54408

SET V (1)

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

(12)

Q1. A) Select correct answer
1 (a) 1 to 2
2 (a) 0.56
3 (c) kidney
4 (b) 70 %
5 (a) Photons
6 (c) eV

(03)

B) Answer in one sentence
1 Reverberation time too small, then sound dies almost instantaneously.
2 The viscosity of a fluid is measure of its resistance to deformation by shear stress and it arises due to frictional forces between liquid layers since liquid layers travel at different velocities
3 Temperature below which the substance exhibit superconductivity.

(5)

C) Fill in the Blanks
1 6000 Å
2 Chemical
3 Diffusion
4 Piezoelectric effect
5 Diamagnetism

(8)

Q2. A) Attempt any oneUNIT I
1 $V = 2250\ m^3$
$\propto \Sigma A = 100\ m^2$
$T = \frac{0.158\,V}{\alpha \Sigma A} = \frac{0.158 \times 2250}{100}$
$= 3.65$
After audience fills the auditorium
$\propto \Sigma A = 200\ m^2$
$\therefore T = 1.85$
2 Here, $V = 5500\ m^3$, $T = 2.3$ s, $A = 750\ m^2$.
Reverberation time, $T = \frac{0.158V}{A\alpha}$ (Sabine's formula for reverberation time)
$\alpha = \frac{0.158V}{AT} = \frac{0.158 \times 5500}{750 \times 2.3} = 0.504$

(8)

B) Attempt any oneUNIT I
1 Diagram – 2 marks
Explanation – 6 marks
2 Coherence – 4 marks
Directionality- 4 marks

(4)

C) Attempt any oneUNIT I

SET V

1 $V = 2250\ m^3$

$\alpha\Sigma A = 100\ m^2$

$T = \frac{0.158V}{\alpha\Sigma A} = \frac{0.158\times2250}{100}$

$= 3.65$

After audience fills the auditorium

$\alpha\Sigma A = 200\ m^2$

$\therefore T = 1.85$

2 Here, $V = 5500\ m^3$, $T = 2.3$ s, $A = 750\ m^2$

Reverberation time, $T = \frac{0.158V}{A\alpha}$ (Sabine's formula for reverberation time)

$\alpha = \frac{0.158V}{AT} = \frac{0.158\times5500}{750\times2.3} = 0.504$

Q3. A) Attempt any one (8)

1 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.

Osmosis is a vital process in biological systems, as biological membranes are semipermeable. In general, these membranes are impermeable to large and polar molecules, such as ions, proteins, and polysaccharides, while being permeable to non-polar or hydrophobic molecules like lipids as well as to small molecules like oxygen, carbon dioxide, nitrogen, and nitric oxide. Permeability depends on solubility, charge, or chemistry, as well as solute size. Osmosis is a special case of diffusion and both can occur simultaneously. (Diffusion has nothing to do with presence of semipermeable membrane). Osmosis is spontaneous flow of water from a more dilute to a more concentrated solution when the two solutions are separated from each other by a semipermeable membrane. Typically, a cell membrane allows water to flow in both directions but sodium and chloride ions cannot flow through so easily (and they can pass only through protein channel) so that cell membrane is said to be selectively permeable. When outside the cell concentration of pure water is more and inside it is sodium chloride solution then, water molecules flow from outside to inside and this is described as osmosis occurring from pure water into sodium chloride solution. The driving force for the water movement is equivalent to a difference in water pressure and is called osmotic pressure. Thus, Osmotic pressure is defined as the external pressure required to be applied so that there is no net movement of solvent across the membrane.

Osmosis provides the primary means by which water is transported into and out of cells. The turgorpressure (which is the force within the cell that pushes the plasma membrane against the cell wall and it is also called *hydrostatic pressure*) of a cell is largely maintained by osmosis across the cell membrane between the cell interior and its relatively hypotonic environment. Every living cell has a definite boundary or is bounded by 'cell membrane' or 'plasma membrane', which is elastic and semipermeable and acts as a barrier with selective permeability. In particular, when a membrane is placed between solvent and a solution and solute molecules are not allowed to pass through but solvent molecules are having free passage then the membrane is semipermeable. Natural pant membranes are usually permeable to water but they may or may not be permeable to substances dissolved in water.

