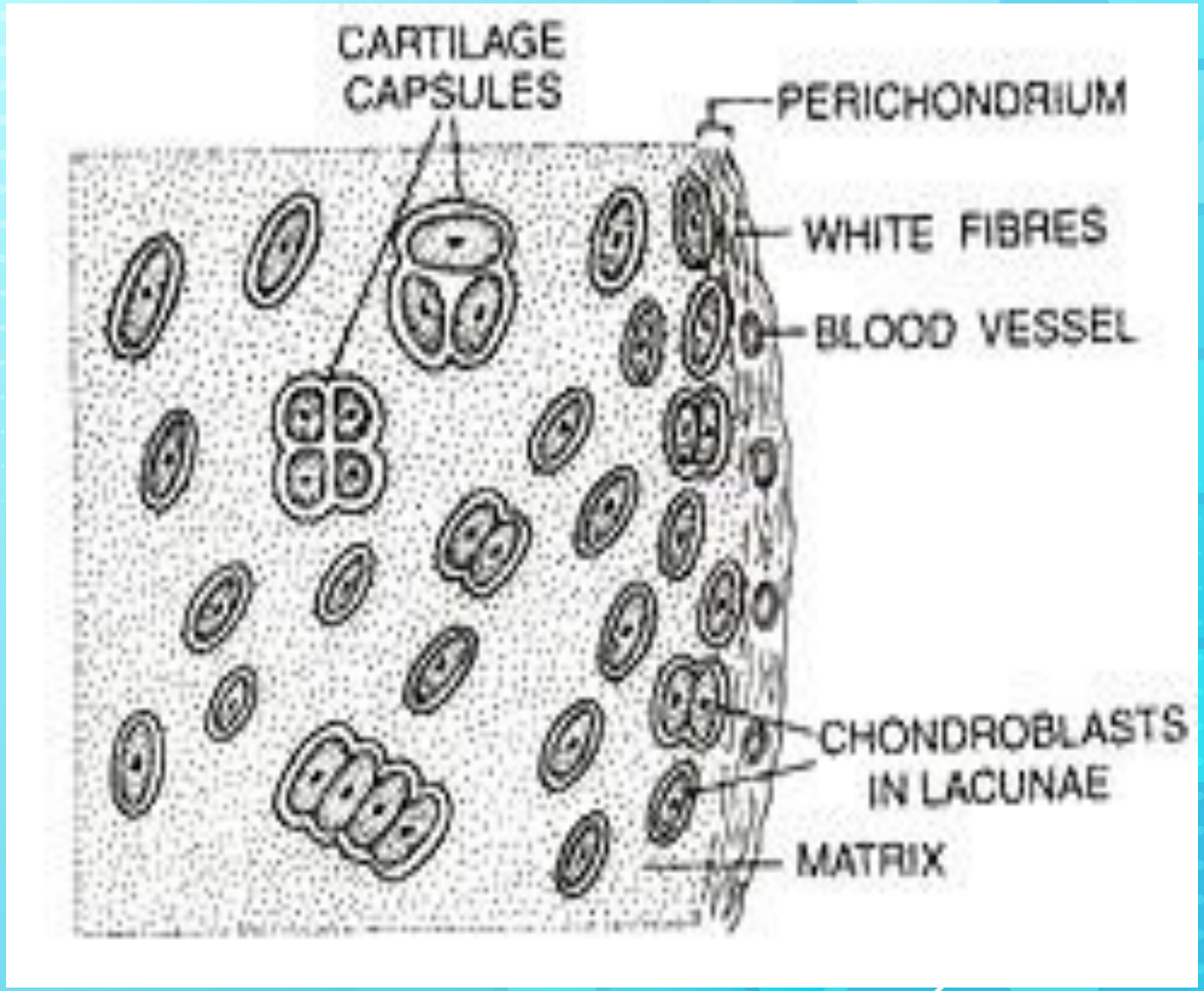
- Most of the part of embryonic skeleton is composed of this cartilage. Therefore, maximum bones of body are cartilaginous bones because they are developed from cartilage.

