

STRUCTURAL ORGANISATION IN ANIMALS

ANIMAL TISSUES

Animal Tissue

Tissues are group of similar cells with intercellular substances perform a specific function

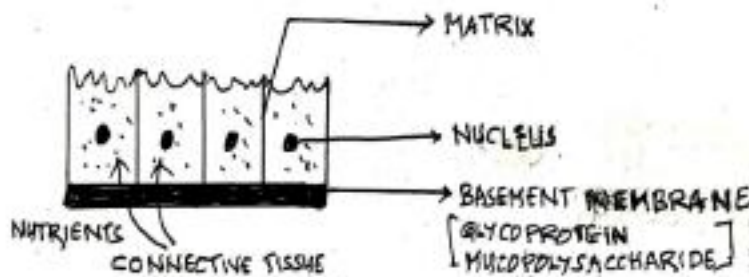
The term tissue was coined by F.X. BICHAT

HISTOLOGY : It is the study of tissues

HISTOGENESIS : It is the process of formation of different tissues from germ layers in gastrula

- The term histology was coined by A.K.F. Mayer
- Father of histology : F.X. BICHAT
- Founder of histology : MARCELLO MALPIGHI
- Types of tissues - 4 types
 - 1) EPITHELIAL TISSUE - derived from ectoderm, mesoderm and endoderm
 - It covers and protect external and internal organs
 - 2) CONNECTIVE TISSUE - derived from mesoderm
 - It connect together different body parts
 - 3) MUSCULAR TISSUE - derived from mesoderm.
 - It helps in movement and locomotion
 - 4) NERVOUS SYSTEM - derived from ectoderm
 - It controls and coordinate different body function
- Most abundant tissue in human body → connective tissue
- Regeneration power is high in epithelial tissue
- Least regeneration power is in nervous tissue
- First formed tissue in our body : NERVOUS TISSUE
- First organ system : CIRCULATORY SYSTEM

EPITHELIAL TISSUE



- In epithelial tissue, cells are arranged very closely to each other with very little intercellular space called matrix
- Epithelial cells rest on a noncellular basement membrane which is composed of mucopolysaccharide and glycoproteins
- This basement membrane separates epithelium from underlying connective tissue
- Epithelial tissues are non vascular (blood supply absent). So, it receive nutrients from underlying connective tissue through basement membrane
- CELL JUNCTION. Three types of cell junction are present in epithelium and other tissues

1) TIGHT JUNCTION / ZONA OCCLUDENS

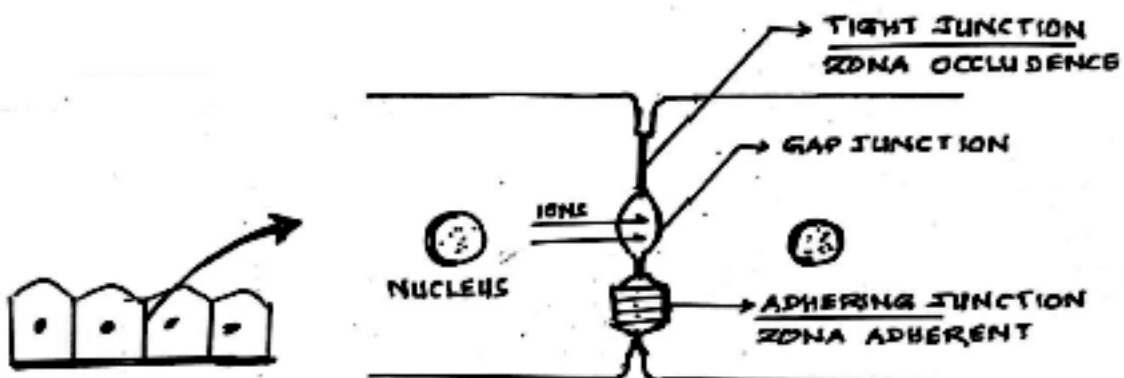
It helps to stop substances from leaking across a tissue

2) GAP JUNCTION

It facilitates cells to communicate with each other by connecting the cytoplasm of adjoining cells for rapid transport of ions, micro and macromolecules

3) ADHERING JUNCTION / ZONA ADHERENT

It cement together neighbouring cells



- **TYPES OF EPITHELIUM**

Based on the function epithelial tissues are of two types :

I) COVERING AND LINING EPITHELIUM

II) GLANDULAR EPITHELIUM

- I **COVERING AND LINING EPITHELIUM**

- It covers and protects internal and external organs
- Based on the number of cell layers, these are of two types

1) SIMPLE EPITHELIUM

2) COMPOUND EPITHELIUM/STRATIFIED EPITHELIUM

1. SIMPLE EPITHELIUM

- It is made of a single layer of cells
- Based on the shape of the cells, these are of 4 types

- A) **SIMPLE SQUAMOUS EPITHELIUM**

(Pavement / Tesselated epithelium)

- It is made of a single thin layer of flattened cells with irregular boundaries (tesselated)
- Location :
 - 1. Walls of blood vessels
 - 2. Air sacs of lungs
- Function : Diffusion
- Simple squamous epithelium mainly present in
 - 1) capillary epithelium (endothelium)
 - 2) alveolar epithelium
 - 3) inner lining of bowman's capsule
 - 4) coelomic epithelium (mesothelium)
 - 5) peritoneum - internal organ lining
 - 6) outer layer - frog's skin

- B) **SIMPLE CUBOIDAL EPITHELIUM**

- It is made of a single layer of cube-like cells
- Location :
 - 1) Duct of glands
 - 2) Tubular part of nephron in kidney
- Function : Secretion and absorption
- Simple cuboidal epithelium present in
 - 1) Thyroid follicles
 - 2) Germinal epithelium - There are sperm and egg producing epithelium present in testes and ovary