By definition, diffusion is a spontaneous process of migration of solute molecules from a region of higher concentration to a region of lower concentration. Thus diffusion is the net movement of molecules or atoms from a region of high concentration (or high chemical potential) to a region of low concentration (or low chemical potential) as a result of random motion of the molecules or atoms. Diffusion is driven by a gradient in chemical potential of the diffusing species.

A gradient is the change in the value of a quantity e.g. concentration, pressure, or temperature with the change in another variable, usually distance. A change in concentration over a distance is called a concentration gradient, a change in pressure over a distance is called a pressure gradient, and a change in temperature over a distance is called a temperature gradient. All molecules, ions, dissolved substances in body fluids are in constant random motion due to thermal agitations and diffusion uses such random walks to 'spread' so that final result is uniform concentration throughout.

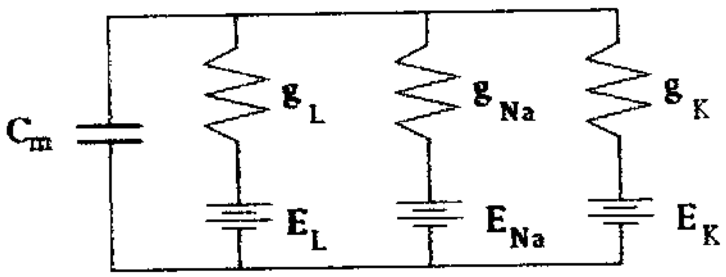
In biology, the terms "net movement" or "net diffusion" is used to describe the movement of ions or molecules by diffusion. For example, oxygen can diffuse through cell membranes so long as there is a higher concentration of oxygen outside the cell. However, because the movement of molecules is random, occasionally oxygen molecules move out of the cell (against the concentration gradient). Because there are more oxygen molecules outside the cell, the probability that oxygen molecules will enter the cell is higher than the probability that oxygen molecules will leave the cell. Therefore, the "net" movement of oxygen molecules (the difference between the number of molecules either entering or leaving the cell) is into the cell. In other words, there is a *net movement* of oxygen molecules down the concentration gradient.

Diffusion is thus basically caused by motion of solute molecules from a concentrated solution into a solvent or motion of solvent molecules into the concentrated solution. Following are the factors that affect diffusion: 1) Diffusion length or diffusion distance and shorter the distance greater is the rate of diffusion. 2) Solubility is proportional to diffusion rate. 3) Diffusion rate is inversely related to diameter of molecules or ions that are diffused. 4) Elongated molecules has low rate of diffusion than spherical molecules of same atomic weight. 5) Greater the concentration difference, higher is the rate of diffusion. 6) Rate of diffusion is inversely proportional to square root of molecular weight. 7) Rate of diffusion is proportional to surface area of molecules that are diffused. 8) Higher the temperature, greater is the rate of diffusion. 9) The Graham's law of diffusion states that diffusion of any gas is inversely proportional to square root of its density. 10) rate of diffusion varies directly with mean molecular velocity.

2 The voltage clamp is an experimental method used in electrophysiology to measure the ion currents through the membranes of excitable cells, such

as neurons, while holding the membrane voltage at a set level. A basic voltage clamp will iteratively measure the membrane potential, and then change the membrane potential (voltage) to a desired value by adding the necessary current. This "clamps" the cell membrane at a desired constant voltage, allowing the voltage clamp to record what currents are delivered. Because the currents applied to the cell must be equal to (and opposite in charge to) the current going across the cell membrane at the set voltage, the recorded currents indicate how the cell reacts to changes in membrane potential. Cell membranes of excitable cells contain many different kinds of ion channels, some of which are voltage-gated. The voltage clamp allows the membrane voltage to be manipulated independently of the ionic currents, allowing the current-voltage relationships of membrane channels to be studied.

The voltage clamp technique was used by Hodgkin and Huxley to determine the behavior of the ionic conductance's responsible for the generation of the action potential. The basic circuit for the squid axon is shown below.



