كلية العلوم
قسم :الفيزياء
المادة :موضوعات مختاره ١ PHY491
Time:3hrs
Date: 15th Jan-2017

Answer the following questions:

1. A) What are the main functions of cell membrane? (**5 Marks**)

Membrane functions?

In animal cells the cell membrane alone establishes a separation between interior and environment, whereas in fungi, bacteria, and plants an additional cell wall forms the outermost boundary. However, the cell wall plays mostly a mechanical support role rather than a role as a selective boundary. One of the key roles of the membrane is to maintain the cell potential. The functions of the cell membrane include, but are not limited to:

1. Controlling what goes in and out of the cell.
2. Anchoring of the cytoskeleton to provide shape to the cell
3. Attaching to the extracellular matrix to help group cells together in the formation of tissues
4. Transportation of particles by way of ion pumps, ion channels, and carrier proteins
5. Containing receptors that allow chemical messages to pass between cells and systems
6. Participation in enzyme activity important in such things as metabolism and immunity

In all cases, the mechanical tension in the membrane has an effect on the rate of exchange. In some cells, usually having a smooth shape, the membrane tension and area are interrelated by elastic and dynamical mechanical properties, and the time-dependent interrelation is sometimes called *homeostasis*, *area regulation or tension regulation*.

B) Write in details about the dielectric properties of biological cells. **(15 Marks)**

Dielectric theory:

In practice, the investigation of dielectric behavior entails the measurement of ε' and ε"as a function of frequency and temperature from, which the dispersion parameters may be deduced. These, in turn, are interpreted in terms of structure. For a biological material this may be quite a complicated procedure due to the possible presence of several dispersion regions which, in some cases, may overlap. Thus Schwan (1957) has shown for muscle there are at least three dispersions (α,β and γ) which occur at Hz , KHz - MHz , and GHz frequency respectively ,and recent work by Schwan (1965) on protein solutions reveals the existence of anther (δ) dispersion occurring between the β and δ dispersion regions this as in fig.(7).