- **BRUSH BORDERED CUBOIDAL EPITHELIUM**

These are cuboidal cells with microvilli on their surface. They are present in PCT and DCT of nephron

C) Simple columnar Epithelium

- It is composed of a single layer of tall and slender cells
- Their nuclei are located at the base
- Their free surface may have microvilli (intestine)
- LOCATION : Inner lining of stomach and intestine
- FUNCTION : Absorption and secretion
- Simple columnar epithelium are of two types

a) NON CILIATED COLUMNAR EPITHELIUM - In this, cilia are absent in their free surface. These are present in inner surface of intestine and stomach

b) CILIATED COLUMNAR EPITHELIUM - They have cilia on their free surface

- These are present in respiratory passage - bronchioles
- Fallopian tube (oviduct) and inner cavity of spinal cord and brain

* **EPENDYMA** - These are ciliated columnar epithelium present in the cavity of brain and spinal cord

A) CILIATED EPITHELIUM - These are cuboidal or columnar cells bearing cilia on their free surface

- Their function is to move particles or mucous in a specific direction over the epithelium
- These are mainly present in inner surface of hollow organs like bronchioles and fallopian tube

D) PSEUDOSTRATIFIED EPITHELIUM

In this tall and short cells are arranged in alternate manner giving a stratified appearance

- These are present in trachea olfactory epithelium etc.

2. COMPOUND / STRATIFIED EPITHELIUM

- These are multilayered epithelium
- LOCATION : Covers the dry surface of skin, moist surface of buccal cavity and pharynx, inner lining of duct of salivary gland and pancreas
- FUNCTION : Provide protection against chemical and mechanical stresses
- Based on the shape of outermost cell layer, compound epithelium are of different types

A) COMPOUND SQUAMOUS EPITHELIUM

→ There are two types

1) non-keratinised squamous epithelium

→ These are present in buccal cavity (cheek epithelium), pharynx etc

2) Keratinised squamous epithelium

→ Its living cytoplasm is gradually replaced by an insoluble protein keratin and that process is called keratinisation

→ These are present in skin hair, nail, horns, claws etc.

→ **DANDRUFF** : These are keratinised cells with degenerated nucleus

B) COMPOUND CUBOIDAL EPITHELIUM

→ These are present in duct of salivary gland and pancreas

C) COMPOUND COLUMNAR EPITHELIUM

→ These are mainly present in embryo

D) TRANSITIONAL EPITHELIUM / URO EPITHELIUM / UROTHELIUM

→ It contains much thinner and more elastic cells

→ Basement membrane is absent in transitional epithelium

→ These are present in urinary bladder, ureter and uterus

*** MODIFIED EPITHELIUM**

- 1) Germinal epithelium - these are modified simple cuboidal epithelium present in testes and ovary for the production of gametes
- 2) Mesothelium - simple squamous epithelium that lines coelom
- 3) Endothelium - simple squamous epithelium present in the inner lining of blood vessels
- 4) Peritoneum - simple squamous epithelium covering all internal organs
- 5) Sensory / neuro - epithelium - these are simple epithelium modified for the perception of external stimuli

Eg. Tongue (taste buds), retina

- 6) Pigmented epithelium - These are pigment containing epithelial cells, lining the posterior segment of the eye

II. GLANDULAR EPITHELIUM .

* These are columnar or cuboidal cells get specialised for secretion.

* On the basis of mode of pouring of their secretion, glands are of two types.

1. ENDOCRINE GLANDS / DUCTLESS GLANDS

→ They do not have duct

→ Their products are called hormones, secreted directly into the fluid bathing the gland

2. EXOCRINE GLANDS / DUCTED GLANDS

→ Their products are released through duct or tubes

→ It secretes mucous, saliva, ear wax, oil, milk, digestive enzymes and other cell products

→ Based on the number of cells, exocrine glands are of two types

i) UNICELLULAR GLAND

→ It consists of isolated glandular cells

Eg. Goblet cells - mucous secreting cell present in digestive, respiratory and reproductive systems.