The voltage clamp apparatus consists of a Feedback Amplifier, a Voltage Amplifier, and an Ammeter. The Voltage Amplifier is connected to a Voltage Electrode implanted inside the neuronal membrane, and to the Feedback Amplifier. The Feedback Amplifier is connected to a Current Electrode (C. E.). Finally, a Ground Electrode completes the feedback and voltage circuits through an ammeter to ground. The Voltage Amplifier is responsible for monitoring the membrane potential, Vm, and transmitting its value to the Feedback Amplifier. The Feedback Amplifier is responsible for maintaining Vm at the value desired by the experimenter. The ammeter displays the magnitude and direction of current flow through the membrane (Im). Information about Vm flows in only one direction, from the voltage electrode to the Voltage Amplifier, then to the Feedback Amplifier. Similarly, the clamping voltage is fed into the Feedback Amplifier by the experimenter. In contrast, current can - and will - be sent in both directions through the Im circuit by the Feedback Amplifier.

The first step in conducting a voltage clamp experiment is to set the value at which Vm is to be maintained. This value is termed the clamping voltage, and is entered into the Feedback Amplifier by the experimenter. Usually, the clamping voltage is entered into the feedback amplifier as a change in the membrane's potential (dVm) relative to its resting value, rather than as a specific Vm value. As soon as the experiment is started by applying the clamping voltage to the axon's membrane, the Feedback Amplifier commences comparison of the actual Vm with the desired clamping voltage. If Vm deviates from the clamping voltage, the Feedback Amplifier uses Ohm's Law to calculate the value of Im required to return Vm to the desired value (recall that $V = I \times R = I/g$), and adjusts Im based on the results of those calculations. Note that both the magnitude and the direction of the current are subject to control by the feedback amplifier, the direction being determined by whether the deviation from clamping Vm is a depolarization or hyperpolarization.

At rest the concentration gradient causing K+ to diffuse out of the cell is balanced by the electrical force (membrane voltage) acting in the opposite direction. Consequently, very little K+ leaks out. When the voltage clamp is turned on, a small pulse of negative charge is delivered to the external membrane surface and an equivalent positive charge is delivered to the internal surface. This new charge is just sufficient to jump the membrane potential from -65 mV to 0 mV. This new 0 mV membrane potential tending to force positive charge into the cell is too weak to balance the tendency of K+ to diffuse out of the cell. In addition, the depolarization of the membrane opens more K+ channels. K+ diffusing out of the cell would add positive charge to the outside and change the membrane potential, but the voltage clamp monitors E and prevents any change by adding one negative charge for each K+ that crosses the membrane out of the cell.

The value of the voltage clamp is due to the fact that with modern technology it is not possible to chemically measure the small amounts of K+ that enter or leave the cell within a fraction of a millisecond, but the charge delivered by the voltage clamp can be measured easily. If both Na+ and K+ channels are open then the measured voltage clamp current equals the sum of the individual Na+ and K+ currents. The sensitivity and response time of the system are such that Vm can be maintained with a few mV (or even nanovolts) of the clamping voltage at all times. The ammeter then records the magnitude and direction of Im, These data allow calculation of time-dependent changes in gm, which is the purpose of the voltage clamp experiment. The voltage clamp experiment is still being used extensively by researchers in their efforts to understand the function of excitable cells.

B) Attempt any one (8)

1 Action potential results from rapid change in permeability of sodium and potassium across neuronal membrane. Neurons communicate over very large distances by generating and sending an electrical signal called nerve impulse or action potential. Alternatively, action potential can be defined as simulation of surface cell membrane, polarization of tissue causing negative wave of polarization propagated along nerve producing nerve impulse.

Following are the types of action potential: 1) Smooth muscle produce rhythmic action potential. 2) Junction tissues in SA mode are present in the heart. Spontaneous depolarization produces action potential called pacemaker potential which is transmitted through cardiac muscle that causes heart contraction regularly. 3) Nerve action potential is the negative depolarize wave transmitted along the nerve in the form of impulse. 4) Compound action potential is produced in sciatic nerve which is a group of nerve fiber of varying conductance. 5) Due to leakage of small quantity of acetyl choline in muscle fiber in resting condition, a very weak action potential of the order of 0.5 mV is produced. It is named as miniature end plate potential. 6) In smooth muscle there are spike potentials and action potentials with plateau. 7) Receptor potential is produced when any type of stimulus is produced at nerve ending. 8) The excitatory post-synaptic potential is the increased potential produced to excite neurons to other stimuli. 9) the inhibitory post-synaptic potential is the decreased potential when excitability of neuron to other stimuli is decreased.