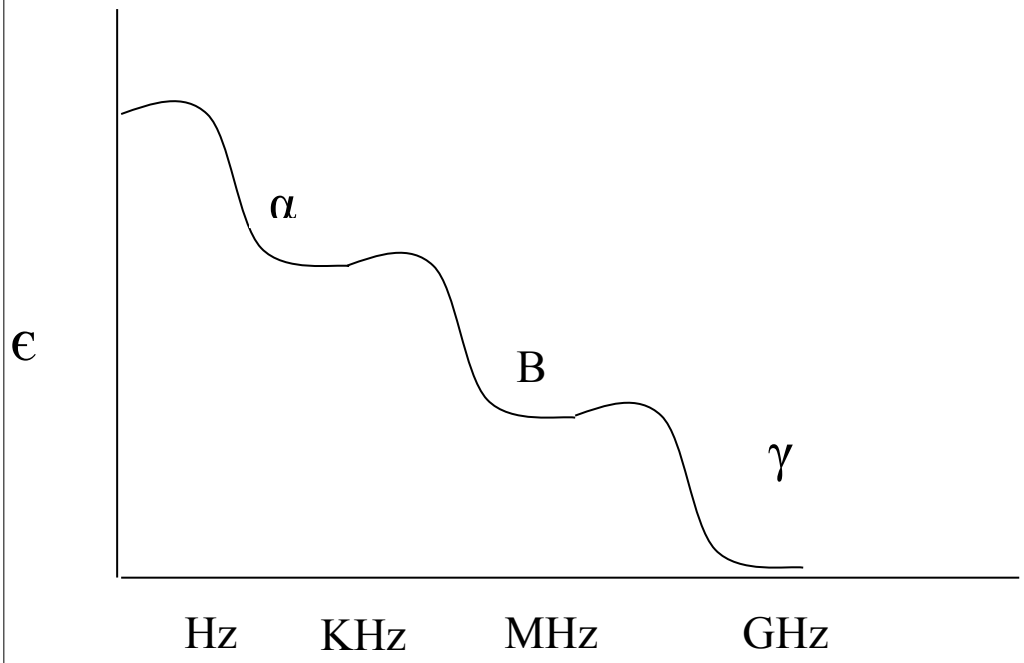


Fig.(7) Represent three dispersions (α ,B & γ

2. A) What are the general properties which electrodes dealing with biological cells should have? **(10 Marks)**

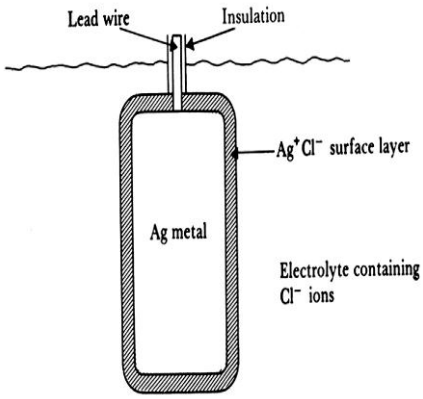
Properties of electrodes:

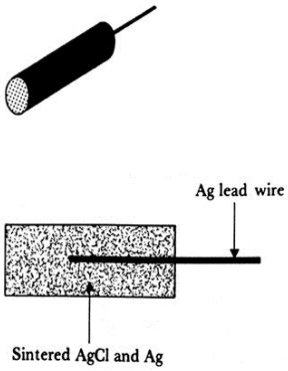
An electrode is a conductor through which electric current is passed. Found in variable forms, electrodes may be wires, plates, or rods. An electrode may be constructed of metal, such as copper, silver, lead, or zinc. However, an electrode may also be made of a nonmetal substance, such as carbon or glass. The electrode must be a good conductor and when it is used for intracellular recording must be very small in diameter with respect to the cell. There are some problems of electrodes as:

1. They may have a toxic effect (ions from electrodes pass into tissue under the action of current).
2. It is difficult to make them fine in diameter to suit the diameter of the cell, even if it becomes fine it becomes flexible.

1. 3. Polarization effect, as the tow electrodes one of them is connected to the outside of the cell (+ve) and the other to the inside of the cell (-ve), causing polarization of the
2. 4. Electrolyte, change in chemical equilibrium and a potential is formed over the electrodes, as in fig.(1)

We can avoid the polarization effect of the metal electrode by coating it by a layer of salt of anion which is found in the cell [e.g. Ag with a layer of Agcl] by that method we can convert polarizable electrodes into non polarizable, as in fig.(2)





B) What is the main difference between glass and metal microelectrodes? **(10 Marks)**

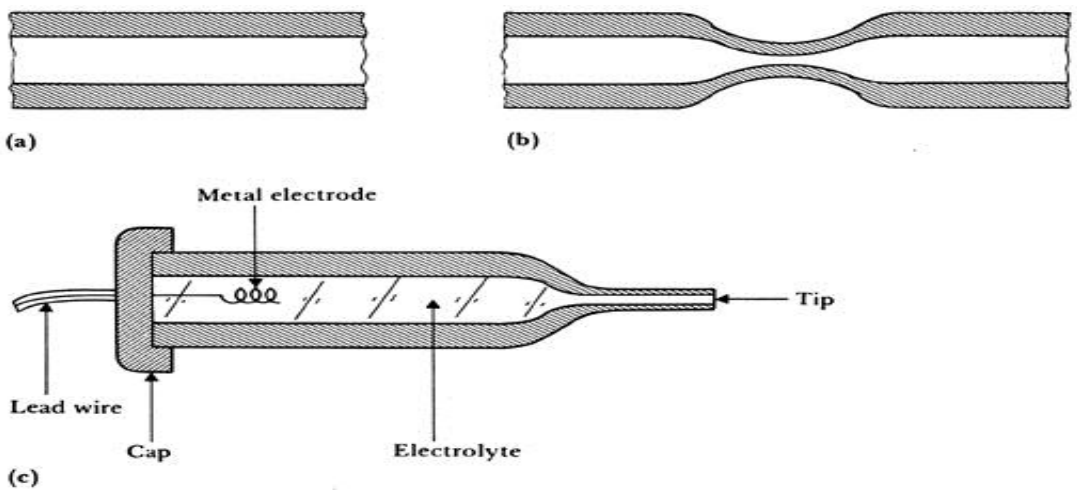
Glass microelectrodes:

