SET II (1) 54405

N.B : (1) All questions are compulsory.
(2) Figures to the right indicate maximum marks.
(3) Use of non-programmable calculators is permitted.
(4) Symbols used have their usual meaning

Q1. A) Select correct answer (12)

1 (b) 3
2 (a) total internal reflection
3 (d) 7.4
4 (b) membrane potential is held at desired constant value
5 (d) None
6 (a) Joule

B) Answer in one sentence (03)

1 Study of sound and its distribution.
2 Osmosis is the spontaneous net movement of solvent molecules through a selectively permeable membrane into a region of higher solute concentration, in the direction that tends to equalize the solute concentrations on the two sides. It may also be used to describe as a physical process in which any solvent moves across a selectively permeable membrane (permeable to the solvent, but not the solute) separating two solutions of different concentrations
3 The band size is around 1 eV.

C) Fill in the Blanks (5)

1 endoscopy
2 Compound action potential
3 -70 mV
4 Quartz (answer can be any other correct substance also)
5 Critical Temperature

Q2. A) Attempt any oneUNIT I (8)

1 Eight factors – 4 marks
Explanation of any two – 4 marks

2 Reverberation explanation – 2 marks
Reverberation time explanation – 2 marks
Sabine formula explanation – 2 marks
Importance of Sabine's formula – 2 marks

B) Attempt any oneUNIT I (8)

1 Digram – 2 marks
Explanation – 6 marks
2 Step index optical fiber - 4 marks
Graded index optical fiber – 4 marks

C) Attempt any oneUNIT I (4)

1 It is given that frequency band width is = 3 KHz
Therefore, the coherence time

$\tau_c = (1/3)\ s^{-1}$
The coherence length,
$l = c.\ \tau_c = (3\times10^8)\ m/s \times (1/3)\ s^{-1} = 10^5\ m$

2 The extent of monochromaticity is given as = $\Delta v/v$
Now $\Delta v = 1/\tau_c = 1/10^{-10} = 10^{10}$ Hz
Further, it is given that $\lambda = 6000$ Å $= 6 \times 10^{-7}$ m
Therefore, $v = c/\lambda = (3 \times 10^8 m/s)/ (6 \times 10^{-7} m) = 0.5 \times 10^{15}$ Hz
Therefore, $\Delta v/v = (10^{10})/ (0.5 \times 10^{15}) = 2 \times 10^{-5}$

Q3. A) Attempt any one (8)

1 The force with which the surface molecules are held together is called surface tension. Basically it is a contractive tendacy of the surface of a liquid that allows it to resist an external flow. According to Gibbs-Thompson principle, substances that lower the surface tension become concentrated at the interface and substances that increase surface tension move away from interface. Lipids and proteins are found concentrated on the cell wall as both are effective in lowering the surface tension. In general, inorganic salts raise the surface tension whereas organic substances usually lower surface tension. Alkalies substances increase surface tension, acid and ammonia lowers it. Surface tension is involved in the process of digestion as bile salts reduce the surface tension of lipids ad thus assist emulsification. As a result of emulsification, surface area is increased which favors lipase activity on lipids.

The free surface of a liquid in a vessel behaves like a stretched membrane. All molecules at the surface film experience stretching force. This force is acting perpendicular to the imaginary straight line drawn anywhere on free surface of liquid. Mathematically, the force per unit length acting at right angles to an imaginary line drawn on the free surface of liquid is called surface tension. S I unit of surface tension is N/m and CGS unit is dynes/cm.

On the basis of molecular theory, the intermolecular cohesive and adhesive forces determine not only the spreading or wetting of surface by liquid, but also determine the surface tension. At 20 $^0$C surface tension of mercury is 435 dynes/cm and that of water is 72.7 dynes/cm. Highly soluble impurities like common salt when dissolved in water, increases the surface tension of water but if sparingly soluble substances like phenol or alcohol are dissolved in water, surface tension decreases. Insoluble impurities also decrease the surface tension. Surface tension of most of the liquids decrease appreciably with increase in temperature and at certain critical temperature it becomes zero.