- Outermost covering **Perichondrium** is present.

LOCATION: Tracheal rings, Embryonic skeleton, end of ribs and nose, larynx

FUNCTION:

- Allows the growth of long bones
- provides rigidity with some flexibility in the trachea, bronchi, ribs, and nose;
- forms the embryonic skeleton



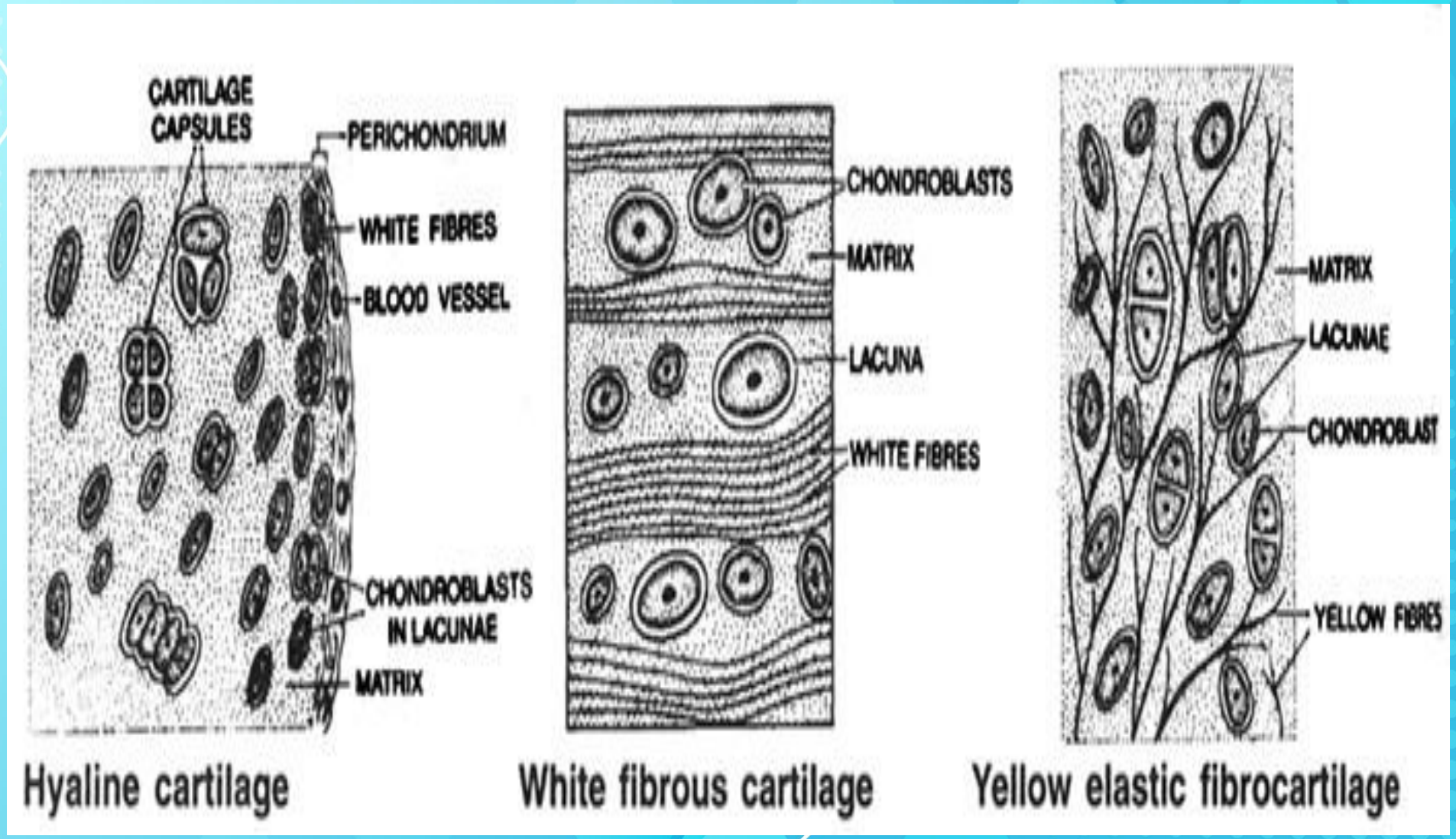
Elastic Cartilage

- Chondrocytes embedded in extracellular matrix which contain elastic fibers
- **Perichondrium** is present
- In the matrix yellow fibres form network so it is highly flexible cartilage of body
- Colour of matrix is pale yellow

