**M.Sc ZOOLOGY**

**PAPER III – CELL AND MOLECULAR BIOLOGY- DZO13**

**Unit -I**

**Plasma membrane and intracellular**

**Compartments**

**SYNOPSIS of the Unit**

Plasma membrane

(A) Structure

(B) Functions

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(A) Structure

(B) Functions

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**Plasma membrane**

Every living cell is externally covered by a thin transparent electron microscopic, elastic regenerative and selective permeable membrane called plasma membrane. It is quasi fluid in nature. According to Singer and Nicolson it is “protein iceberg in a sea of lipid”. A cell wall lies external to plasmalemma in plant cells, many monerans, some protists and fungal cells. Membranes also occur inside the cells. They are collectively called biomembranes. The term cell membrane was given by C. Nageli and C. Cramer (1855) for outer membrane covering of the portoplast. It was replaced by the term plasmalemma or plasma membrane by Plowe (1931).

Proteins lipoprotein (Lipid +Protein) are the major component forming 60% of the plasma membrane. Proteins provide mechanical strength and responsible for transportation of different substances. Proteins also act as enzyme. Lipids account may 28%-79% depending upon the type of cell and organism involved(in humans, myelin 79%). Because of the presence of lipids, membranes are always continuous, unbroken structures and are deformable and their over all shape can change. The lipids of plasma membra ne are of three types namely phospholipids, glycolipids and sterols. A glycolipid may be cerebroside organglioside. The sterol found in the membrane may be cholesterol (Animals), phytosterol (Plants) or ergosterol (Microorganisms). A lipid molecule is distinguishable into a head of glycerol and two tails of fatty acids.

Carbohydrates form 2%–10%. Oligosaccharides are the main carbohydrates present in plasma membrane. The carbohydrates of plasma membrane are covalently linked to both lipid and protein components. The common sugars found in the plasma membrane are D – glucose, D – mannose, D – glactose, N – acetyl glucosamine, N – acetyl galoactosamine (Both are amino sugars) and sialic acid. Generally the terminal sugar of oligosaccharides is sialic acids (Also known as N – acetylneuraminic acid NANA) which gives them a negative charge.

**A.Structure :**

Under electron microscope the plasma membrane appears three layered, i.e. trilaminar or tripertite. One optically light layer is of lipid and on both sides two optically dense protein layers are present. Generally the plasma membrane is 75 Å thick (75 – 100Å), light layer is 35 Å

while dark layers are in thickness.

**Molecular structure and different models :**

Several models have been proposed to explain the structure and function of the plasma membrane.

(i) **Overton’s model :** It suggests that the plasma membrane is composed of a thin lipid bilayer.

(ii) **Sandwich model :** It was proposed by Davson and Danielli (1935). According to this model the light biomolecular lipid layer is sandwiched between two dense protein layers. This model was also said to be unit membrane hypothesis.



(iii) **Robertson’s unit membrane model :** It states that all cytoplasmic membranes have a similar structure of three layers with and electron transparent phospholipid bilayer being sandwiched between two electron dense layer of proteins. All biomembranes are either made of a unit membrane or a multiple of unit membrane. Its thickness is about 75 Å with a central lipid layer of 35 Å thick and two peripheral protein layers of 20 Å thick.



(iv) **Fluid mosaic model :** The most important and widely accepted latest model for plasma membrane was given by **Singer and Nicolson in 1972**. According to them it is “protein iceberg in a sea of lipids.”



According to this model, the cell membrane consists of a highly viscous fluid matrix of two layers of phospholipid molecules. These serve as relatively impermeable barrier to the passage of most water soluble molecules. Protein molecules occur in the membrane, but not in continuous layer; Instead, these occur as separate particles asymmetrical arranged in a mosaic pattern. Some of these are loosely bound at the polar surfaces of lipid layers, called peripheral or extrinsic proteins. Others penetrate deeply into the lipid layer called integral or intrinsic proteins. Some of the integral proteins penetrate through the phospholipid layers and project on both the surface. These are called trans membrane or tunnel proteins (glycophorins). Singly or in groups, they function as channels for passage of water ions and other solutes. The channels may have gate mechanism for opening in response to specific condition. The carbohydrates occur only at the outer surface of the membrane. Their molecules are covalently linked to the polar heads of some lipid molecules (forming glycolipids) and most of the proteins exposed at outer surface (formingglycoproteins).

