1- Fluid mosaic model of cell membrane

At body temperature the lipid bilayer is fluid and many of the integral protein particles are free to move laterally within the plans of the membrane. The protein particles are like ice cubes that float on the surface of water. So, the integral protein particles (about 60 types) and cholesterol within the fluid lipid bilayer forming the " fluid mosaic model of membrane structure".

2- Modifications of lateral surface of cell membrane

This surface is in contact with other cell surface of the same kind and is separated from them by an intercellular substance.

The modifications are called cell cohesion or cell junctions .

Types of cell junctions:

According to the distance between the two cell membranes they may be:

1- Inter cellular cement:

Mucopolysaccharide found in the intercellular space between the facing surfaces of epithelial cells in the form of cement substance. L/M: stained with silver nitrate & PAS .

E/M: Devoid of resolvable structure.

Function: Acts as plastic cement.

2- Tight (occluding) junctions:

The distance between the two cell membranes is zero.

There is fusion of the outer surfaces of the opposed plasma membranes with obliteration of the inter cellular space .

They are of two types:

Zonula (Belt) occludens:

Complete band encircling the cell near apical part of its lateral surface.

Site: columnar cells of small intestine, cells of kidney tubules and urinary bladder.

L/M: Appearing as terminal bar.

E/M: - Formed of 5 layers.

The middle dense layer is formed by the fusion of the 2 outer layers of the trilaminar membranes and on either sides by a light which is the middle layer of the trilaminar membrane and dense which is the inner layers of the trilaminar membrane.

A band of dense cytoplasm is associated with the zonula.

Fascia (sheet - like) occludens:

It is the site of patchy fusion of two cell membranes.

Site: Endothelial cells of blood capillaries.

Function of tight junction: form barriers preventing passage of fluids, electrolytes macromolecules from the intercellular space to the free border.

3- Adherent junction:

The cell membranes of adjacent cells adhere to each other.

A medium of intercellular component holds adjacent cells together.They are of 3 types.

i- Zonula adherens (Belt desmosomes):

Site: Columnar cells of small intestine - cells of kidney tubules and urinary bladder (as occludes in site and extent).

L/M: Appearing as a terminal bar.

E.M: Inter cellular space (20 nm) filled with amorphous substance.

The cell membranes run parallel with a clear trilaminar structure.

The next cytoplasm is dense containing actin micro filaments.

ii- Fascia (band) adherens:

- As a sheet only.

Site: Intercalated disc of the heart to anchor the cells and help transmission of force from on cell to the other.

iii- Macula adherens (Focal or Spot desmosome):

Site: intestinal epithelium, cardiac muscle and deep layers of epidermis .

L/M: Forming the terminal bar.

E/M :

Spine - like processes with tonofilaments.

It is spot like not a belt or band.

Intercellular space (24 -30 nm) filled with microfilaments.

The cell membrane on either side running parallel to each other.

Disk shaped attachment plaque located opposite each other in the cytoplasm

Tonofilament are inserted into the plaques where make hairpin turn then extend back into the cytoplasm.

Function:

1-Strong attachment.

2- help the structural stability of the epithelium by linking the cytoskeleton of adjacent cells.

4- Gap (communicating) junction (nexus):

Site: Gastro intestinal tract, cardiac and smooth muscle and nervous tissue.

E/M: Very narrow intercellular space (2 nm).

Direct cylindrical communicating channel between the cells.

Each channel is formed of 6 particles (connexons) that extends to join the opposing membranes.

Function:

1-Permits passage of ions and small molecules from one cell to cell.

2- Coordinating activity of a group of cells.

3- Microvilli and microplicae:

They project into the intercellular cleft.As in liver.

4- Interlocking membranes:

Site: Most epithelium as alimentary canal.

E/M: Ridges and grooves in the facing of surfaces of the cells.

Functions: Increase the mechanical resistance to the shearing forces of fluid transfer.

3- Polyploidy and its causes

Polyploidy means presence of extra set of chromosome .