LOCATION: Pinna, external auditory canal of ear, epiglottis, eustachian tubes and tip of nose

FUNCTION:

- Provides rigidity with even more flexibility than hyaline cartilage
- maintains shape of certain structures.



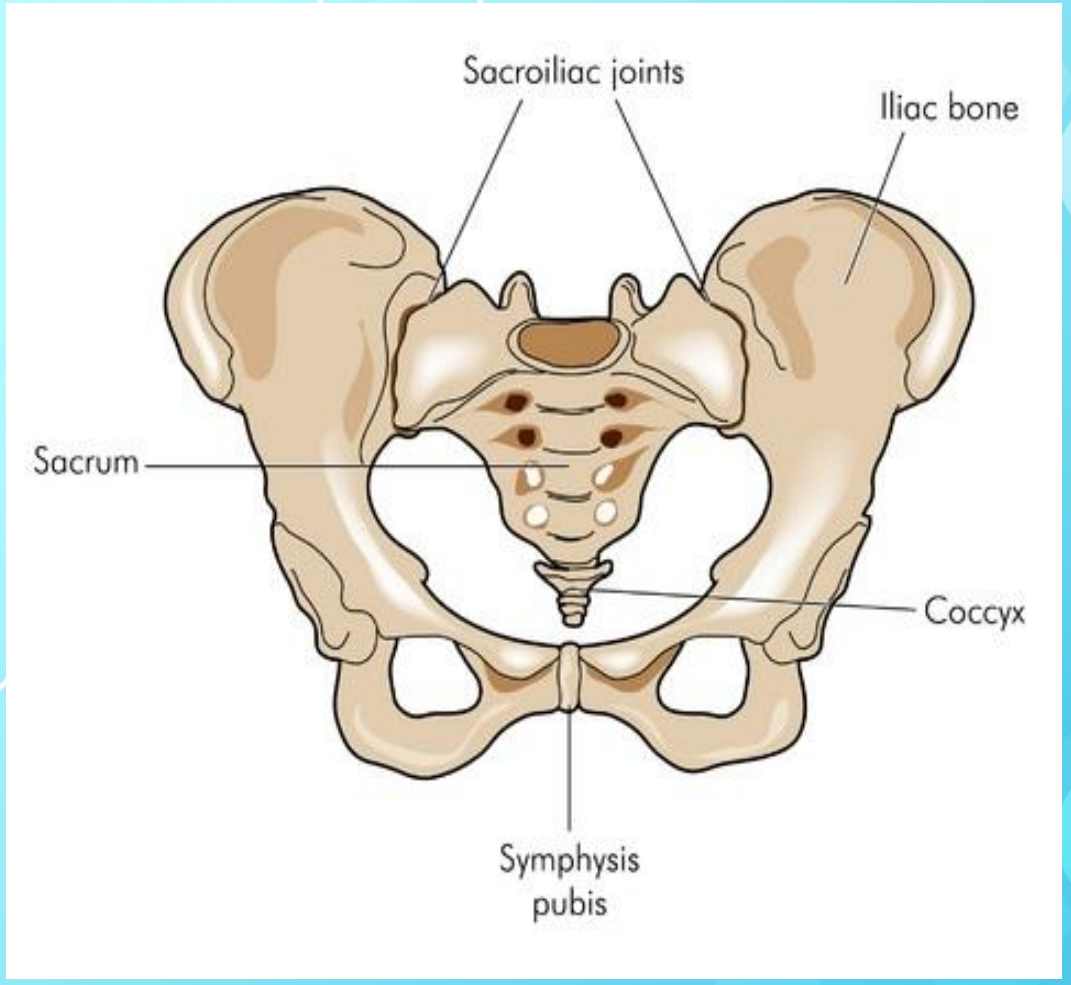
Fibro-Cartilage

- Have collagen fibers similar to those in hyaline cartilage which are arranged in thick bundles
- Lack perichondrium