The sugar protions of glycolipids and glycoproteins are involved in recognition mechanisms :–

(a) Sugar recognition sites of two neighbouring cells may bind each other causing cell to cell adhesion. This enables cells to orientate themselves and to form tissues.

(b) Through glycoproteins, bacteria recognise each other. e.g., female bacteria are recognised by male bacteria.

(c) These provide the basis of immune response and various control system, where glycoproteins act as antigens. Lipid and integral proteins are amphipathic in nature i.e., they have hydrophilic and hydrophobic

groups within the same molecules. The NMR (Nuclear magnetic resonance) and ESR (Electron spin resonance) studies showed that the membrane is dynamic. The lipid tails show flexibility. The molecule can rotate or show flip flop motion.

**Difference between protein types**

|  |  |
| --- | --- |
| **Extrinsic Protein** | **Intrinsic Protein** |
| These are associated with surface only. | These lie throughout phospholipid matrix and project on both surfaces, also called transmembrane or tunnel protein. |
| They form about 30% of the total  membrane protein. | They form about 70% of total  membrane proteins. |
| Example – Spectrin in red blood  cells & ATPase in mitochondria. | Example – Rhodopsin in retinal rod cells. |

**Membrane protein can be of following types with different functions**

**Carrier molecules :** These bind with the specific molecules into or out of the cell. This provides selective exchange of materials. The carrier protein molecules are called “permeases” *e.g., Na*+ – *K*+ pump, *Na*+– sugar transport.



(ii) **Receptor molecules :** The glycoproteins on the cell surface act as receptors that recognize and bind with specific molecules.

(iii) **Enzyme molecules :** The inner mitochondrial membrane carrier enzyme comprising the electron transport chain for cellular respiration.

(6) **Cell membranes are fluid and dynamic due to**

(i) The constituent molecules can move freely in the membrane.

(ii) The cell membranes are constantly renewed during the cells life.

(iii) They can repair minor injuries.

(iv) They expand and contract during cell movement and during change in shape.

(v) They allow interactions of cells such as recognition of self and fusion of cells.

(7) **Membrane permeability :** According to permeability, membranes are classified as –

(i) **Permeable membrane** : They allow both solvent and solute molecules or ions through them. e.g., cellulose wall, lignified cell walls.

(ii) **Impermeable membrane :** They do not allow solute and solvent molecules. e.g., heavily cutinised or suberinised cell walls in plants.

(iii) **Semi-permeable membrane :** They allow solvent molecules only. e.g., membranes of colloidion, parchment paper and copper ferrocyanide membranes.

(iv) **Differentially permeable membrane :** All membranes found in plants allow some solutes to pass through them along with the solvent molecules. e.g., plasma membrane, tonoplast (vacuolar membrane) etc.

**Intercellular communications/modification of plasma membrane/following structures are derived from plasma membrane**

(i) **Microvilli :** They are fingers like evaginations of 0.1 diameter, engaged in absorption. e.g., intestinal cells, hepatic cell, mesothelial cells. The surface having microvilli is called striated border or brush

border.

(ii) **Lomasomes :** They are plasmalemma foldings found in fungal cells.

(iii) **Mesosomes :** It serves as site for cellular respiration in prokaryotes.

(iv) **Tight junctions :** Plasma membrane of two adjacent cells are fused at a series of points with a network of ridges or sealing strands. e.g., capillaries, brain cells collecting tubules etc.

(v) **Plasmodesmata :** They are protoplasmic bridges amongst plant cells, which occur in area of cell wall pits. It was discovered and reported by Tangle and Strasburger respectively.

(vi) **Desmosomes :** concerned with cell adherence.