1- Triploidy (69 chromosome) :It deviation from the normal number of chromosomes .Each chromosome is presen in threefold instead of twofold .
2- Tetraploidy, four copies of each chromosome are present.
3- Endoreduplication: Is a special case of tetraploidy. There are two sequential DNA replications in S phase .Cell enter division containing 92d chromosomes (not 92 S chromosomes).Each chromosome pair appears to have another homologus pair .

Causes of polyploidy:

1- Spindle apparatus defects: There is paralysis of the Spindle apparatus results in failure of cytokinesis.
2- abnormal separation of polar bodies: The failure of the second polar body to be extruded from the fertilized ovum and the subsequent fusion with the male and female pronuclei lead to the formation of triploid zygote.
3- If an abnormal oocyte with a double chromosome (46, XX) complement instead of a haploid complement (23, X) is formed. After fertilization by a normal spermatocyte, triploidy (69, XXX) or (69, XXY) arises .
4- Abnormalities during spermatogenesis, resulting in an abnormal spermatozoon that does not contain the normal haploid chromosome complement, but rather the diploid (46XY .(
5- Di-spermy or fertilization of a normal egg by two normal sperm.
6- Drugs affecting microtubule system as colchicine, vinblastin, and cytocalasin B.
7- Virus infection as rubella virus of German measles

4- White pulp of the spleen

Is closely associated with central arteriole. Is composed of the:

1- Periarterial lymphatic sheath (PALS):

It surrounds the central arteriole.

Composed of T lymphocytes

It is the thymus dependant zone.

2- Lymphoid nodules :

Composed of B lymphocytes.

May contain Germinal center (indicative antigenic challenge).

3- Marginal zone :

Surrounds the lymphoid nodule.

Separates the white pulp from the red pulp.

Composed of plasma cells ,B lymphocytes, macrophages and interdigitating dendritic cells (APCs).

5- Unit of structure of skeletal muscle

The skeletal muscle consists of muscle fibers arranged in bundles of very long (up to 40 mm) cylindrical cells with a diameter of 10-100 µm.

Shape: are long , cylindrical.
Nuclei: are multiple, oval , peripheral in position and euchromatic.
The cell membrane is called sarcolemma.
The cytoplasm: Is called sarcoplasm.
It contains all organoids and inclusions.
1-myofibrils. The sarcoplasm is filled with long filamentous bundles called myofibrils. In a cross section these bundles of myofibrils are separated from each other by sarcoplasm and appear as fine dots called Colienheim's areas.
Skeletal muscle show 2 types of striations:
a- Longitudinal striations: due to longitudinally placed myofibrils parallel to the long axis of the muscle fiber.
b- Cross striations (transverse striations) : caused by regular arrangement of dark and light bands .Each myofibrial shows alternating dark and light bands.
The dark bands of all myofibrils are arranged to lie in the same level and all the light hands also lie in another level. So the dark bands and the light bands appear passing from one side of the muscle fiber to the other side, thus giving the muscle fiber striated appearance.
a-Dark bands
Are Anisotropic bands, they cause double refraction to the polarized light and are called A bands.
b-Llight bands
Are Isotropic hands, they cause single refraction to the polarized light, they are called I hands.
Each dark band (A band) is divided into two equal parts by a pale region called Hensen's disc or H band and within this a very fine dark middle strip or M line is present.
Each light band (I band) is divided into two equal parts by dark membrane called Krouse's membrane or Z-line.
The Z lines divided the myofibrils into contractile units called the sarcomeres.
The sarcomere:

It is the unit of contraction of the muscle fiber.

It is the distance between two successive Z lines.

Each sarcomere includes the whole dark band and half of the two light bands on both sides of the dark band.

The region of the sarcomere which contain both actin and myosin filaments appears darker than the region which contains actin filaments only.

The H band appears lighter because it has only myosin filaments.

When the sarcomere contracts, the actin filaments on either side of the H hand approaches each other to make the H band not seen from the other regions of the dark band.

2-Myofilament: Myosin and actin represent 55% of the total protein of striated muscle.

a- Thick myofilament:

They are 1.6 µm long and l5 nm wide and formed of myosin and are present in the dark (A) bands.

b- Thin myofilaments:

They are 1.0 µm long and 8 nm wide .Composed of actin, tropomyosin and troponin .