- **FUNCTION**
- flexible and capable of withstanding considerable pressure (strongest of all cartilage)
- connects structures subjected to great pressure. Act as shock absorber

LOCATION

- Intervertebral disks, symphysis pubis, articular disks (e.g., knee and temporomandibular joints)

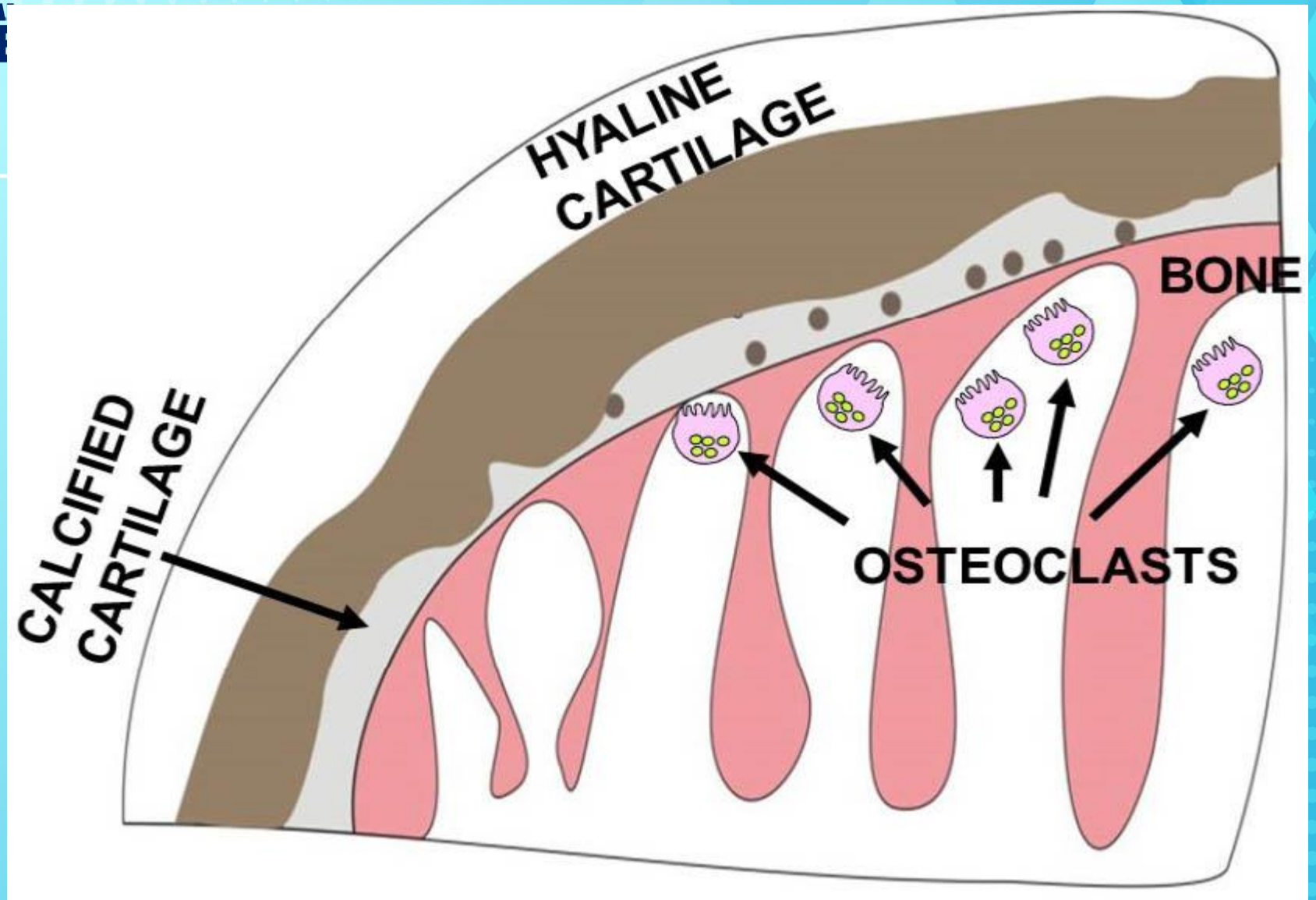


Calcified cartilage

- It is modified hyaline cartilage but due to deposition of calcium salts(caco3) its matrix becomes hard like bones.
- It is **hardest cartilage** of the body

LOCATION:

- **Pubis of frog's pelvic girdle.**
- **Supra scapula of pectoral girdle**
- **Head of Femur & Humerus**
- **Vertebrae of sharks**


HYALINE CARTILAGE
BONE
CALCIFIED CARTILAGE
OSTEOCLASTS

BONE

- Study of Bone – **Osteology**
- Process of bone formation – **Ossification**
- Mesodermal origin
- Hardest Tissue – Bones
- (Softest Tissue – Blood.)
- Hardest substance – Enamel. (It is not a group of cell but it is formed by the secretion of ameloblast cells of teeth.)
- Outermost covering of bone is **Periosteum** composed of white fibrous connective tissue.
- Bone producing cell called **Osteoblast.** They divide to form **Osteocyte** & synthesize organic part of matrix.
- Mature cell of bone is called **Osteocyte** which is found in Lacuna. Only one osteocyte is found in lacuna.

- It consist of two parts.

Inorganic Part – 65 – 68%

$Ca_3(PO_4)_2$ – 80% max. rest 20% $CaCO_3$, $Mg_3(PO_4)_2$, Fluorides.

Organic part – 32-35% Ossein in which bundle of collagen fibres suspended in sulphated mucopolysaccharide.