Following are the characteristic features of action potential: 1) Action potential=Nerve impulse and it is a transient, rapid sequence of changes in membrane potential. 2) Propagation velocity of action potential in nerves can vary from 100 m/s to less than tenth of ammeter per second. 3) Majority of action potentials are generated in axon. 4) Action potential is triggered when the membrane potential reaches a threshold value of -55 mV. 5) Depolarization means change in action potential from -70 mV to +30 mV. 6) Repolarization is the reversal from +30 mV back to -70 mV.

2 Fick developed two laws to describe the diffusion process and first laws is mathematically similar to heat equation whereas, second law is having form identical to Schrodinger's equation. In biology the laws can explain the absorption of pentoses etc. and the transport process in living cells, neurons as well as in lipids can be modeled using these laws.

First law states that the diffusive flux (J) which is essentially the rate of transport is proportional to the negative concentration gradient $(\partial c/\partial x)$ times the diffusion constant or diffusion coefficient (D) of the diffusing substance.

$\therefore J = -DK(\partial c/\partial x)$ *in one dimension* *and*

$J = -DK\,\nabla c$ *in three dimension*

Where proportionality constant K is partition coefficient for the diffusing material between membrane lipid and water and is very small for hydrophilic substances, so that their diffusion is very slow through lipid. The diffusion coefficient D is the quantity of solute diffusing per second across a surface area of unit dimension (1 square cm for example) when there is concentration gradient of unity.

From this first law with D and K as constants over time and space for given situation, we can obtain the flux gradient as time rate of change of concentration gradient. $(\partial J/\partial x) = -(\partial c/\partial t)$

Second law predicts how diffusion causes the concentration to change with time and it is a partial differential equation obtained by differentiating first law with respect to space (x–dimension) so that

$$\frac{\partial J}{\partial x} = -DK\frac{\partial 2c}{\partial x2}$$

and then $\frac{\partial c}{\partial t} = -\frac{\partial J}{\partial x} = DK\frac{\partial 2c}{\partial x2}$ which is one dimensional form of second law. **(4)**

C) Attempt any one

1
$$V_m = \frac{RT}{F}\ln\left(\frac{p_K[K^-]_o + p_{Na}[Na^+]_o + p_{Cl}[Cl^-]_i}{p_K[K^-]_i + p_{Na}[Na^-]_i + p_{Cl}[Cl^-]_o}\right)$$

$= +44$ **mV**

negativity outside and positivity inside. Again, the membrane potential rises high enough within milliseconds to block further net diffusion of sodium ions to the inside; however, this time, in the mammalian nerve fiber, the potential is about 61 millivolts positive inside the fiber.

Thus, in both parts we see that a concentration difference of ions across a selectively permeable membrane can, under appropriate conditions, create a membrane potential. Many of the rapid changes in membrane potentials observed during nerve and muscle impulse transmission result from the occurrence of such rapidly changing diffusion potentials.

Virtually all eukaryotic cells (including cells from animals, plants, and fungi) maintain a non-zero transmembrane potential usually with a negative voltage in the cell interior as compared to the cell exterior ranging from –40 mV to –80 mV. The membrane potential has two basic functions. First, it allows a cell to function as a battery, providing power to operate a variety of "molecular devices" embedded in the membrane. Second, in electrically excitable cells such as neurons and muscle cells, it is used for transmitting signals between different parts of a cell. Signals are generated by opening or closing of ion channels at one point in the membrane, producing a local change in the membrane potential. This change in the electric field can be quickly affected by either adjacent or more distant ion channels in the membrane. Those ion channels can then open or close as a result of the potential change, reproducing the signal.