(9) **Functions of Plasma membrane**

(i) They control the flow of material through them and provides passage for different substances.

(ii) It is differentially permeable, solute particles (1-15 Å) can pass through it.

(iii) It is not only provides mechenical strength but also acts as a protective layer.

(iv) Plasma membrane is responsible for the transportation of materials,

molecules, ions etc.

(v) It helps in osmoregulation.

(vi) Diffusion of gases take place through plasma membrane by simple and facilitated diffusion.

(vii) Transport of ions, small polar molecules through active (energy used) and passive transport (energy not used).

(viii) Gases like and diffuse rapidly in solutions through membranes.

(ix) Ions and small polar molecules diffuse slowly through the membranes.

(x) Some solute molecules or ions first bind with certain specific carrier or transport proteins called permeases.

(xi) Water as well as some solute molecules and ion pass through membranes pores; pores are always bordered by channel proteins.

(xii) When diffusion takes place through channel, called simple diffusion and through carrier proteins, called facilitated diffusion.

**Principles of Membrane Transport**

**Membrane transport :** It is passage of metabolites, by-products and biochemicals across biomembrane. Membrane transport occurs through four methods–passive, facilitated, active and bulk. Size of the particles passing through plasmalemma is generally 1 – 15 Å.

(i) **Passive transport :** No energy spent. Passive transport occurs through diffusion and osmosis.

(a) **Diffusion :** It is movement of particles from the region of their higher concentration or electrochemical potential to the region of their lower concentration or electrochemical potential. Electrochemical potential operates in case of charged particles like ions. Diffusion can be observed by opening a bottle of scent or ammonia in one corner, placing a crystal of copper sulphate in a beaker of water or a crystal of on a piece of gelatin. Simple diffusion does not require carrier molecules.

**Independent Diffusion :** In a system having two or more diffusion substances, each individual substance will diffuse independent of others as per gradient of its own concentration, diffusion pressure or partial pressure form region of higher one to region of lower one. Rate of diffusion is proportional to difference in concentration and inversely to distance between the two ends of the system, inversely to square root of relative density of substance and density of medium, directly to temperature and pressure.

(b) **Osmosis** is diffusion of water across a semipermeable membrane that occurs under the influence of an osmotically active solution.

(c) **Mechanism of passive transport :** Passive transport can continue to occur if the absorbed solute is immobilised. Cations have a tendency to passively pass from electropositive to electronegative side. While anions can pass from electronegative to electropositive side. There are two modes of passive transports.

**Lipid matrix permeability :** Lipid soluble substances pass through the cell membrane according to their solubility and concentration gradient, e.g., triethyl citrate, ethyl alcohol, methane.

**Hydrophillic membrane channels :** They are narrow channels formed in the membrane by tunnel proteins. The channels make the membrane semipermeable. Water passes inwardly or outwardly from a cell through these channels according to osmotic gradients. and also diffuse through these channels as per their concentration gradients. Certain small ions and other small water soluble solutes may also do so.

(d) **Ultrafiltration** is fine filtration that occurs under pressure as from blood capillaries, epithelia and endothelia. It is of two types : –

Paracellular through leaky junctions or gaps in between cells.

Transcellular through fenestrations in the cells. ‘Dialysis’ is removal of waste products and toxins from blood by means of diffusion between blood and an isotonic dialysing solution.

(e) **Facilitated transport or Facilitated diffusion :** It is passage of substances along the concentration gradient without expenditure of energy that occurs with the help of special permeating substances called permeases. Permeases form pathways for movement of certain substances without involving any expenditure of energy. At times certain substances are transported alongwith the ones requiring active transport. The latter phenomenon called cotransport. Facilitated transport occurs in case of some sugars, amino acids and nucleotides



(ii) **Active transport :** It occurs with the help of energy, usually against concentration gradient. For this, cell membranes possess carriers and gated channels.

**Carrier particles or Proteins**

They are integral protein particles which have affinity for specific solutes. A solute particles combines with a carrier to form carrier solute complex. The latter undergoes conformational change in such a way as to transport the solute to the inner side where it is released into cytoplasm.