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Structure of bone

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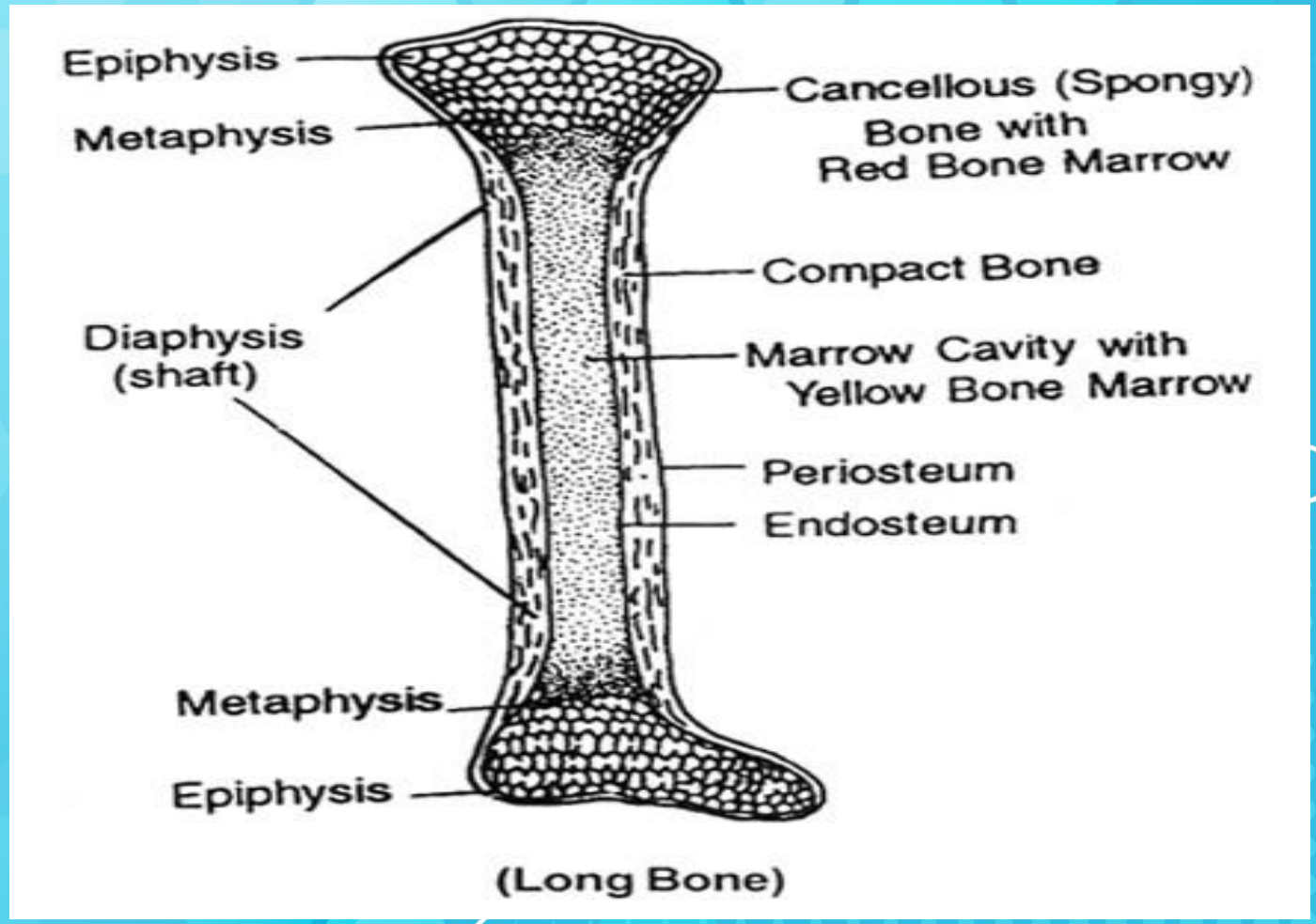
Long bone has three region

- Epiphysis
- Diaphysis
- Metaphysis



(Long Bone)

EPIPHYSIS:

Ends of long bone is called **Epiphysis.** 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.

Cavity is present in the form of **Trabeculae** filled with red bone marrow.

It is composed of myeloid Tissue which produce blood corpuscles so epiphysis act as a **Haemopoietic** organ.