In the Drop-weight method of measurement of surface tension weight of natural drop of given liquid produced using drop-pipette is measured and is proportional to surface tension. Stalagmometer is an instrument used to measure surface tension of liquid where again a drop method is used but here number of drops for fixed volume of given liquid are counted and then compared to number of drops of same volume of some standard liquid of known surface tension.

Biologically, fat molecules have large surface tension and it digestion and absorption is possible only when its surface tension is decreased. Bile salts in small intestine emulsify fats and decrease their surface tension. Surface tension affects the stretchability of the lungs. A complex 2-phase mixture of proteins and lipids called surfactant produced by large epithelial cells forms inner lining of alveoli (which are the tiny air sacs in the lung). These surfactant molecules are spread apart when alveolar size increases (inspiration on inhale) and they come closer during expiration or exhale of air in lungs. In each of this process of respiration surface tension is adjusted. During exhale stage of respiration, when alveoli contract, surfactant molecular concentration increases and surface tension decreases, so that collapse of alveoli is prevented. Whereas, during inhale stage air is taken in alveolus become larger, surfactant fluid film expands, concentration decreases and surface tension increases. This helps in elastic recoil of lungs. Thus phenomenon of surface tension is the crucial factor in stabilizing the size of alveoli.

2 Basically, the channel or a pore is a protein structure that facilitates the translation of molecules or ions or water across the membrane through the creation of central aqueous channel in the protein. A family of biological membrane proteins which allow the passive movement of ions thus defines ion channels that allows water define water channels or aquaporins and the corresponding material is passively passed through the membrane down their electrochemical gradient. Channels are generally build from 4,5 or 6 proteins subunits that are assembled to form a pore. Certain membrane channels open and close spontaneously, some are gated or opened by chemical action of signaling substance such as calcium, glycine. Some channels are gated by changes in electric potential across the membrane.

These central channels facilitate diffusion in both directions and actual flow direction is decided by concentration gradient. These channels have specificity for ions or molecules may be decided by size or charge like property. For example, sodium channel has diameter of 0.5 nm so that it excludes ions that are bigger than this size. Ions flow down their electrochemical gradient at the rate about $10^8$ ions/sec. Flow rate through channel can be regulated by variety of mechanism that also can result in complete opening and closing of the passage way.

Membrane channels are of three different types: 1. α type channels are homo or hetero oligometric structures that in the latter case consists of several dissimilar proteins. Molecules move through this α type channels down their concentration gradients and thus requires no input of metabolic energy. Aquaporins (AQP) are family of α type channels responsible for transport of water across membrane 2.β type channels (also called as porins) are so named because they have a trans membrane domain that consist of β barrel structure. Porins are found in outer membranes of mitochondria and these are voltage gated. 3. The pore forming toxins form third class of membrane channels. This is a large class of proteins identified in bacteria.

B) Attempt any one (8)

1 Active transport is divided into two types according to the source of the energy used to cause the transport: primary active transport and

secondary active transport. In primary active transport, the energy is derived directly from breakdown of adenosine triphosphate (ATP) or of some other high-energy phosphate compound. In secondary active transport, the energy is derived secondarily from energy that has been stored in the form of ionic concentration differences of secondary molecular or ionic substances between the two sides of a cell membrane, created originally by primary active transport. In both instances, transport depends on carrier proteins that penetrate through the cell membrane, as is true for facilitated diffusion. However, in active transport, the carrier protein functions differently from the carrier in facilitated diffusion because it is capable of imparting energy to the transported substance to move it against the electrochemical gradient.

Primary Active Transport - Sodium-Potassium Pump: Among the substances that are transported by primary active transport are sodium, potassium, calcium, hydrogen, chloride, and a few other ions. The active transport mechanism that has been studied in greatest detail is the sodium-potassium ($Na^+$- $K^+$) pump, a transport process that pumps sodium ions outward through the cell membrane of all cells and at the same time pumps potassium ions from the outside to the inside. This pump is responsible for maintaining the sodium and potassium concentration differences across the cell membrane, as well as for establishing a negative electrical voltage inside the cells. This pump is also the basis of nerve function, transmitting nerve signals throughout the nervous system.