ii) MULTICELLULAR GLAND

→ It consists of cluster of cells Eg : Salivary Gland

TYPES OF MULTICELLULAR GLAND: It is of two types : -

a) Simple multicellular glands - 5 types

1) SIMPLE NON-COILED TUBULAR GLAND



Eg. Crypts of Lieberkuhn

2) SIMPLE COILED TUBULAR GLAND



Eg. Sweat gland

3) ALVEOLAR GLAND/SACCULAR GLAND/
ACINNAR GLAND



Eg. Mucus secreting gland in skin of frog

4) SIMPLE BRANCHED TUBULAR GLAND



Eg. Gastric gland

5) SIMPLE BRANCHED ALVEOLAR GLAND



Eg. Sebaceous gland

B) COMPOUND MULTICELLULAR GLAND - 3TYPES

1) COMPOUND TUBULAR GLAND



Eg. Brunner's gland

2) COMPOUND ALVEOLAR GLAND



Eg. Salivary gland

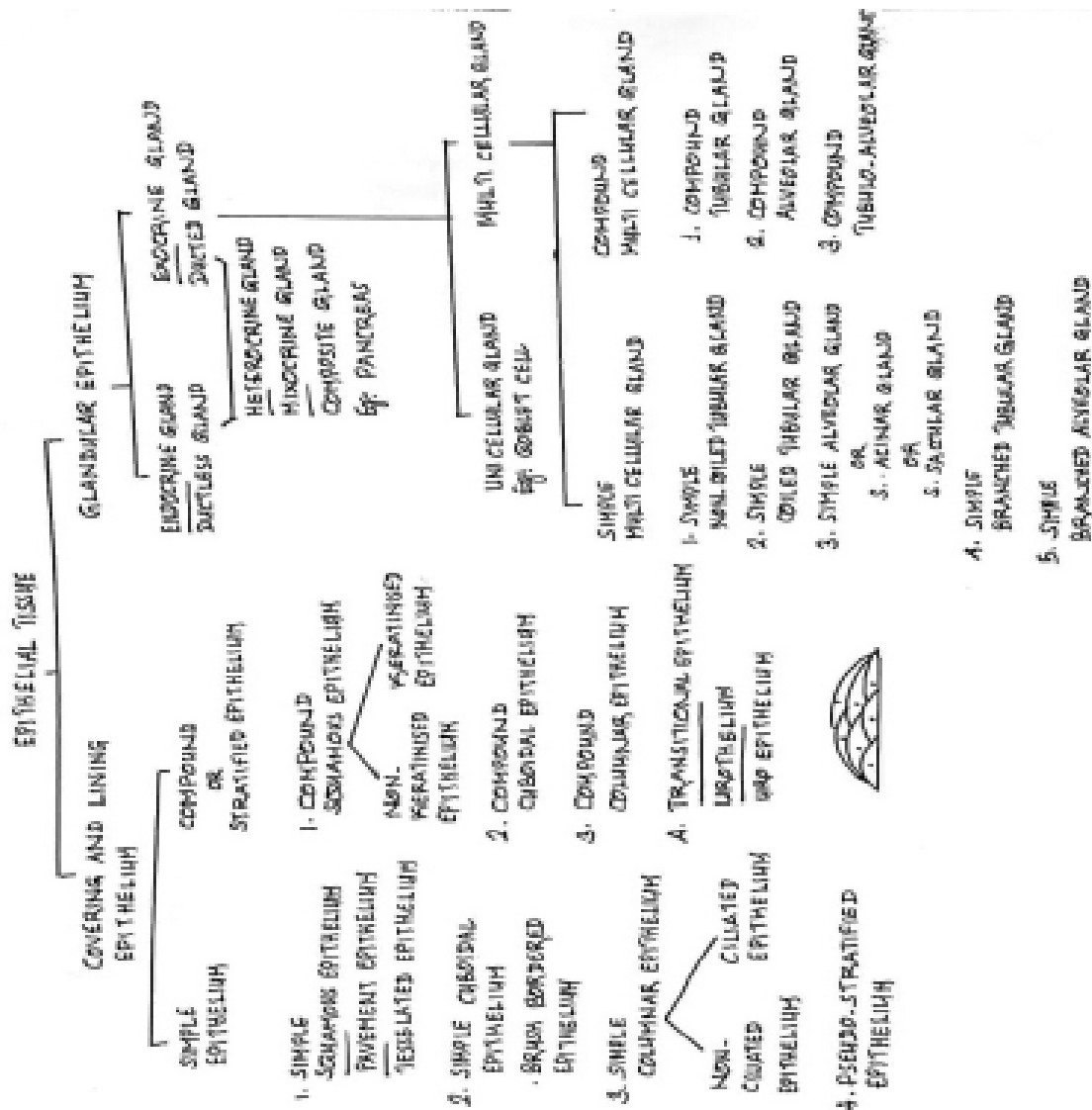
(sub maxillary and sub lingual)

3) COMPOUND TUBULO-ALVEOLAR GLAND



Eg. Mammary gland,

Salivary gland (parotid) pancreas



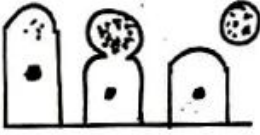
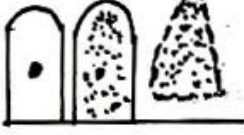

* **HETEROCRINE GLAND / MIXOCRINE / COMPOSITE GLAND**

It contains both exocrine and endocrine part

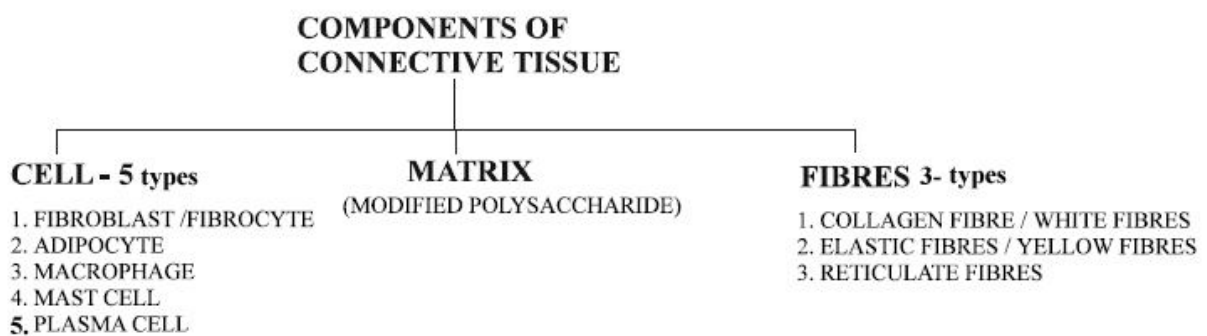
Eg. PANCREAS

Its exocrine part is pancreatic acini which secrete pancreatic juice and its endocrine part is islets of Langerhans which secrete insulin and glucagon

* Based on the mode of discharge of product from an individual cell in a gland, these are of three types