Diaphysis

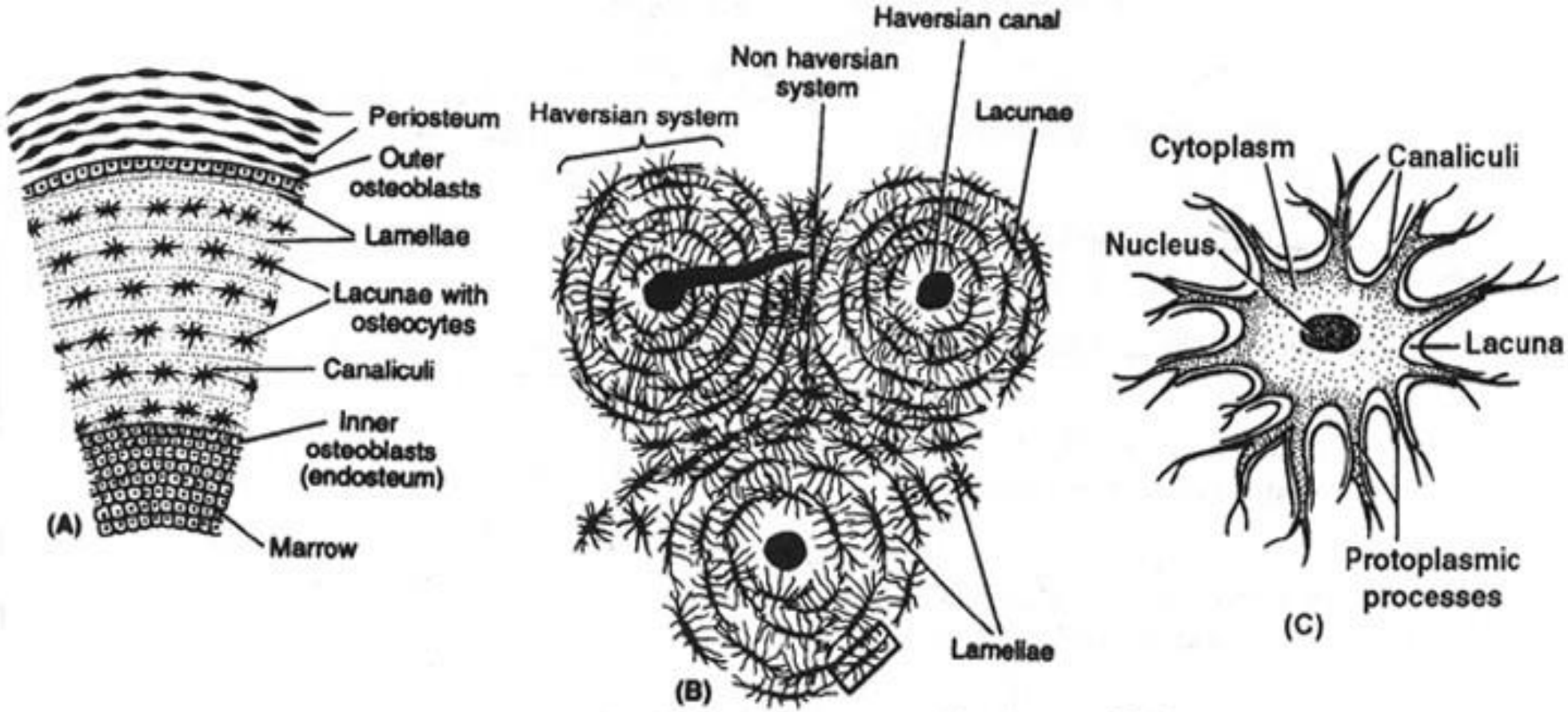
- Middle part of shaft of long bone is diaphysis which is composed of **compact bone.**
- In this region hollow cavity is present called bone marrow cavity filled with yellow bone marrow composed of white fat. Function is storage of fat.
- If required in anemic condition YBM is replaced by RBM.

Metaphysis

- Lies in 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 epiphysial plate is responsible for elongation of bone.

- After complete development of long bone this plate is destroyed. So a complete developed bone shows 2 regions while in a developing bone 3 regions are found.