In non-excitable cells, and in excitable cells in their baseline states, the membrane potential is held at a relatively stable value, called the resting potential. For neurons, typical values of the resting potential range from –70 to –80 millivolts; that is, the interior of a cell has a negative baseline voltage of a bit less than one-tenth of a volt. The opening and closing of ion channels can induce a departure from the resting potential. This is called a depolarization if the interior voltage becomes less negative (say from –70 mV to –60 mV), or a hyperpolarization if the interior voltage becomes more negative (say from –70 mV to –80 mV). In excitable cells, a sufficiently large depolarization can evoke an action potential, in which the membrane potential changes rapidly and significantly for a short time (on the order of 1 to 100 milliseconds), often reversing its polarity. Action potentials are generated by the activation of certain voltage-gated ion channels. In neurons, the factors that influence the membrane potential are diverse. They include numerous types of ion channels, some of which are chemically gated and some of which are voltage-gated. Because voltage-gated ion channels are controlled by the membrane potential, while the membrane potential itself is influenced by these same ion channels, feedback loops that allow for complex temporal dynamics arise, including oscillations and regenerative events such as action potentials.

5 **Pyroelectricity**

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.

SET V

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.

6 Piezoelectric effect:

1) Piezoelectricity was discovered by two French scientists' brothers Jacques and Pierre Curie in 1880.
2) 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.
3) They later referred to that strange and scientific phenomenon as the piezoelectric effect.
4) The term piezoelectricity comes from the Greek word Piezo meaning to Squeeze or Press.
5) 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. Piezoelectric Speakers and Buzzers: 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.

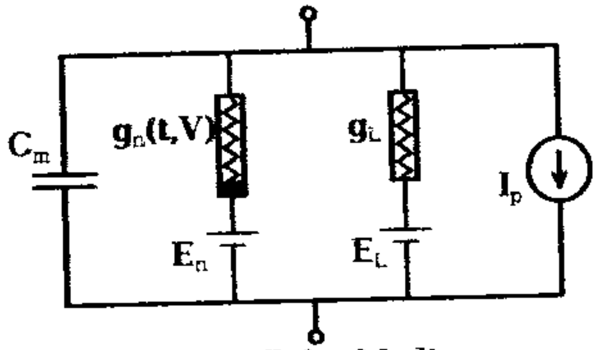
Marks:-100

Time: 3Hrs

(7)

SET V

2 The Hodgkin–Huxley model or conductance-based model, is a mathematical model that describes how action potentials in neurons are initiated and propagated. It is a set of nonlinear differential equations that approximates the electrical characteristics of excitable cells such as neurons and cardiac myocytes. The model explains the ionic mechanisms underlying the initiation and propagation of action potentials in the squid giant axon. The typical Hodgkin–Huxley model treats each component of an excitable cell as an electrical element (as shown in the figure). The lipid bilayer is represented as a capacitance(C_m). Voltage-gated ion channels are represented by electrical conductances (g_n, where n is the specific ion channel) that depend on both voltage and time. Leak channels are represented by linear conductances (g_L). The electrochemical gradients driving the flow of ions are represented by voltage sources (E_n) whose voltages are determined by the ratio of the intra- and extracellular concentrations of the ionic species of interest. Finally, ion pumps are **represented by current sources (I_p).**



Q4. A) Attempt any oneUNIT III (8)

1 Nano materials: 1) Chemical substances or materials that are manufactured and used at a very small scale. 2) Nano materials are developed to exhibit novel characteristics compared to the same material without nano scale features such as increased strength, chemical reactivity or conductivity.3) A natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution one or more external dimensions is in the size range 1 nm - 100 nm. 4) Nanomaterials on the other hand are intentionally produced and designed with physico-chemical properties for a specific purpose or function.

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.

B) Attempt any oneUNIT III **(8)**

1 **Alloys: Alloys are metallic compounds composed of one or more metal or non-metal elements. Examples of common alloys include 1) Steel: Combination of iron (metal) and carbon (non-metal), Bronze: Combination of copper (metal) and tin (metal) and Brass: Mixture of copper (metal) and zinc (metal)2) Individual pure metals may possess useful properties such as: Good electrical conductivity, High strength, Hardness, Heat resistance, Corrosion resistance.3) Commercial metal alloys attempt to combine these beneficial properties in order to create a metal that is more useful for a particular application than any of its component elements.5) The precise properties of new alloys are difficult to calculate because elements do not just combine to become a sum of parts but form through chemical interactions that depend on their component parts as well as the production method. Application: Galinstan a low-melt alloy containing gallium, tin, and indium, is liquid at temperatures above 2.2°F (-19°C), meaning that its melting point is 122°F (50°C) lower than pure gallium and more than 212°F (100°C) below indium and tin.**

2 1)Resists heat and electricity

2) Exhibit high resistivity

3) Valence electrons are tightly held together.