**Ion Channels** / **Gated channels :** The channels are opened by either change in electrical potential or specific substances, e.g., Calcium channels. Active transport systems are also called pumps, e.g., pump, pump, pump, pump. The pumps operate with the help of ATP. exchange pump occurs in guard cells. exchange pump operates across many animal membranes. For every ATP hydrolysed, three ions are passed out while two ions are pumped in. Sea Gulls and Penguins operate pump for excreting NaCl through their nasal glands. Active transport of one substance is often accompanied by permeation of other substances. The phenomenon is called secondary active transport. It is of two main types, cotransport (e.g., glucose and some amino acids alongwith inward pushing of excess ) and counter-transport ( and movement outwardly as excess passes inwardly).

**Endoplasmic Reticulum**

Though Endoplasmic Reticulum (E.R), a part of cytoplasm vesicular system was first observed by Grainier (1897) and named it as ergastoplasm, but its ultrastructure was first given by Porter, Claude and Fullan (1945) term ER was coined by K.R. porter (1953).Porter defined ER as a “well developed electron microscopic network of interconnected cisternae, tubules and vesicles present throughout the cytoplasm, especially in the endoplasm. The ER is found almost all animal and plant cells. The only exceptions are mature erythrocytes and prokaryote. It can be recognised as early as in the two celled stage.Development of ER depends upon the metabolic state and stage of differentiation of the cells eg. absent from embryonic cells, less developed in spermatocytes (only a few vesicles) well developed in fully differentiated andmetabolically active cells like animal cells of pancreas, hepatocytes of liver etc.

**Types of Endoplasmic Reticulum**

There are two basic morphological types of the ER, rough ER (RER) or granular form (ergastoplasm) and the smooth ER (SER) or agranular form. Originally the Golgi complex was included in the SER but was later considered as a separate system. The rough ER is so called because the membrane are covered with ribosomes, giving them a rough appearance in sections. The smooth ER membranes are not covered with ribosomes. Depending upon the metabolic requirements of the cell, RER and SER are inter convertible.

**1. Rough Endoplasmic Reticulum (RER)**

The RER is predominant in cells which actively synthesize proteins eg. The enzyme secreting cells. Generally it is found in that part of cytoplasm which is basophilic (ergostoplasm) a property which is

attributed to attached ribosomes which contain RNA. Only rarely it has been found that basophilic region is devoid of ER, since in these regions ribosomes are free. Such regions are found in embryonic animal and

plant cells.RER is particularly well developed in pancreatic and liver cells where secretory proteins are synthesized on the attached ribosomes and are translocated through cisternae to different sites in the cells.

**2. Smooth Endoplasmic Reticulam SER ( AGLANULAR )**

The SER is characteristic of cells in which synthesis of non protein substances like phospholipids, glycolipids and steroid hormones takes place e.g. adipose tissue cells, adrenocortical cells and interstitial cells of the testis. Smooth ER forms a continuous system with rough ER, but was of different morphology. It consists of smooth membrane segments and found in regions rich in glycogen. SER is used for the formation of transport vesicles, which carry proteins and lipids to the Golgi complex.

**Differences between RER and SER**

|  |  |  |
| --- | --- | --- |
| Character | SER | RER |
| Ribosomes | Absent | Present |
| Position | Mainly present near the  cell membrane | Mainly present near the  nucleus |
| Components | Mainly formed of tubules | Mainly formed of cisternae |
| Occurrence | Mainly found in lipids or  steroids forming cells or  glycogen ( fat cells of  adipose connective tissue)  interstitial cells (of testis)  glycogen-storing cells (of  liver ) muscle cells,  leucocytes, retinal cells  etc. | Mainly found in protein  forming cells e.g. animal  cells  ( pancreas) goblet cells  ( gut cells secreting mucus)  plasma cells ( antibodies  producing cells ), Nissil  granules of endocrine cells  ( anteriorpituitary) etc. |
| 5) Function | Lipid synthesis | Protein synthesis |

**Ultra structure**

Electron microscopic studied showed the presence of 3 types of Element’s in ER.