As with other enzymes, the $Na^+$ - $K^+$ ATP pump can run in reverse. If the electrochemical gradients for $Na^+$ and $K^+$ are experimentally increased enough so that the energy stored in their gradients is greater than the chemical energy of ATP hydrolysis, these ions will move down their concentration gradients and the $Na^+$ - $K^+$ pump will synthesize ATP from ADP and phosphate. The phosphorylated form of the $Na^+$ - $K^+$ pump, therefore, can either donate its phosphate to ADP to produce ATP or use the energy to change its conformation and pump Na+ out of the cell and K+ into the cell. The relative concentrations of ATP, ADP, and phosphate, as well as the electrochemical gradients for $Na^+$ and $K^+$, determine the direction of the enzyme reaction. For some cells, such as electrically active nerve cells, 60 to 70 percent of the cells' energy requirement may be devoted to pumping $Na^+$ out of the cell and $K^+$ into the cell.

Energetics of Primary Active Transport: The amount of energy required to transport a substance actively through a membrane is determined by how much the substance is concentrated during transport. Compared with the energy required to concentrate a substance 10-fold, to concentrate it 100-fold requires twice as much energy, and to concentrate it 1000-fold requires three times as much energy. In other words, the energy required is proportional to the logarithm of the degree that the substance is concentrated, as expressed by the following formula: Energy (in calories per osmole) = $1400 \log C_1/C_2$

Thus, in terms of calories, the amount of energy required to concentrate 1 osmole of a substance 10-fold is about 1400 calories; or to concentrate it 100-fold, 2800 calories. One can see that the energy expenditure for concentrating substances in cells or for removing substances from cells against a concentration gradient can be tremendous. Some cells, such as those lining the renal tubules and many glandular cells, expend as much as 90 percent of their energy for this purpose alone.

Secondary Active Transport - Co-Transport and Counter-Transport: When sodium ions are transported out of cells by primary active transport, a large concentration gradient of sodium ions across the cell membrane usually develops— high concentration outside the cell and low concentration inside. This gradient represents a storehouse of energy because the excess sodium outside the cell membrane is always attempting to diffuse to the interior. Under appropriate conditions, this diffusion energy of sodium can pull other substances along with the sodium through the cell membrane. This phenomenon is called co-transport; it is one form of secondary active transport. For sodium to pull another substance along with it, a coupling mechanism is required. This is achieved by means of still another carrier protein in the cell membrane. The carrier in this instance serves as an attachment point for both the sodium ion and the substance to be co-transported. Once they both are attached, the energy gradient of the sodium ion causes both the sodium ion and the other substance to be transported together to the interior of the cell.

In counter-transport, sodium ions again attempt to diffuse to the interior of the cell because of their large concentration gradient. However, this time, the substance to be transported is on the inside of the cell and must be transported to the outside. Therefore, the sodium ion binds to the carrier protein where it projects to the exterior surface of the membrane, while the substance to be counter-transported binds to the interior projection of the carrier protein. Once both have bound, a conformational change occurs, and energy released by the sodium ion moving to the interior causes the other substance to move to the exterior.

Co-Transport of Glucose and Amino Acids along with Sodium Ions Glucose and many amino acids are transported into most cells against large concentration gradients; the mechanism of this is entirely by co-transport. Note that the transport carrier protein has two binding sites on its exterior side, one for sodium and one for glucose. Also, the concentration of sodium ions is high on the outside and low inside, which provides energy for the transport. A special property of the transport protein is that a conformational change to allow sodium movement to the interior will not occur until a glucose molecule also attaches. When they both become attached, the conformational change takes place automatically, and the sodium and glucose are transported to the inside of the cell at the same time. Hence, this is a sodium-glucose co-transport mechanism.

Sodium-glucose co-transporters are especially important mechanisms in transporting glucose across renal and intestinal epithelial cells. Sodium co-transport of the amino acids occurs in the same manner as for glucose, except that it uses a different set of transport proteins. Five amino acid transport proteins have been identified, each of which is responsible for transporting one subset of amino acids with specific molecular characteristics. Sodium co-transport of glucose and amino acids occurs especially through the epithelial cells of the intestinal tract and the renal tubules of the kidneys to promote absorption of these substances into the blood. Other important co-transport mechanisms in at least some cells include co-transport of chloride ions, iodine ions, iron ions, and urate ions.