1. APOCRINE GLAND	2. HOLOCRINE GLAND	3. MEROCRINE GLAND
		
In this gland, secretions accumulate in the apical part of the cell and this part is later on pinched off Eg: MAMMARY GLAND	These glands discharge their product after the disintegration of individual cells Eg: SEBACEOUS GLAND	It discharges their product without any damage of parental cells Eg: SALIVARY GLAND

II. CONNECTIVE TISSUE



→ Three components of connective tissues are

- 1) Cells 2) Matrix 3) Fibres

1) CELLS

Five types of cells are present in connective tissue :-

i) Fibroblast / Fibrocyte - These are irregular flat cells with protoplasmic processes. It synthesise three types of fibres ie collagen, elastin, reticulate

ii) Adipocyte - These are oval shaped cells which store fat

iii) Macrophage - These are amoeboid, phagocytic cells

iv) Mast cells - These are oval shaped cells which secrete :-

a) Matrix

b) Serotonin - It is vasoconstrictor and raises blood pressure

c) Histamine - It is a vasodilator and reduces blood pressure. It secretes during allergy

d) Heparin - It is an anticoagulant

* In blood, BASOPHIL is called mast cell of blood

v) Plasma cell - These are called cart-wheel cells. It produces antibodies




2) MATRIX

→ Connective tissue has wide matrix

→ Matrix is modified polysaccharide

3) FIBRES

→ They are of three types

COLLAGEN FIBRES (WHITE FIBRES)	ELASTIC FIBRES (YELLOW FIBRES)	RETICULATE FIBRES
		
These are tough, long and unbranched fibres	These are flexible, long and branched fibres	These are tough, very thin, short, thread like, branched fibres
These are arranged in parallel bundles	Solitary fibre	Solitary fibre
It is composed of non contractile protein collagen	Composed of contractive protein elastin	Composed of noncontractile protein reticulin
On boiling, collagen changes to another protein gelatin	Resistant to boiling	Resistant to boiling
In tanning, collagen fibres become tough and resistant to form leather	In mummies, elastic fibres of the body are preserved by chemical treatment	These are present around nerves and blood vessels
Wrinkled skin in old age due to the degeneration of collagen fibres		

TYPES OF CONNECTIVE TISSUE

Three types of connective tissue

1. Loose connective tissue
2. Dense connective tissue
3. Specialised connective tissue

1. LOOSE CONNECTIVE TISSUE / Proper connective tissue

In this cells and fibres are loosely arranged in a semifluid ground substance. It is of two types

A) AREOLAR TISSUE / SPONGY CONNECTIVE TISSUE

→ It is present beneath the skin

→ It serves as a support framework for epithelium

→ It connect skin or integument to muscles

B) ADIPOSE CONNECTIVE TISSUE

→ It stores fat

→ It is present under the skin and internal organs

2. DENSE / FIBROUS connective tissue

→ In this, fibres and fibroblast are compactly packed

→ It is of two types

A) DENSE REGULAR CONNECTIVE TISSUE

→ In this collagen fibres are present in rows between many parallel bundles of fibres