**Cisternae** : These are narrow, two-layered and unbranched elements generally present near the nucleus. These lie one upon the other and may be interconnected. Each is about 40-50um in diameter and studded with ribosomes. Ribosomes attached to ER by a glycoprotein are called ribophorin.

These are abundant in protein forming cells. Each cisternal of ER has two surfaces : Cytoplasm or protoplasmic face cis with ribosomes and in direct contact with cytosol ) Luminal face ( towards the cisternal space and borders the cavities of cisternal )

**Vesicles** – These are oval or spherical elements scattered in the cytoplasm. Size ranges from 25-500 um in diameters. These often occur isolated in the cytoplasm and are also studded with ribosomes thus mainly found in protein forming cells.

**Tubules**

These are wider, tubular and branched elements mainly present near the cell membrane.Each is about 50-100 um in diameters. These are without ribosome so are more in lipid and asteroids forming cells and

the cells involved in glycogen metabolism. In liver cells, fine tubules with glycogen granules are called glycosomes.



Three types of elements of ER may be present within the same cell and are interconnected with one another, and are also connected with the membrane of other cell organelles like Golgi body, mitochondria, nuclear membrane and even with the cell membrane to form a cytoplasm vacuole system. ER forms about 30% to 60% (average 50% ) of the cytoplasm vascular system and 10% of total cell volume. ER also contains a fluid called endoplasmic matrix in the elements.

**1. Modifications of ER**

Sarcoplasmic reticulum – A modified form of the SER is the sarcoplsmic reticulum found in striated muscles. (Fig 1) this is a delicate plexus surrounding the myofibrils. The longitudinal sarcoplasmic

tubules merge to form terminal cisternae. A terminal cisternae from each sarcomere, together with a small transverse tubule between them, constitute a triad, which lies over the I band. Along the H band level is a

central cisternae which have pores. The central cisternae are formed by confluence of the longitudinal sarcoplasmic tubules. In some muscles the triad lies over the functions of A and I bands, and thus there are two triads per sarcoma.



It helps in distributing energy-rich material form muscular contraction.It provides channels for conducting the nerve impulses on the whole muscle fibers.It also helps in expelling of lactic acid formed during muscle contraction. So prevents muscle fatigue.

**Ergastoplasm or Basoplasm or Chromodial Substance**

It is an accumulated mass of cisternae with ribosomes (i.e. RER) present in the cytoplasm of some metabolically active cells.Term ergastoplasm was coined by Garnier (1899).In the cyton of neurons, such bodies are called Nissil granules (also called trigoid granules).Casperson (1955) found it to be basophillic in nature due to the presence of RNA

**Function** It is involved in protein synthesis.

3. **Myeloid bodies** – These are found in retinal cells. Each myeloid body is a biconvex, about 4-5 um long formed from stacks of packed tubules so are modified SER and not associated with ribosomes.

**Function** These are probably related with photoreception.

**Annulated lamella –**

These are found in immature oocytes and spermatocytes (afzelius,1955) and were first reported in the oocytes of sea Urchin -Arbacia. These occur either in the form of free unstacked vesicles in the cytoplasm or as stacked annulated lamella (2-12 in number) near the nucleus. Two membranes

are interspaced by 20-40mm.

**Interrelationship between ER and other membrane**

Watson (1955) demonstrated continuity between the outer nuclear membrane and the ER. The ER also shows connections with the plasma membrane and Golgi complex. It is suggested that : Ectokaryotheca of nucleus form vesicles by blebbing. These vesicles fuse to form annulated lamella. Annulated lamella loses their pore complexes, become associated with the ribosomes and form RER cisternae.

RER produces transition vesicles which fuse to form the cisternae of Golgi complex. Golgi body forms the vesicles which fuse to form the plasma lemma (Northcote, 1971). Golgi body also gives rise to secretory granules and primary lysosomes by blebbing. Plasmalemma invaginates to form pinocytotic vesicles.