Two especially important counter-transport mechanisms (transport in a direction opposite to the primary ion) are sodium-calcium counter-transport and sodium-hydrogen counter-transport. Sodium-calcium counter-transport occurs through all or almost all cell membranes, with sodium ions moving to the interior and calcium ions to the exterior, both bound to the same transport protein in a counter-transport mode. This is in addition to primary active transport of calcium that occurs in some cells. Sodium-hydrogen counter-transport occurs in several tissues. An especially important example is in the proximal tubules of the kidneys, where sodium ions move from the lumen of the tubule to the interior of the tubular cell, while hydrogen ions are counter-transported into the tubule lumen. As a mechanism for concentrating hydrogen ions, counter-transport is not nearly as powerful as the primary active transport of hydrogen ions that occurs in the more distal renal tubules, but it can transport extremely large numbers of hydrogen ions, thus making it a key to hydrogen ion control in the body fluids.

2 When a membrane is permeable to several different ions, the diffusion potential that develops depends on three factors: (1) the polarity of the electrical charge of each ion, (2) the permeability of the membrane *(P)* to each ion, and (3) the concentrations *(C)* of the respective ions on the inside *(i)* and outside *(o)* of the membrane. Thus, the following formula, called the **Goldman equation or the Goldman-Hodgkin- Katz equation**, gives the calculated membrane potential on the *inside* of the membrane when two univalent positive ions, sodium (Na+) and potassium (K+), and **one univalent negative ion, chloride (Cl–), are involved.**

$$V_m = \frac{RT}{F}\ln\left(\frac{p_K[K^+]_o + p_{Na}[Na^+]_o + p_{Cl}[Cl^-]_i}{p_K[K^+]_i + p_{Na}[Na^+]_i + p_{Cl}[Cl^-]_o}\right)$$

$V_m$ is the membrane potential. This equation is used to determine the resting membrane potential in real cells, in which $K^+$, $Na^+$, and $Cl^-$ are the major contributors to the membrane potential. Note that the unit of $V_m$ is the Volt. However, the membrane potential is typically reported in millivolts (mV). If the channels for a given ion ($Na^+$, $K^+$, or $Cl^-$) are closed, then the corresponding relative permeability values can be set to zero. For example, if all $Na^+$ channels are closed, $p_{Na} = 0$.

$R$ is the universal gas constant (8.314 $J.K^{-1}.mol^{-1}$).

$T$ is the temperature in Kelvin (K = °C + 273.15).

$F$ is the Faraday's constant (96485 $C.mol^{-1}$).

$p_K$ is the membrane permeability for $K^+$. Normally, permeability values are reported as relative permeabilities with $p_K$ having the reference value of one (because in most cells at rest $p_K$ is larger than $p_{Na}$ and $p_{Cl}$). For a typical neuron at rest, $p_K : p_{Na} : p_{Cl} = 1 : 0.05 : 0.45$. Note that because relative permeability values are reported, permeability values are unitless.

$p_{Na}$ is the relative membrane permeability for $Na^+$.

$p_{Cl}$ is the relative membrane permeability for $Cl^-$.

$[K^+]_o$ is the concentration of $K^+$ in the extracellular fluid.

$[K^+]_i$ is the concentration of $K^+$ in the intracellular fluid.

$[Na^+]_o$ is the concentration of $Na^+$ in the extracellular fluid.

$[Na^+]_i$ is the concentration of $Na^+$ in the intracellular fluid.

$[Cl^-]_o$ is the concentration of $Cl^-$ in the extracellular fluid.

$[Cl^-]_i$ is the concentration of $Cl^-$ in the intracellular fluid.