Eg. Tendons and Ligaments

→ TENDONS - Modified white fibrous connective tissue

It contains more collagen fibres and less elastic fibres

It connects muscles to bones

→ LIGAMENTS - Modified yellow elastic connective tissue

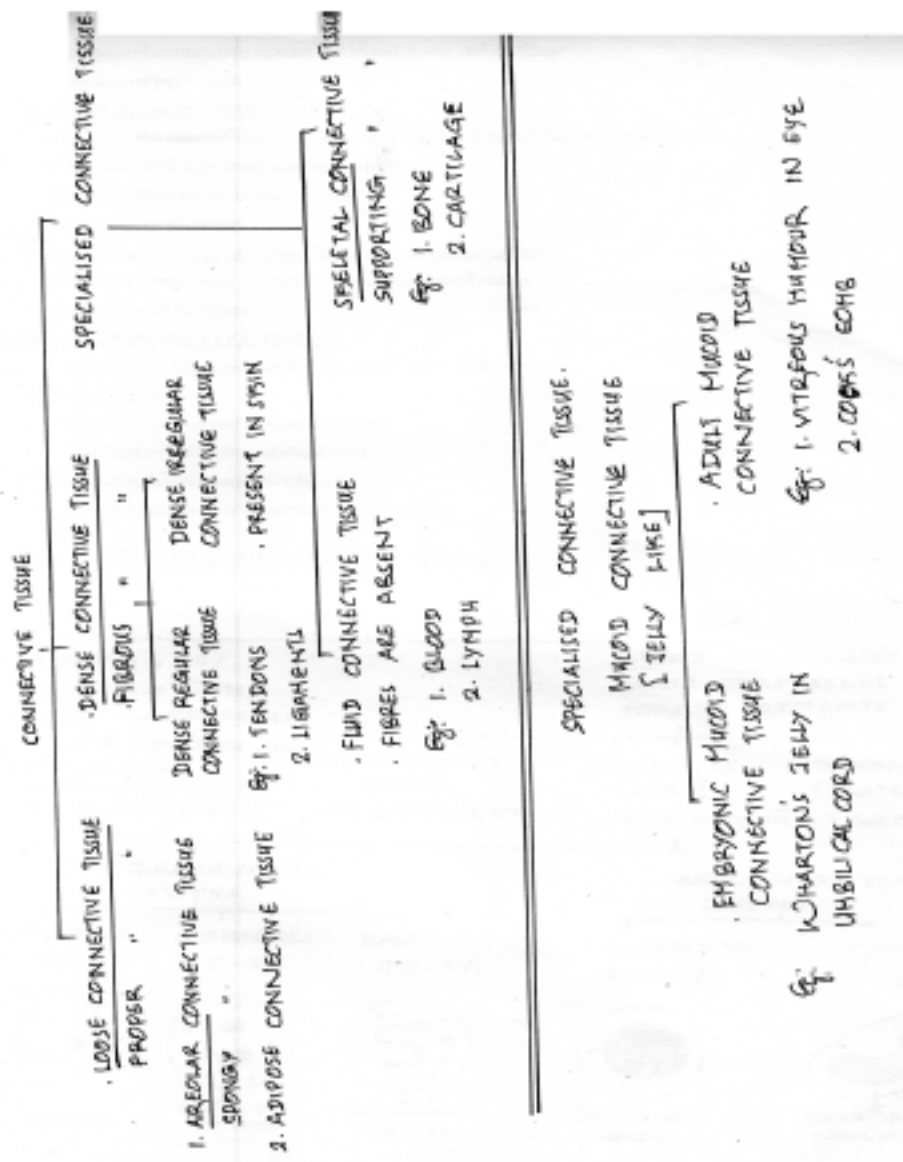
It contains collagen and elastic fibres

* SPRAIN :-It is the stretching of ligaments

b) DENSE IRREGULAR CONNECTIVE TISSUE

in this , fibroblasts and many fibres (mostly collagen) that are oriented differently

It is mainly present in skin



SPECIALISED CONNECTIVE TISSUE

→ Specialised connective tissues are blood, bone and cartilage

→ They are of two types

i) Fluid connective tissue

These are the specialised connective tissue in the form of fluid or liquid

Fibres are absent in fluid connective tissue

It is the softest tissue in human body

Eg. Blood and Lymph

ii) Skeletal connective tissue / Supporting connective tissue

These are specialised connective tissue with hard matrix

Eg. Bone and cartilage

MUCOID CONNECTIVE TISSUE

→ These are modified connective tissue with jelly like matrix

It is of two types :-

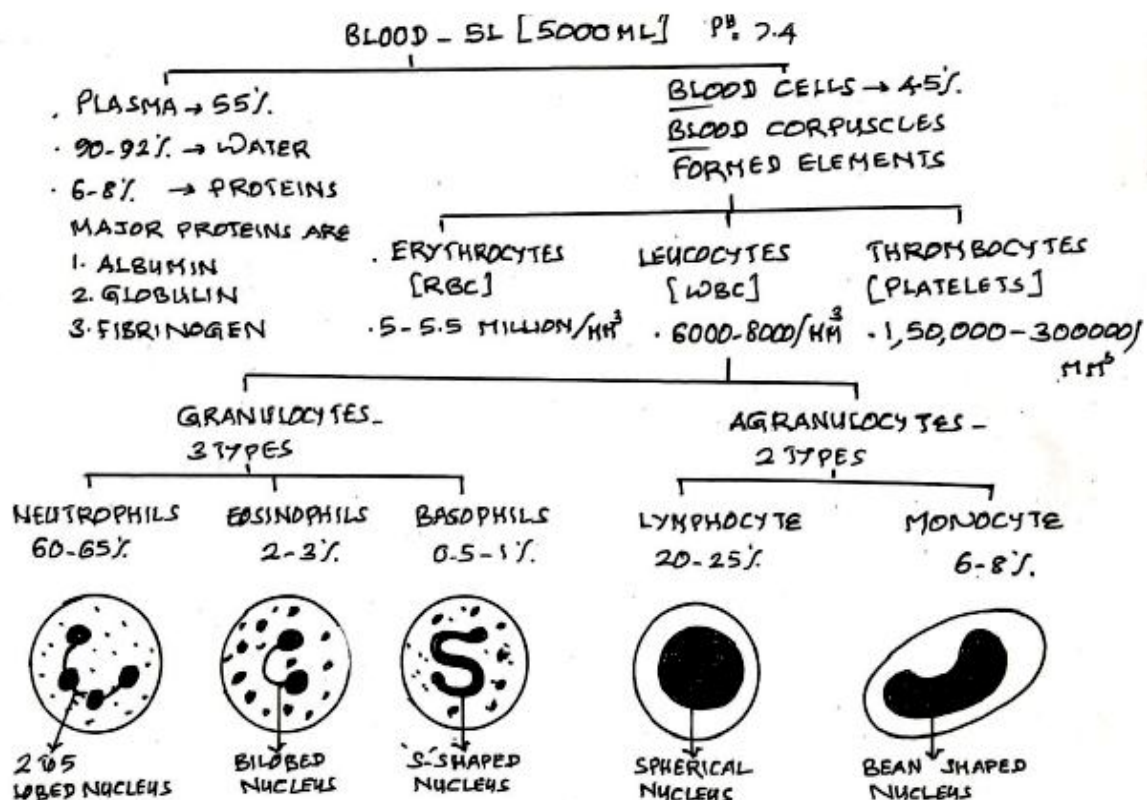
a) Embryonic mucoid connective tissue

Eg. Wharton's jelly in umbilical cord

b) Adult mucoid connective tissue

Eg. Vitreous humour in eye and Cock's comb

i) FLUID CONNECTIVE TISSUE : BLOOD



1. RBC

It helps in the transport of respiratory gases, oxygen and carbon dioxide

2. WBC - 2 types

a) GRANULOCYTES - In this, protein granules are present in their cytoplasm. It is of three types

i) NEUTROPHILS - These are amoeboid phagocytic cells

ii) EOSINOPHILS - It resists infections and also associated with allergic reactions (eosinophilia)

iii) BASOPHILS - Secrete serotonin, histamine and heparin.