Are present in the light bands and extend for a short distance in the dark bands.

3-Sarcoplasmic reticulum:

Each myofibril is surrounded by a network of sarcoplasmic reticulum formed of thin tubes and sacs which are interconnected with one anther.

They are smooth endoplasmic reticulum .

At the regions of the A-I junction the sacs are wider and are called the Terminal cisternae.

4-T- tubule: It is a transverse tubule between each 2 neighboring terminal cisternae .

It is formed by the invagination of the sarcolemma.

It extends transversely to encircle the sarcomeres like collars at the A-I junction.

All the T- tubules of a muscle fiber are together called the T- system.

5-The triad :

Formed of two terminal cisternae with a T-tubule in between.

The terminal cisternae in successive triads are joined by smaller tubules of the sarcoplasmic reticulum forming fenestrated collars around the sarcomeres.

The triads play an important role in conducting the waves of excitation to the myofibrils.

6-Mitochondria

7-Glycogen:

It is found in the form of coarse granules serves as a source of energy for muscle contraction.

8-Myoglobin:

It is oxygen - binding protein which is similar to hemoglobin it is responsible for the dark red color of some muscles.

It acts as oxygen - storing pigment which is necessary for the high oxidative phosphorylation level.

9- Golgi complex , rER and ribosomes.

10-Connective Tissue of skeletal muscle

The skeletal muscle fibers are arranged in regular bundles.

Every skeletal muscle is surrounded from outside by a dense connective tissue sheath called the epimysium.

The bundles of fibers are separated from each other by CT tissue sheath called the Perimysium.

Each muscle fiber is itself surrounded by a delicate layer of CT called the endomysium composed mainly of basal lamina and reticular fibers.

The role of connective tissue is :

mechanically transmit the forces generated by contracting muscle cells.

Blood vessels penetrate the muscle within C.T and form capillary network that runs between and parallel to the muscle fibers. The capillaries are of the continuous type and lymphatic vessels are also found in the C.T.

6- Synapses

Def: It is the point where nerve impulses are transmitted from the axon to another neuron.

The synapse consists of :

1- Presynaptic membrane: It is the part of the axon that delivers the impulse to the synapse. It is expanded forming end-bulb or terminal button. It contains mitochondria, actin-like filaments and neurovesicles are membranous vesicles containing the chemical transmitter acetyl choline and catecholamines, involved in transmitting the nerve impulse across the synapse

2- Postsynaptic membrane: the part that receives the impulse.

3- The synaptic cleft: The space between the presynaptic membrane and the postsynaptic membrane. It contains glycoproteins and glycolipids.

Types of synapses:

a- According to the site of termination of the axon:

1- Axo-somatic synapse: The axon terminate on the cell bodys.

2- Axo-dendritic synapse: the axon terminates on a dendrite.

3- Axo-axonic synapse: the axon makes synaptic contacts with other axons.

b- According to the presence of electron-dense granules:

1- Assymmetrical synapse with thick postsynaptic density and wide synaptic cleft.

2- Symmetrical synapse: The two synaptic membranes are of similar densities.

c- According to the presence or absence of chemical transmitter:

1- Chemical synapse: the synaptic vesicles containing the neurotransmitter.

2- Electrical synapse: without vesicles. It resembles a gap junction. It has a very fast conduction. It is present in brain stem, cerebral cortex and retina.

3- Mixed synapse: the two types of synapse are represented.

Function of the synapse:

- The arrival of a nerve impulse at the synapse cause depolarization of the presynaptic membrane, which becomes permeable to Ca++ ions.
- The Ca ions entering the terminal will cause the neurovesicles to fuse with the presynaptic membrane and discharge the chemical transmitter into the synaptic cleft .
- The release of the neuro-transmitter will either excite (depolarize) or inhibit (hyperpolarize) the postsynaptic membrane
- The excitation or inhibition depends on the relative thickness and densities of the presynaptic and post synaptic membranes coupled with the width of the synaptic cleft .
- The asymmetric synapse is the site of excitatory responses.
- The symmetric synapse is the site of inhibitory responses.