We can explain the importance and the meaning of this equation. First, sodium, potassium, and chloride ions are the most important ions involved in the development of membrane potentials in nerve and muscle fibers, as well as in the neuronal cells in the nervous system. The concentration gradient of each of these ions across the membrane helps determine the voltage of the membrane potential. Second, the degree of importance of each of the ions in determining the voltage is proportional to the membrane permeability for that particular ion. That is, if the membrane has zero permeability to both, potassium and chloride ions, the membrane potential becomes entirely dominated by the concentration gradient of sodium ions alone, and the resulting potential will be equal to the Nernst potential for sodium. The same holds for each of the other two ions if the membrane should become selectively permeable for either one of them alone. Third, a positive ion concentration gradient from inside the membrane to the outside causes electronegativity inside the membrane. The reason for this is that excess positive ions diffuse to the outside when their concentration is higher inside than outside. This carries positive charges to the outside but leaves the nondiffusible negative anions on the inside, thus creating electronegativity on the inside. The opposite effect occurs when there is a gradient for a negative ion. That is, a chloride ion gradient from the outside to the inside causes negativity inside the cell because excess negatively charged chloride ions diffuse to the inside, while leaving the nondiffusible positive ions on the outside. Fourth, as explained later, the permeability of the sodium and potassium channels undergoes rapid changes during transmission of a nerve impulse, whereas the permeability of the chloride channels does not change greatly during this process. Therefore, final conclusion is that, the rapid changes in sodium and potassium permeability are primarily responsible for signal transmission in neurons.

C) Attempt any one. (4)

SET II

1 EMF (millivolts) = ± 61 × log (Concentration inside / Concentration outside)

= 63.98 mV

2 The method for measuring the membrane potential is simple in theory but often difficult in practice because of the small size of most of the fibers. A small pipette filled with an electrolyte solution is impaled through the cell membrane to the interior of the fiber. Then another electrode, called the "indifferent electrode," is placed in the extracellular fluid, and the potential difference between the inside and outside of the fiber is measured using an appropriate voltmeter. This voltmeter is a highly sophisticated electronic apparatus that is capable of measuring small voltages despite extremely high resistance to electrical flow through the tip of the micropipette, which has a lumen diameter usually less than 1 micrometer and a resistance more than a million ohms. For recording rapid *changes* in the membrane potential during transmission of nerve impulses, the microelectrode is connected to an oscilloscope. The electrical potential that is measured at each point in or near the nerve fiber membrane, beginning at the say left side and passing to the right. As long as the electrode is outside the nerve membrane, the recorded potential is zero, which is the potential of the extracellular fluid. Then, as the recording electrode passes through the voltage change area at the cell membrane (called the *electrical dipole layer*), the potential decreases abruptly to −90 millivolts. Moving across the center of the fiber, the potential remains at a steady −90-millivolt level but reverses back to zero the instant it passes through the membrane on the opposite side of the fiber.

To create a negative potential inside the membrane, only enough positive ions to develop the electrical dipole layer at the membrane itself must be transported outward. All the remaining ions inside the nerve fiber can be both positive and negative. Therefore, an incredibly small number of ions must be transferred through the membrane to establish the normal "resting potential" of −90 millivolts inside the nerve fiber; this means that only about 1/3,000,000 to 1/100,000,000 of the total positive charges inside the fiber must be transferred. Also, an equally small number of positive ions moving from outside to inside the fiber can reverse the potential from −90 millivolts to as much as +35 millivolts within as little as 1/10,000 of a second. Rapid shifting of ions in this manner causes the nerve signals

Q4. A) Attempt any oneUNIT III (8)

1 1) An inorganic non-metallic solid
2)Excellent strength and hard
3)Some ceramics are good candidate for superconductors
4)Resistant at high temperatures and harsh environment
Application: White wares & Cements

2 **<u>Soft Magnets</u> 1) Soft materials are used in devices in which change in the magnetization during operation is desirable sometimes rapidly as in AC generators and transformers. 2) Soft magnetic materials do not retain their magnetism when removed from a magnetic field.3) In Soft magnets eddy**

SET II

current loss is minimized through alloying that increase the electrical resistivity. A high permeability which is necessary for motors and power transformers is increased by the alignment of the anisotropy through development of crystal texture or magnetically induced anisotropy.4) Common soft magnetic materials are iron, iron-silicon alloys and nickel-iron alloys. Irons are widely used for their magnetic properties because of their relatively low cost.