“Mast cell of blood”

b) AGRANULOCYTES - Protein granules are absent in cytoplasm - 2 types

i) LYMPHOCYTE : It assist immunity

ii) MONOCYTE : These are amoeboid phagocytic cells

Kupffer cell -> phagocytic cells in liver

3. PLATELETS / THROMBOCYTES

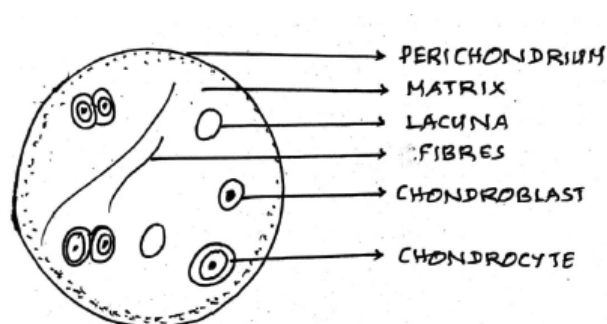
It helps in blood clotting

SERUM : - It is the plasma without clotting factors

DIAPYCNOSIS:- It is the amoeboid movement of WBC through the walls of blood vessels

(ii) SKELETAL CONNECTIVE TISSUE (Supportive)

3) CARTILAGE



→ Cartilage is firm and flexible skeletal connective tissue (pliable)

→ Cartilage is non-vascular tissue (blood vessels absent)

→ Chondrology - It is the study of cartilage

→ Chondrin - It is the solid protein in cartilage

→ Chondroitin sulphate - It is the jelly like protein in cartilage

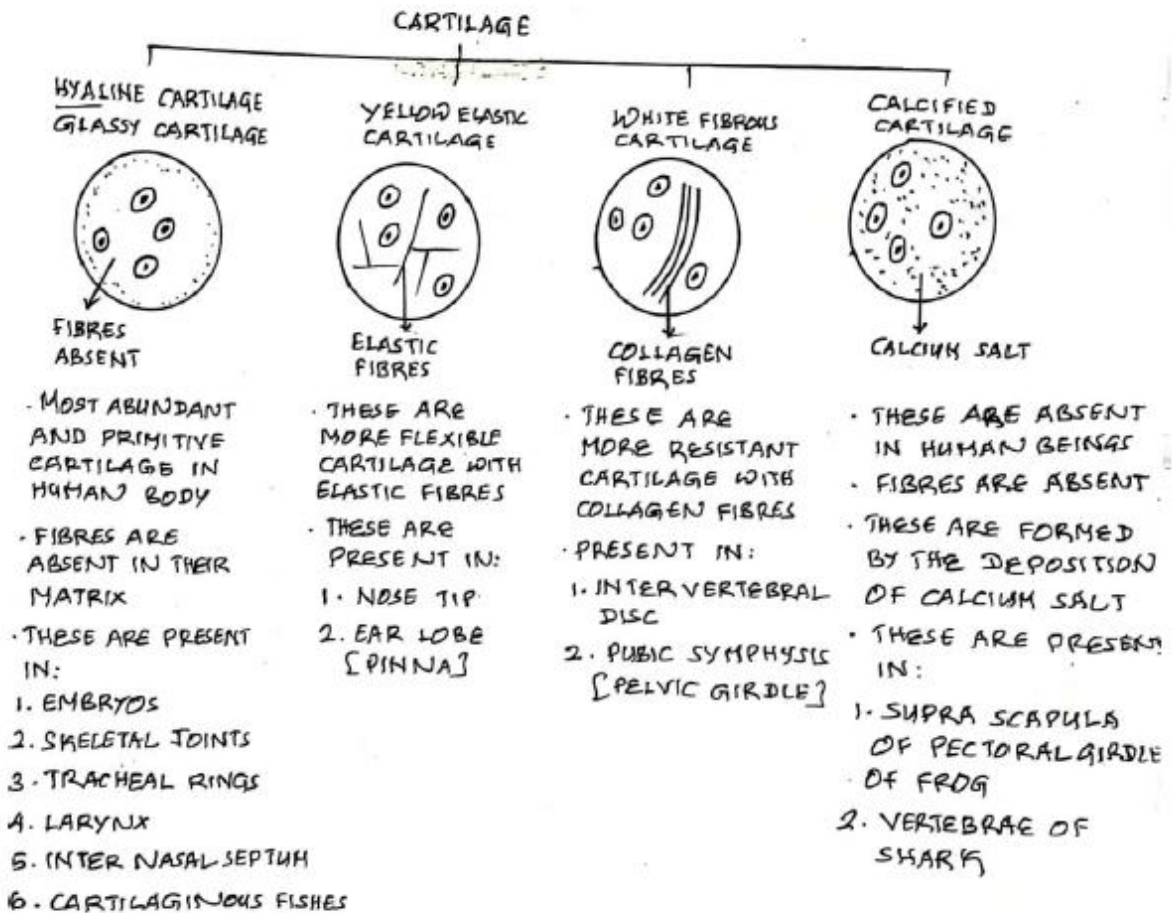
→ Lacuna - It is the fluid filled areas in the matrix

→ Chondroblast - It is the immature cartilage cells without lacuna

→ Chondrocyte - These are mature cartilaginous cells present within the lacuna

→ Perichondrium - It is the outer covering of cartilage

TYPES OF CARTILAGE



(ii) SKELETAL CONNECTIVE TISSUE : BONE

- * OSTEOLOGY - It is the study of bone
- * OSSEIN - It is the protein in bone
- * HAVERSIAN SYSTEM / OSTEONS - It is the structural and functional unit of bone
- * VOLKMAN'S CANAL - It is the horizontal canal present in bone that connect adjacent haversian canal system
- * OSTEOCYTE - These are the mature cells present in haversian system