Pinocytotic vesicles and primary lysosomes fuse to form the secondary lysosomes (Novikaff, 1962).

RER loses the ribosomes to form SER.

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**Origin**

Most accepted view, regarding the origin of ER is that RER arises as an evagination of outer nuclear membrane (Palade, 1956) while SER is formed from RER by the loss of ribosomes.This view is supported by the following similarities between ER and nuclear membrane.

Both are similar in chemical composition (lipoproteinous and trilaminar).

Intercistrnal space of ER is continuous with perinuclear space.

Both RER and ectokaryotheca of nuclear envelope are studded with ribosomes.

Fluid present in the ER cisternae and per nuclear space is of similar nature.

Derivation of SER from RER is further proved by the use of radioactively

labelled amino acids.

**Function of ER**

Common function of ER

**Intracellular transport –** ER acts as cell-circulatory system (Palade, 1956) and helps in transportation of materials inside the cell. Eisner and Novikoff (1962) suggested a directional flow of materials as under.

**RER SER Golgi body** Primary lysosome \_\_\_\_ out of cell(exocytosis).

**Storage –** ER helps in storage of metabolic products of cell. eg. glycogen

**ATP Synthesis –** ER is the site of ATP synthesis to provide energy for intracellular transport materials or RNA metabolism.

**Cytoskeleton –** ER is the major component of cytoplasm – vacuole system which acts as cytoskeleton and provides mechanical support and a definite shape to the cell.

**Formation of cell plate –** During cytokinesis in the plant cells, ER provides small sized phragmoplasts which arrange themselves at the equator and later fuse to form the cell plate which changes into the middle lamella at the end.

**Transportation of genetic information –** ER acts as a passage for the transportation of genetic informations from the nucleus through various cell organelles to control biosynthesis of proteins, fats and carbohydrates.

**Photoreception –** ER of pigmented epithelial cells of retina act as a photoreceptor.

**Formation of primary lysosome –It forms primary lysosomes** with hydrolytic enzymes (Novikoff, 1965).

**Functions of RER –**

**Protein synthesis –** Palade (1951) reported that there is a direct and close correlation between the RNA content of the microsomal fraction and rate of protein synthesis. RER provides two dimensional arrangement of the ribosomes and increases the of protein synthesis.

Formation of SER from RER by the loss of ribosomes.

RER packages the polypeptides into the proteins.

**Formation of transition vesicles –** RER forms the transition or transport vesicles which carry the materials like the proteins to the cisternae of Golgi apparatus for their condensation into secretory vesicles.

**Formation of nuclear envelope –** Porter and machado (1960) reported that nuclear membrane break into a number of fragments which merge with the ER elements during later stages of prophase of mitosis and meiosis. Nuclear envelope is reformed from the cisternae of ER during telophase of cell division.

**Function of SER**

**Lipid synthesis –** Christensen (1963) reported a correlation between the relative amount of a granular ER and rate of lipid (e.g. triglyceride) synthesis in the adipocytes.

**Detoxification of drugs –** Claude (1970) demonstrated that there is considerable hypertrophy of SER when drugs like phenalbabital, steroid hormones, carcinogens etc are administered.

SER is also involved in synthesis of ascorbic acid.

**Fat oxidation -** SER membrane have enzymes to regulate the initial reactions in the oxidation of fats.

**Synthesis of steroid hormones –** Amount of SER has been found to be well developed in those cells which are involved in the biosynthesis of steroid hormones. E.g. corticoids in adrenal cortex ( Rodin, 1971) **;** testosterone in the interstitial cells of testes of opossum ( Christensen and Fawcett, 1961) and

estrogens in the follicular cells of mature ovarian follicle.

**Signal Recognition Particles**

The signal recognition particle (SRP) is an abundant,cytosolic,universally conserved ribonucleoprotein( protein-RNAcomplex ) that recognizes and targets specific proteins to the ER in eukaryotes and the plasma membrane in prokaryotes.The eukaryotic SRP is composed of 6 distinct polypeptides bound to an RNA molecule with GTase activity. The components are SRP6 SRP14, SRP19, SRP54, SRP68, SRP72 & SRPRNA while in prokaryotons it is composed of only one polypeptide bond to an RNA molecule,its components of the complex are Fth and 4.5SRNA.