7- Granular leucocytes

1- NEUTROPHIL or Polymorphonuclear Leucocytes

percentage : 60 to 75% of the total leukocytes.

diameter : 10 to 12 microns .

L/M: nucleus is single but it is segmented, it is formed of 2 to 5 segments connected with each other by chromatin threads.

The cytoplasm: contains large azurophilic granules and small specific granules.

Neutrophils have an amoeboid movement, they can protrude pseudopodia in order to engulf micro-organisms.

E/M: The cytoplasm contains few mitochondria, endoplasmic reticulum, glycogen granules and the following two types of ***Granules:***

Azurophilic Granules: are few in number and large in size. They are lysosomes very rich in hydrolytic enzymes.

Specific Granules are numerous and small in size. They contain collagenase enzyme, alkaline phosphatase and bacteriocidal substance.

Function: (carried outside blood stream).

- Phagocytosis and destruction of microorganisms by the specific & the azurophilic granules.
- Secretion of proteolytic enzymes, which cause lysis of the bacteria & surrounding C.T. (forming pus which prevents spreading of bacteria to surroundings).
- Attraction of monocytes to the site of infection.
- Produce pyrogens which elevate body temperature (fever), to inhibit the growth of bacteria.
- Secretion of trephone, which helps in healing by stimulation of fibroblasts to form new connective tissue.
- Stimulation of bone marrow to form new neutrophils.

NEUTROPHILIA:

It is increase number of neutrophils. This occurs in acute infections which may produce pus as in: tonsillitis, appendicitis and in any abscess formation.

NEUTROPENIA:

It is the decrease in the number of neutrophils. It occurs in typhoid fever, T.B. influenza and in severe poisoning.

2- EOSINOPHIL LEUCOCYTES:

percentage: 2 to 5 % of the total leucocyte

diameter: 12-14 microns.

L/M: nucleus is bilobed or horse shoe shaped.

cytoplasm contains large, coarse, specific acidophilic granules which appear shiny red.

EM: cytoplasm contains few mitochondria, small Golgi body and few endoplasmic reticulums.

It is rich in granules (has longitudinal crystalloid core) considered as Lysosomes and contain the following enzymes:

1- Histaminase enzyme to destroy histamine substance.

2- Sulphatase enzyme to destroy sulphate substance

Functions of Eosinophils:

1- They are attracted to the site of allergic reactions by eosinophil chemotactic factors which are released by mast cells and basophil cells.

2- Eosinophils contain histaminase and sulphatase enzymes to destroy histamine and sulphated substances.

3- Eosinophils can phagocytose the antigen - antibody complex in allergic conditions.

Life span of eosinophil is from 8 to 12 days.

Eosinophillia:

It is increase in the percentage of eosinophils which occurs in:

Allergic diseases as urticaria, eczema, bronchial asthma, skin and blood diseases.

Parasitic diseases as ascaris, bilharziasis and ankylostoma infestation.

Eosinopenia :

It is decrease in number of eosinophils which occurs during treatment with cortisone because it inhibits their formation in the bone morrow.

3- BASOPHILS:

percentage : 0 - 1%.

diameter :10-12 microns.

L/M :

cytoplasm is filled with large basophilic electron dense granules similar to those of mast cells.

These granules can be stained by Giemsa stain

nuclei are large and irregular (S shaped) in shape.

E/M: The cytoplasmic granules are large, membrane bounded.

Function :

1- production and carriage of histamine and heparin .

2- They are slightly phagocytic cells.

Life span from 10-15 days.

Basophilia: increase in the percentage of basophils occurs in: liver cirrhosis, small pox and in allergic and parasitic diseases.

8- Nuclear pore complex

The NPC is composed of four protein elements :

1- The scaffold surrounds the pore and supports the other elements. It maintains the pore and simple diffusion channels.