- * **OSTEOBLAST** - These are present in periosteum and endosteum which helps to deposit Ca in bone. So it is called "bone forming cells"
- * Hormone calcitonin from thyroid gland helps to deposit Ca in bone (activate osteoblasts)
- * **OSTEOCLAST** - These are present in periosteum which remove Ca from bone. So it is called bone deforming cells
- * Parathyroid hormone (PTH) from Parathyroid gland stimulate osteoclasts
- * **LACUNA** - The bone cells are present in the spaces called lacuna
- * **HAVERSIAN LAMELLA** - These are the concentric rings of matrix in bone
- * **ENDOSTEUM** - It is the outer covering of bone marrow
- * **PERIOSTEUM** - It is the outer covering of bones
- * **BONE MARROW** - It is the central cavity in bone which is filled with fatty tissues, nerves and blood vessels
- * Bone marrow is of two types

<u>RED MARROW</u>	<u>YEALLOW MARROW</u>
Present throughout life	After about 5th year of development red marrow is gradually replaced by yellow marrow

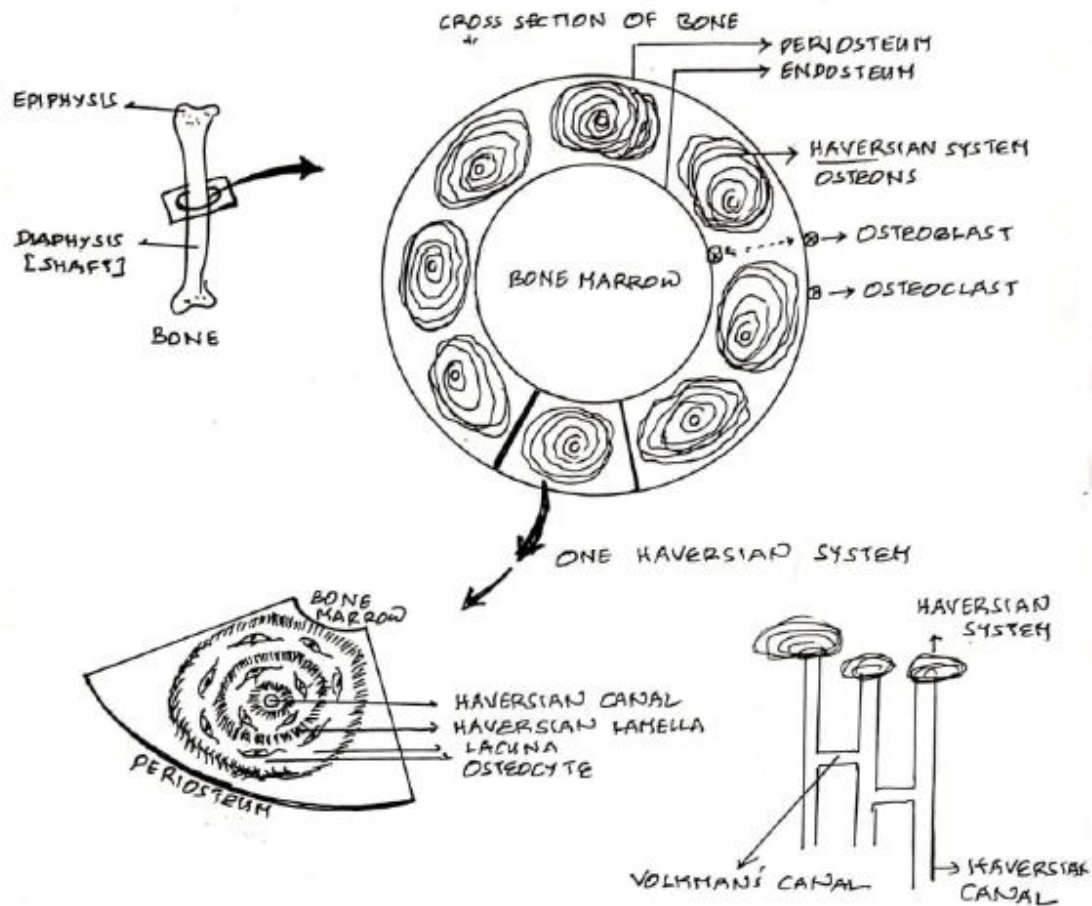
- * In adult red marrow : It is present in the shaft of the restricted in tip of bone, vertebrae, ribs, sternum, cranial bones etc.
- * **APLASTIC ANAEMIA** - It is the anaemia due to the destruction of bone marrow

TYPES OF BONE - 5 types

1. **COMPACT BONE** - These are the bones with haversian system Eg. Shaft of bone, clavicle (collar bone)
2. **SPONGY BONE** - In this haversian systems are absent Eg. Tip of bone ribs
3. **CARTILAGINOUS BONE** or Replacing bone

These are formed by the deposition of calcium in cartilage (ossification)

Eg. Limb bones -(Humerus, Femur)



4. MEMBRANEOUS BONE or DERMAL BONE or INVESTING BONE

These are formed by the deposition of Ca in connective tissue membrane

Eg. Cranial bones

5. SESAMOID BONE - These are formed by the deposition of Ca in tendons

e.g.. Patella (knee cap) largest sesamoid bone

III. MUSCULAR TISSUE - Mesodermal origin

→ Sarcology / myology - It is the study of muscles


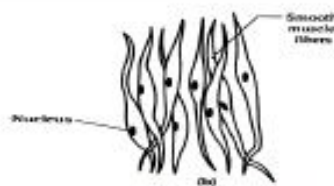
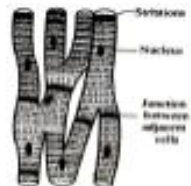
→ MUSCLE FIBRE - It is the muscle cell