B) Attempt any oneUNIT III (8)

1 Polymers:1) A polymer is a large "molecule" composed of repeating structural typically connected by chemical bonds like covalent bonds. 2) Polymers are composed of very high molecular masses formed by the combination of large number of simple molecules. Polymers (or macromolecules) are very large molecules made up of smaller units called monomers or repeating units, covalently bonded together.3) Types of polymers: Linear polymers, Branched polymers, Cross-linked polymers, Elastomers, Fibers, Thermoplastics, Thermosetting polymers.4) Examples: bakelite, formaldehyde etc. Applications: Natural rubber, obtained from the sap of the hevea tree. Rubber was named by the chemist joseph priestley who found that a piece of solidified latex gum was good for rubbing out pencil marks on paper.

2 1) A dielectric is an electrical insulator that can be polarized by an applied electric field.

2) When a dielectric is placed in an electric field electric charges do not flow through the material as they do in an electrical conductor, but only slightly shift from their average equilibrium positions causing dielectric polarization.

3) Because of dielectric polarization positive charges are displaced toward the field and negative charges shift in the opposite direction. This creates an internal electric field that reduces the overall field within the dielectric itself.

4) If a dielectric is composed of weakly bonded molecules, those molecules not only become polarized, but also reorient so that their symmetry axes align to the field.

Applications: Dielectrics are important for explaining various phenomena in Electronics, Optics, Solid-state Physics, and Cell biophysics. (4)

C) Attempt any oneUNIT III

1 Diamagnetism: 1) Diamagnetic substances are those which have a tendency to move from stronger part of the external magnetic field to the weaker part of the external magnetic field.2) We can also say that the diamagnetic substances get repelled by a magnet. 3) If we place this substance in a non-uniform magnetic field, it tends to move from the point of high electric field to that of low electric field.

Para-magnetism: 1)Paramagnetic substances are those substances that get weakly magnetized in the presence of an external magnetic field. 2) In the presence of an external magnetic field these substances tend to move from a region of a weak magnetic field to a region of strong magnetic field. 3)

In other terms we can say that these substances tend to get weakly attracted to a permanent magnet. 4) In a paramagnetic material the individual atoms possess a dipole moment, which when placed in a magnetic field, interact with one another, and get spontaneously aligned in a common direction, which results in its magnetization. 5) As per the Curie's law, the magnetism of a paramagnetic substance is inversely proportional to the absolute temperature until it reaches a state of saturation.

2
1) Pyroelectricity the ability of certain materials to generate a temporary voltage when they are heated or cooled.
2) The best example is the gallium nitride semiconductor.
3) The large electric fields in this material are very helpful for the fabrication of power transistors.
4) The change in temperature modifies the positions of the atoms slightly within the crystal structure such that the polarization of the material changes. This polarization change gives rise to a voltage across the crystal.

Piezoelectric: Piezoelectricity was discovered by two French scientists' brothers Jacques and Pierre Curie in 1880.

1) They found out about piezoelectricity after first realizing that pressure applied to quartz or even some certain crystals creates an electrical charge in that certain material.
2) They later referred to that strange and scientific phenomenon as the piezoelectric effect.
3) The term piezoelectricity comes from the Greek word Piezo meaning to Squeeze or Press.
4) Applications: For example, when you use some type of voice recognition software on your smart phone the microphone that you're speaking into is probably using piezoelectricity. That piezo crystal turns the sound energy in your voice and changes it into electrical signals for your computer or your phone to interpret. <u>Piezoelectric Speakers and Buzzers:</u> Piezoelectric speakers and buzzers use the inverse piezoelectric effect to generate and produce sound. When voltage is applied to speakers and buzzers, it creates sound waves. An audio voltage signal applied to the piezoelectric ceramic of speakers or buzzers will cause the material to vibrate.