Due to the above disadvantages of the metal microelectrodes, glass microelectrodes are now most commonly used for the intracellular stimulation and recording from the living cells and tissues. they are prepared with tip diameter greatly less than 0.1 micron and electric resistance more than 100MΩ.

The glass microelectrodes are in the first stage prepared from Pyrex glass capillary tubes of diameter 1-2mm. this tube is then horded between the two microelectrode puller machine clamps, which was first constructed by Alexander and Nastuk, 1953. This machine is consisted of two clamps one is fixed and the other moves freely by the action of an electromagnet coil. Fig.(3) shows a simple schematic diagram for such machine.

The technique of this machine could be as the follows. At the beginning, a Pyrex glass capillary tube of diameter 1-2mm is holded between the two machine clamps, as shown in Fig.(3). When the machine is started on, the heater begins to heat up the capillary tube. When it gets red, the machine relay system starts to control the current passing in the electromagnet coil in a manner that first to produce a gentle pull proceeded by a strong one. The result is the production of two identical microelectrodes.

The tip diameter of the produced electrodes depends on both the heater temperature and the pulling forces in addition to the initial diameter of the capillary tube.



Metal electrodes

Metal microelectrodes are suitable for recording extracellular and intracellular action potentials in addition to the synaptic activity.On the other hand these electrodes are not suitable for recording steady or resting potential accurately because of polarization, contact potentials and poor stability

Preparation of metal electrode:

Usually metal microelectrodes are prepared from stainlesstel or tungsten wire, diameter 0.15-0.3mm. The wire is gradually heated to red and straightened by slight stretching. The surface is thoroughly cleaned with sand paper. Then a pace 5-6 cm in length is cut from the wire and is bent to an angle of one cm from its end and half of its length is inserted into an injection needle (diameter 0.3 mm) as shown in Fig (4). The sharpening of metal electrode tip is carried out by an etching electrolytic process in an electrolytic cell, Fig.(4). The carrier needle is fixed into a vertically movable holder in such a way that the wire is well visible in the horizontally placed microscope.

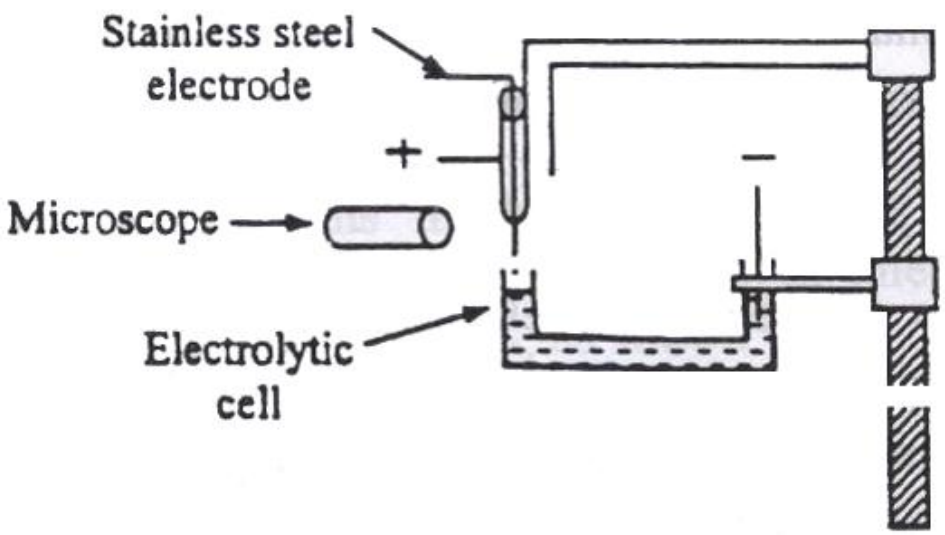


Fig.(4): An arrangement used for preparing the metal microelectrode.