* Each muscle is made of many, long, cylindrical fibres arranged in parallel array

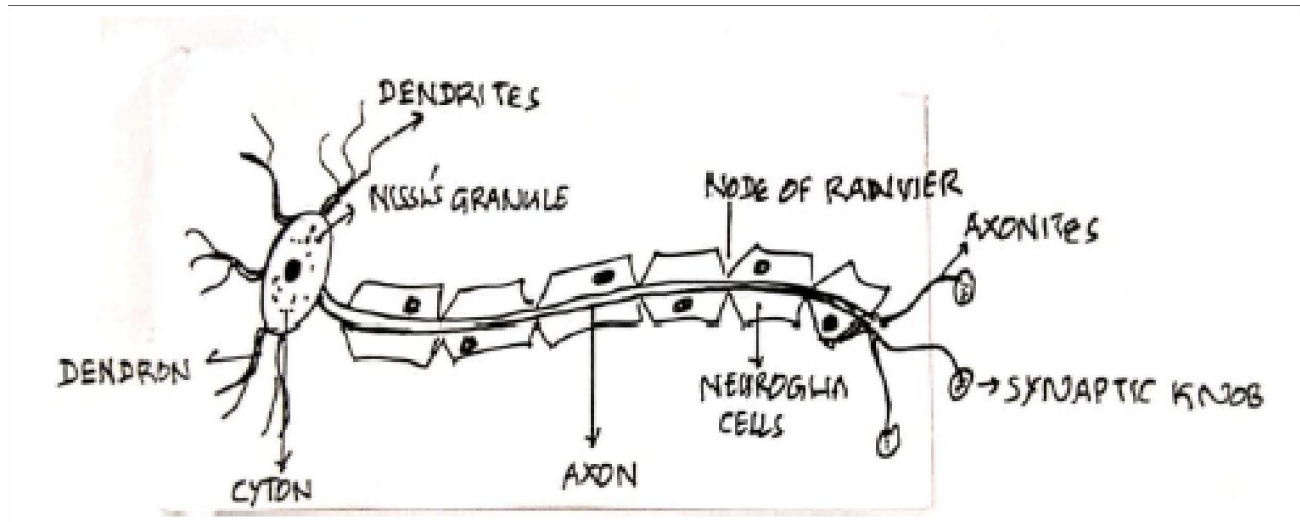
* MYOFIBRIL - These muscle fibres are composed of fine fibrils called myofibrils

* SARCOLEMMA - It is muscle plasma membrane

- * SARCOPLASM - It is muscle cytoplasm
- * SARCOPLASMIC RETICULUM - It is muscle endoplasmic reticulum
- * SARCOSOME - Muscle mitochondria
- * MYOGLOBIN - is muscle haemoglobin
- * SARCOMERE - is the structural and functional unit of muscles
- * TYPES OF MUSCLE

SKELETAL MUSCLE OR VOLUNTARY MUSCLE OR STRIATED MUSCLE	VISCERAL MUSCLE OR INVOLUNTARY MUSCLE OR NONSTRIATED MUSCLE OR SMOOTH MUSCLE OR SPINDLE MUSCLE OR FUSIFORM MUSCLE	CARDIAC MUSCLE
		
These are present attached to bones	Present in internal organs like alimentary canal, blood vessel, uterus, urinary bladder etc.	Present only in heart wall
These are long cylindrical and unbranched muscles	These are spindle shaped muscles	These are short cylindrical and branched muscles
It shows multinucleated condition called SYNCITIUM	Uninucleate	Uninucleate
Voluntary in action	Involuntary in action	Involuntary in action
Striations or dark and light bands are present	Striations are absent	Striations are present
		Intercalated disc or booster rings are present. Intercalated discs are zig-zag intercellular partitions in cardiac muscles

VI. NEURAL TISSUE



1. **NISSL'S GRANULE** : These are coloured granules of ribosomes or rough endoplasmic reticulum present in cyton and dendron
2. **NEUROGLEA CELLS** : These are protective and supporting cells present on axon. Neuroglia makes up more than one half the volume of neural tissue in our body

TYPES OF NEUROGLIA CELLS

1. **OLIGODENDROCYTE** - Present in central nervous system (CNS)
 2. **SCHWANN CELLS** - Present in peripheral nervous system(PNS)
- NODE OF RANVIER**: It is the conducting part present in myelinated neuron in between neuroglia cells
- * **MYELIN SHEATH OR MEDULLARY SHEATH** : It is the protective layer on axon formed of neuroglia cells
 - * **MYELINATED NEURON / MEDULLATED NEURON** : In this myelin sheath is present
 - * **NON MYELINATED / NON MEDULLATED NEURON** : In this, myelin sheath is absent in their axon

UNIPOLAR NEURONS



A single process arise from the cyton

Eg. EMBRYOS

Bipolar nuerone



A single dendron and an axon are present at opposite part of cyton.

. RETINA
. OLFACTORY EPITHELIUM.

Multipolar neurons



It has one axon and many dendrons

Eg. BRAIN
- SPINAL CORD

- * More than 99% of neurons are multipolar neurons
- * Non-polar neurons are present in Hydra
- * Pseudo unipolar neurons are present in the dorsal root ganglion of spinal cord.