Q5. Attempt any Four (20)

1 Definition of directionality – 1 mark
Explanation – 4 marks

2 Definition of coherence – 1 mark
Explanation – 4 marks

SET II

3 Eukaryotic cells are larger, with a typical plasma membrane - some with a cell wall. This cell contains cytoplasm with a cytoskeleton which are protein tubules and fibers. The important components of many eukaryotic cells are: Nucleus, Endoplasmic reticulum, Ribosomes, Golgi apparatus, Mitochondria, Chloroplasts, Lysosomes, Vacuoles, Vesicles…

Following are the details of these Cellular Organelles:

i) Nucleus– This is the largest and most obvious membrane bound compartment that controls cell activities, it contains the nucleolus which is a darkened region where ribosomal RNA is synthesized. The nucleus also contains chromosomes that holds DNA wrapped around proteins. Nucleus is surrounded by the nuclear envelope which is a double *membrane*. Nuclear membrane has nuclear pores that control entry and exit of materials. The exact meaning of the word chromosomes is "colored body" and it consists of both DNA and protein which are threadlike structures. The most common proteins are histones. DNA is coiled around histones in a regular pattern that produces structures called nucleosomes.

ii) Endoplasmic reticulum (ER)- It is a web-like series of membranes within the cytoplasm in the form of flattened sheets, sacs, tubes etc. It creates many membranes enclosed spaces that spreads throughout the cytoplasm. It has connections with the outer membrane of the nucleus and the plasma membrane. The important functions of ER are circulation and transport, storage of proteins and minerals, synthesis of lipids, carbohydrates, and proteins. In addition, ER also provides a large surface area for enzyme action. There are two types of ER; rough and smooth. Rough ER is studded with ribosomes and are the site of synthesis of many proteins. All ribosomes on rER are actively involved in protein synthesis. Smooth ER is site for synthesis of steroids and other lipids further they are also responsible for $Ca^{++}$ storage in muscles, detoxification of drugs, toxins, alcohol (especially in liver).In general, the highly convoluted surface of ER provides a large surface area for enzymatic activities.

iii) Ribosomes– They are the protein synthetic machinery There are two subunits - large and small - each made of protein and ribosomal RNA (rRNA). These sub-units associate when they are synthesizing proteins. The protein synthesis occurs on ribosomes that are free-floating in the cytoplasm and on ribosomes attached to ER The rRNA is synthesized in the nucleolus.

iv) Golgi Apparatus– It is a collection of membranes associated with the ER, it concentrates and packages proteins synthesized on the ER. The Golgi is functionally associated with the ER. Proteins synthesized on the ER are concentrated internally and transport vesicles are budded off. Transport vesicles fuse with the Golgi, dump their contents into the Golgi then Golgi packages proteins in vesicles so that they may be excreted from the cell or used within the cell. Secretary vesicles are used for excretion and they leave the Golgi and move to plasma membrane where they fuse and dump their contents outside.

The Golgi Apparatus also forms lysosomes which are vesicles filled with digestive enzymes and are used for intracellular digestion. Particles can be taken into cell by phagocytosis and vesicle fused with lysosomes. The components of organelles can be recycled after digestion by lysosomes.

v) Mitochondria- Mitochondriaare the cellular powerhouses i.e the site of much of the energy harvest by cells. They have double membrane structure, inner membrane folded into inward projections called *cristae*. There aretwo spaces within the mitochondrion, the space inside the inner membrane called the matrix and the *intermembrane space* between the two membranes. Following are the characteristics of Mitochondria-

- The site of oxygen consumption within cells.
- Have their own DNA that is similar to prokaryotic DNA.
- Have their own ribosomes and they are similar in construction to prokaryotic ribosomes.
- Synthesize many, but not all, of their own proteins.
- Mitochondria replicate by binary fission - similar to prokaryotic cell division.

vi) Chloroplasts– These are the sites of *photosynthesis* in nearly all plants and some protists. They trap light energy and convert it into chemical energy. They have double membrane structure and inner space is the stroma. Within the stroma theyhave a series of stacks of flattened membrane structures called thylakoids– the stacks are called grana.The light energy trapping molecules of photosynthesis are found in the membranes of the thylakoids. Chloroplasts have their own DNA, similar to prokaryotic DNA and they can synthesize many of their own proteins using prokaryote-like ribosomes. They can replicate through division similar to prokaryotic cell division. Chloroplasts can take on other functions like synthesize and store starch in roots and tubers. They also have pigments and give fruits ripened color.

vii)Centrioles– The are part of specialized region of the cell called the centrosome(cell center) and are found in animals and most protists. The centrioles are involved in the production of microtubules. Microtubules have many functions including moving chromosomes during cell division.