**Signal Hypothesis**

Free ribosomes synthesis mostly soluble proteins whereas RER bound ribosomes manufacture transmembrane proteins and protein destined for secretion. These large protein molecules pass through the RER membrane. Gunter Blobel, Cesar Milstein, and David Sabatini formulated “signal hypothesis” which partially explain how this happens. These proteins are synthesized with leading ( N – terminal ) signal peptide. A signal peptide first protrude beyond the ribosomal surface after a little growth. At this stage a complex of polypeptide and RNA molecule called signal recognition particle binds to ribosome which arrest further polypeptide growth and prevent it from being released in the cytosol. The SRP – ribosome complex diffuses to the RER surface, where it is bounded by the SRP receptor,which stimulate the bound ribosome to resume polypeptide elongation and facilitates the passage of growing polypeptides N – terminal through the membrane into the lumen of RER. After entry of polypeptide, signal peptide is removed in the presence of signal peptidase enzyme. The other enzyme of lumen cause post translational modification of still growing polypeptide chain. When protein synthesis is completed, secretary, ER and lysosomal proteins pass completely through the RER membrane into the lumen. Transmembrane proteins remain embedded in the ER membrane with their c – terminal on its cytoplasmic side.



**ER. Signal Peptides & Signal Transduction**

Permeability of plasma membrane is one of the most crucial feature of any cell. It is impermeable to certain water soluble materials as they have to react with protein resident in the plasma membrane. The extracellular material is called a legend and the target protein to which it binds is known as receptor. When membrane bound receptor respond to legend binding by triggering a response pathway in the cytosol, the process is designated as signal transduction. It amplifies the original signal and convert it from an inactive to an active form. In its active form, the receptor stimulates a catalytic activity that generates a cytosolic signal whose amplitude is much greater than the original extracellular signal( the ligand ). A molecule produce in response to transduction of an extracellular signal is called a second messenger ( ligand first messenger). The receptor may be a transmembrane protein with domain on both the extracellular side and cytoplasmic side. The receptor may interact with a G– protein that is associated with the membrane. It causes a chain of events in cytoplasm which often stimulate the production of second messenger, the classic example being the production of cyclic AMP ligand –binding may trigger the process of internalization,in which the receptor–ligand combination is brought into the cell by the process of endocytosis.

**Glossary**

 **Plasma membrane ;** A sheet-like membrane,7.5-10nm thick, that forms a selectively permeable barrier enclosing and delimiting the protoplasm of a cell. It is a living structure consisting of lipid molecules in a fluid bilayer, and associated proteins.

 **Active Transport;** The transport of substances across a membrane against a concentration gradient .Such process require, the source of energy often being ATP.

 **Passive Transport;** The transport of molecules across a membrane from higher conc. To lower conc. by diffusion, facilitated-diffusion, filteration or across a semipermeable membrane by osmosis.

 **Endoplasmic reticulum;** A complex network of cytoplasmic membranaeous sacs and tubules which appears to be continuous with both the nuclear and cell membranes .It occurs in two forms; that bearing ribosomes are termed as rough ER; that without ribosomes are smooth ER. Both are involved in the synthesis, transport and storage of cells.

 **Signal Transduction;** Conversion of a signal form one physical or chemical form to another. It is the process by which a cell produces a response to an extracellular signal.

**Self Learning Exsercise**

**Section A ( Short Answer Type)**

1. Define Plasma membrane.

2. Describe Robertson s unit membrane model of plama membrane.

3 . Defferentiate between active and passive transport machenism.

4 . What is the carrier proteins.

5 . What is the Signal hypothesis.

**Section B ( Long Answer Type)**

1. Explain the Fluid mosaic model in detail.

2. What are the functions of plasma membrane.

3. Defferentiate between RER and SER.

4. Give an account of function of ER.

5. Explain Signal transduction in detail.

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