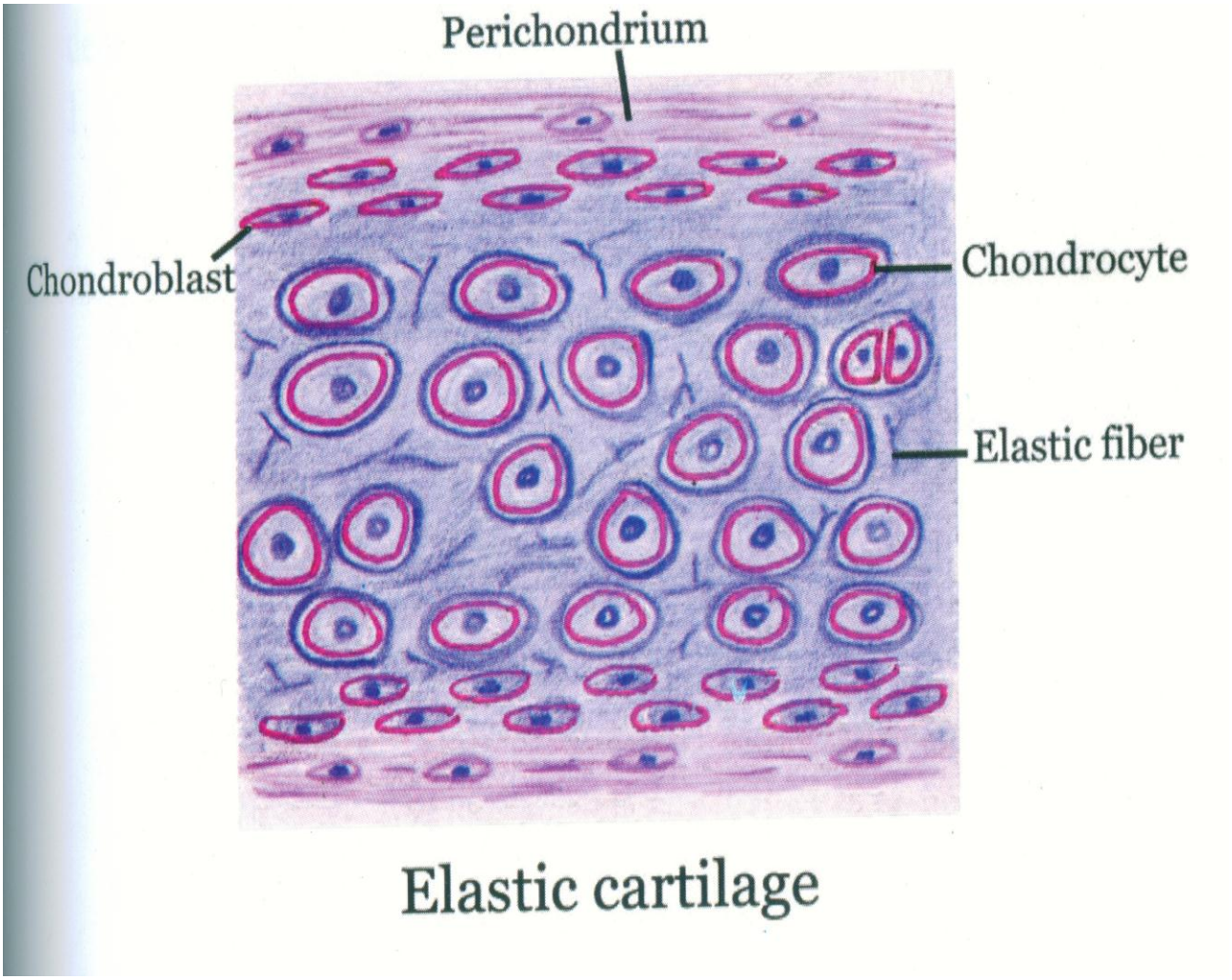
2- The transporter (central hub) is the central protein ring responsible for transporting proteins into and out of the nucleus via receptor-mediated transport.

3- Thick filaments (about 3 nm in diameter) project from the scaffold ring into the cytoplasm and may serve as a staging area prior to protein transport.

4- The basket is projecting from the scaffold ring into the nucleoplasm. it is function in RNA transport.

Function: The NPC permits passive movement across the nuclear envelope via a 9 nm open channel. Most proteins, regardless of size, pass in either direction only by active transport.

9- a labeled diagrams of Elastic cartilage.



10- a labeled diagrams of Decalcified compact bone.