When preparing steel microelectrodes, a U-shaped vessel filled with 10-20% HCL is placed below the end of the wire. The holder of this vessel can also be moved vertically. By alternately lifting and lowering the vessel, the wire is immersed and pulled out of the acid. The positive pole (1.5-3V) of a dry cell is connected to the electrode, the negative pole (silver foil) to the electrolyte. The first 10-15mm of wire are immersed into the acid and current is permitted to flow for 30-60S.

3. A). What is Radiation and its classifications **(10 Marks)**

Radiation is classified into two main categories, nonionizing and ionizing, depending on its ability to ionize matter. The ionization potential of atoms, i.e., the minimum energy required for

ionizing an atom, ranges from a few eV for alkali elements to 24.6 eV for helium (noble gas). Non-ionizing radiation cannot ionize matter because its energy is lower than the ionization potential of matter.

Q1. 5.1 Types of ionizing radiation:

Ionizing radiation can ionize matter either directly or indirectly because its energy exceeds the ionization potential of matter. It contains two major categories:

Directly ionizing radiation consists of several groups of charged particles, such as light charged particles (electrons and positrons), heavy charged particles (protons, deuterons, and alpha particles), and heavier charged particles (e.g., carbon-12).

Indirectly ionizing radiation consists of photons (x rays, gamma rays) and neutrons.

Directly ionizing radiation deposits energy in the medium through direct Coulomb interactions between the directly ionizing charged particle and orbital electrons of atoms in the medium.

Indirectly ionizing radiation (photons or neutrons) deposits energy in the medium through a two step process:

B) The genetic effects of radiation. (10 Marks)

Genetic Effects of Radiation:

We saw earlier that if the chromosome of a cell gets permanently damaged, it can lead to genetic changes. If the exposed cell is related to reproduction, the damage to its DNA can lead to developmental problems in the offspring of the person. Such cell changes are generally termed as germline mutations and do not affect the exposed person. The hazards associated with germline mutations range from premature death and miscarriage to cancer in later life.

A number of studies have been performed to determine the probability of damage due to germline mutations. Since it is difficult to determine whether a germline mutation in an individual has occurred or not, these studies have largely been based on finding the correlation of dose received by radiation workers and the genetic disorders in their children. Fortunately up until now, no conclusive evidence of strong correlation between the exposure and childbirth defects has been found. However a few studies have indicated that the occurrence of leukemia on the children whose fathers received occupational exposures was about 2 to 2.5 times higher than in general population. Unfortunately these studies have suffered from low statistics, that is, the number of individuals available for analysis was fairly small. Because of this, many researchers do not regard this inference as conclusive evidence of leukemia occurrence in children. It should, however, be mentioned that the type of exposure to father has also been found to be important in this regard. The internal exposure to radionuclides is considered as a high risk cause of childhood cancer as opposed to whole body exposure.

4. Complete. (**20 Marks**) الاجابة في نفس الورقة

i. The symbol λ refers to …….

a. activity constant b. **decay constant** c. radiation loss d. radiation gain

ii. The branch of medicine that uses radiation in treatment of disease is called……

a. **Radiotherapy** b. nuclear medicine c. diagnostic radiology d. disease diagnosing

iii. ……..is a branch that uses ionizing radiation in examining patients.

a. Radiotherapy b. Nuclear medicine c. **Diagnostic radiology** d. Disease diagnosing

iv. When radiation beam is used to label pharmaceutical radionuclides, this is called.....

a. Radiotherapy b. **Nuclear medicine** c. Diagnostic radiology d. Disease diagnosing