4 In this type called *facilitated diffusion*, also called as carrier-mediated diffusion, it is required that interaction of a carrier protein be taking place. The carrier protein aids passage of the molecules or ions through the membrane by binding chemically with them and shuttling them through the membrane in this form. In facilitated diffusion the rate of diffusion approaches a maximum, called $V_{max}$, as the concentration of the diffusing substance increases and then cannot be increased beyond even if amount of substance available increases.

In the basic mechanism of facilitated diffusion, the molecule to be transported enters the pore and becomes bound. Then, in a fraction of a second, a conformational or chemical change occurs in the carrier protein, so the pore now opens to the opposite side of the membrane. Because the binding force of the receptor is weak, the thermal motion of the attached molecule causes it to break away and to be released on the opposite side of the membrane. The rate at which molecules can be transported by this mechanism can never be greater than the rate at which the carrier protein molecule can undergo change back and forth between its two states. *Glucose* and most of the *amino acids* are the important substances that cross the cell membrane by facilitated diffusion. In case of glucose, 5 or more transporter molecules are known in different tissues. Some of these can also transport similar molecules like *fructose* and these transporter molecules are activated by *insulin* so that rate of diffusion considerably increases (10 to 40 times). This is the principal mechanism by which insulin controls glucose used in body.

Many substances can diffuse through the cell membrane. Usually the net rate of diffusion of a substance in desired direction is the quantity of interest and this net rate is determined by several factors like concentration difference, membrane electric potential, pressure difference across membrane and osmosisacross selectively permeable membrane. The rate at which the substance diffuse inward is proportional to the concentration of molecules on outside because this concentration determines how many molecules strike the outside of the membrane each second. Conversely, the rate at which molecule diffuse outward is proportional to their concentration inside the membrane. Therefore, the rate of net diffusion into the cell is proportional to the concentration on the outside *minus* the concentration on the inside, or: Net diffusion = ( $C_o$- $C_i$)

Sometimes considerable pressure difference develops between the two sides of a diffusible membrane, for example the pressure is about 20 mm of Hg greater inside a blood capillary than outside. Higher pressure means greater number of molecules striking the membrane per second so that increased amount of energy is available to cause net movement of molecules from the high pressure side towards the low pressure side.

By far the most abundant substance that diffuses through the cell membrane is water. Enough water ordinarily diffuses in each direction through the red cell membrane per second to equal about *100 times the volume of the cell itself.* Yet normally the amount that diffuses in the two directions is balanced so precisely that zero net movement of water occurs. Therefore, the volume of the cell remains constant.

5 Ferromagnetism: 1) Ferromagnetic substances are those substances that when placed in an external magnetic field gets strongly magnetized. 2) Also they tend to move from a region of weak magnetic field to the region of strong magnetic field and get strongly attracted towards a magnet. 3) In a ferromagnetic material, the individual atoms possess a dipole moment similar to a paramagnetic material. When placed in a magnetic field, the atoms interact with one another and get spontaneously aligned in a common direction. 4) The direction is common over a macroscopic volume which we term as a domain. Application: To produce strong magnets.

6 Superconductor: 1) A material that can conduct electricity or transport electrons from one atom to another with no resistance. No form of energy would be released from the material when it has reached "critical temperature" (Tc); the temperature at which the material becomes superconductive. 2) The other characteristic of SCs is critical magnetic field beyond which it does not remain superconductor. 3) During superconducting they behave as perfect dia magnets and expels whole magnetic field (Messiner effect).4) Superconductors come in two different flavors: type I and type II. Type I are characterized by single Tc while type II are having two Tc1 & Tc2. beyond Tc2 it behaves as normal conductor, below Tc1 it behaves as superconductor and in between it is having a mix (Vortex) property of conductor and superconductor. By adding appropriate

(14)

SET II

impurities in appropriate proportion Type I can be converted into Type II.
Application: Use to produce strong magnetic fields

Marks:-100

Time: 3Hrs