4) However may conduct electricity under very high voltage because of breakdown.

Applications: Insulating DC & AC cables. On roofs for not allowing heat to rooms.

C) Attempt any oneUNIT III (4)

1 Diamagnetism:

1) Diamagnetic substances are those which tend 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 Dielectrics

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

Ferroelectric: Ferroelectric substances:
1) Produces spontaneous polarization
2) Inverting the direction of field inverts the direction of polarization
3) Unlike ferromagnetic it is not necessary that all ferroelectric must have iron.
4)Beyond Curie temperature ferroelectrics becomes paraelectric.

Q5. Attempt any Four (20)

1 Definition – 1 mark
Explanation of method – 4 marks

2 Each requirement – 1 mark

3 Prokaryotic cells are small, with a plasma membrane surrounded by a rigid cell wall -in many the cell wall is made of a carbohydrate with cross-linked polypeptides. Cell wall may be covered with a capsule made of polysaccharides where few or no membrane enclosed spaces within the cytoplasm. They have no nucleus - DNA is in a region called the nucleoid and DNA is circular and naked (has no protein associated with it).
Bacteria often have flagella with a single protein core (flagellin), that they can use to move in a rotary corkscrew like fashion. The rotary motor of prokaryotic flagella is powered by proton flow through the cell membrane.

SET V

Rotating structures are rare in nature. Membrane enclosed spaces allow cell functions to be compartmentalized and isolated from other functions. Some prokaryotes are photosynthetic. The biochemical machinery for trapping light energy is contained within a highly folded 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...

4 Electrical potentials exist across the membranes of virtually all cells of the body. In addition, some cells, such as nerve and muscle cells, are capable of generating rapidly changing electrochemical impulses at their membranes, and these impulses are used to transmit signals along the nerve or muscle membranes. In other types of cells, such as glandular cells, macrophages, and ciliated cells, local changes in membrane potentials also activate many of the cells' functions. We consider membrane potentials generated both at rest and during action by nerve and muscle cells.

Basically Membrane potential is the difference in electric potential between the interior and the exterior of a biological cell. With respect to the exterior of the cell, typical values of membrane potential may range from –40 mV to –80 mV. All animal cells are surrounded by a membrane composed of a lipid bilayer with proteins embedded in it. The membrane serves as both an insulator and a diffusion barrier to the movement of ions. Transmembrane proteins, also known as ion transporter or ion pump proteins, actively push ions across the membrane and establish concentration gradients across the membrane, and ion channels allow ions to move across the membrane down those concentration gradients.

Basic Physics of Membrane Potentials - Membrane Potentials Caused by Diffusion: "Diffusion Potential" is caused by an ion concentration difference on the two sides of the membrane. Typically, the potassium concentration is great inside a nerve fiber membrane but very low outside the membrane. Let us assume that the membrane in this instance is permeable to the potassium ions but not to any other ions. Because of the large potassium concentration gradient from inside toward outside, there is a strong tendency for extra numbers of potassium ions to diffuse outward through the membrane. As they do so, they carry positive electrical charges to the outside, thus creating electropositivity outside the membrane and electronegativity inside because of negative anions that remain behind and do not diffuse outward with the potassium. Within a millisecond or so, the potential difference between the inside and outside, called the diffusion potential, becomes great enough to block further net potassium diffusion to the exterior, despite the high potassium ion concentration gradient. In the normal mammalian nerve fiber, the potential difference required is about 94 millivolts, with negativity inside the fiber membrane.

On the other hand, with high concentration of sodium ions outside the membrane and low sodium inside, these ions are also positively charged so that this time, the membrane is highly permeable to the sodium ions but impermeable to all other ions. Diffusion of the positively charged sodium ions to the inside creates a membrane potential of opposite polarity, with