Internal structure of bone



(A) T.S. of amphibian bone, (B) T.S. of mammalian bone, (C) An osteocyte

- **PERIOSTEUM**

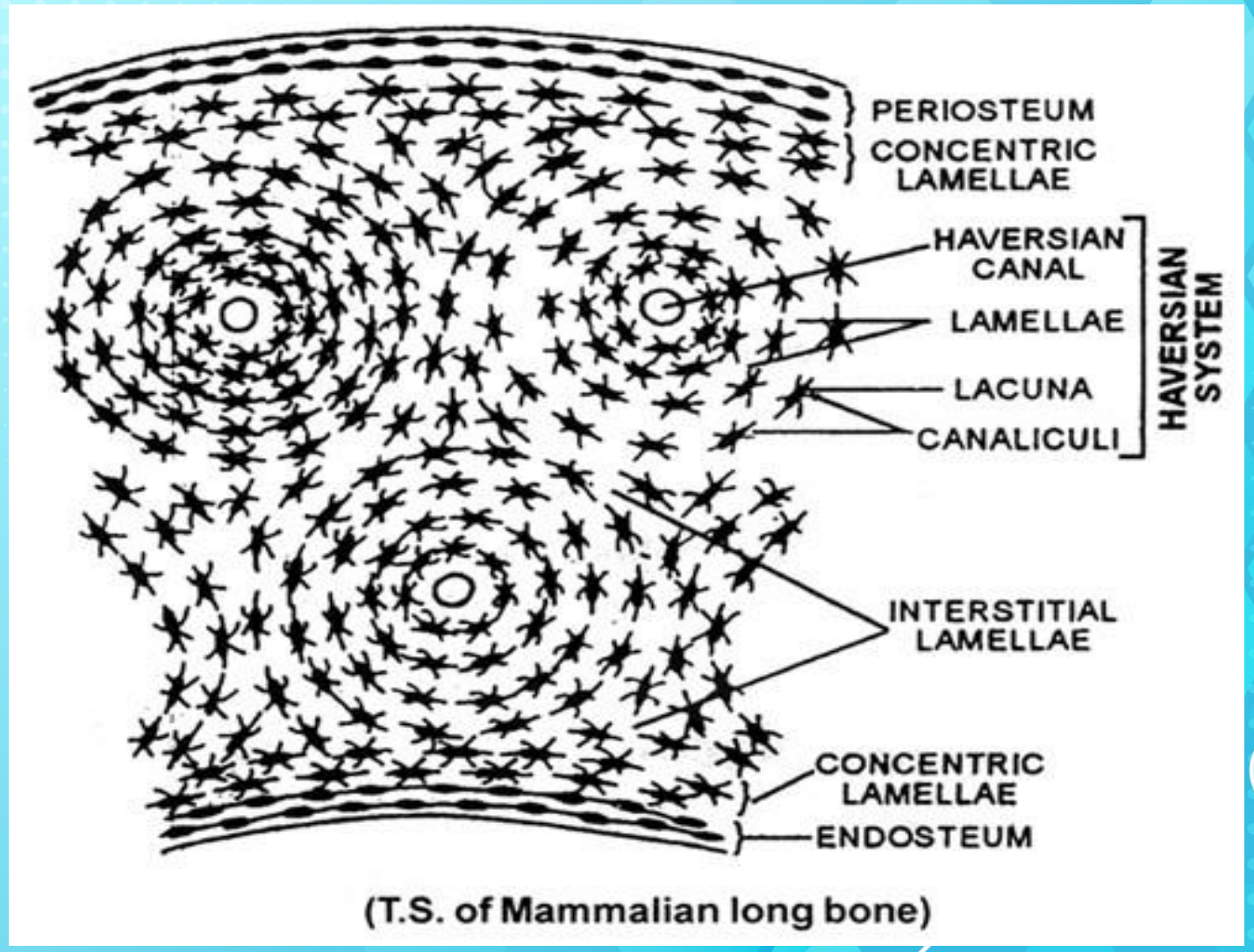
- Outermost covering consists of two layers.
- Outer layer consists of White fibrous connective tissue in which blood circulation is present.
- Inner layer – consists of single layer of osteoblast cells. These cells are cube like in shape in which oval shaped nucleus & basophilic granules are present in cytoplasm.
- They divide to form osteocyte and secrete layer of matrix.

Matrix

It is composed of inorganic & organic compounds. Matrix of bone is synthesized in the form of layer called **Lamellae.** Between these lamellae layer of Osteocyte cells are also present. Osteocyte are present in the lacuna. Each Osteocyte is interconnected with adjacent Osteocytes by their cytoplasmic process called canaliculi.

- In the matrix of bone 2 types of canals are present.

1. Haversian canal **2. Volkmann's canal**



(T.S. of Mammalian long bone)

•Haversian canals are central Longitudinal canals which are arranged parallel to long axis of bone. In this canals 1 or 2 blood capillaries and nerve fibres are present.

•Where as Volkmann's canals are transverse/horizontal or oblique canals that interconnect the Haversian canals.

• Haversian canal, Haversian lamellae & Osteocyte form **Haversian** system or **Osteon.**

Endosteum

consist of 2 layers.

a) Towards bone marrow cavity lined with layer of reticular fibrous connective tissue.

b) Towards matrix of bone line with layer of Osteoblast cell. They divide to form osteocyte & synthesize matrix. So growth of bone is bidirectional (Periphery and central region).

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.

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