Medical Instruments II (Third class)

Prepared by

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2024-2025

Fundamentals of medical Instrumentation

Lecture 3

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2024-2025

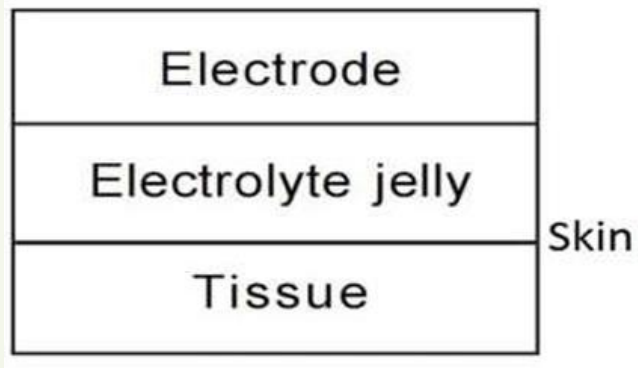
Types of Bioelectrodes

Electrodes are events have to be picked up from the surface of the body before they can be put to the amplifier for subsequent record or display. This is done by use of electrodes.

Bioelectrodes can be classified as:

1- **Surface electrodes**: These electrodes pick up potentials from the surface of the tissue.
2- **Deep seated electrodes**: These electrodes are inserted inside a live tissue or cell.

Key Properties of Bioelectrodes



Bioelectrodes should possess the following properties:

1- They should be good conductors
2- They should have low impedance
3- They should not polarize when a current flows through them
4- They should establish a good contact with the body and not cause motion
5- Potentials generated at the metal electrolyte (jelly) surface should be low.
6- They should not cause itching, swelling or discomfort to the patient for example the metal should not be toxic
7- They should be mechanically rugged
8- They should be chemically inert
9- They should be easy clean

Materials used for Electrodes

The materials used to make Electrodes include:

• Aluminium (Al) • Copper (Cu) • Silver (Ag) • Gold (Au) • Platinum (Pt)

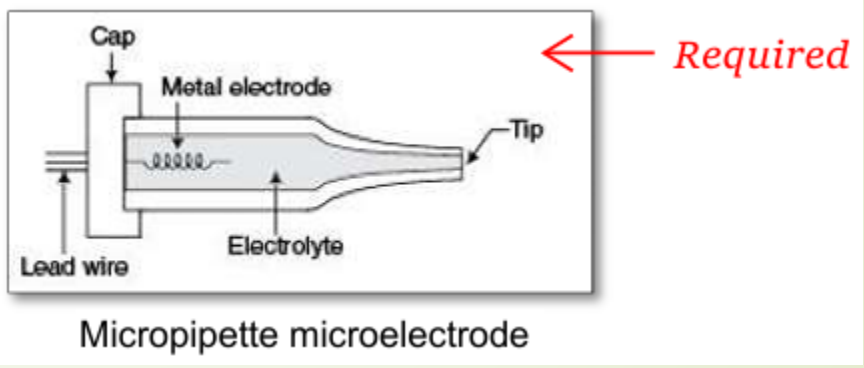
Types of Electrodes used in Biomedical Measurements

The three basic types of biopotential electrodes used in biomedical measurements are:

- Microelectrodes
- Skin surface electrodes
- Needle electrodes

Microelectrodes These electrodes are designed to measure bioelectric potentials near or within the cell. Microelectrodes can be of two types:

- Metal: Metal microelectrodes are formed from a fine needle of a suitable metal down to a fine tip.
- Micropipette: The Micropipette microelectrode is a microcapillary made of glass which is filled with an electrolyte as shown in the figure below:



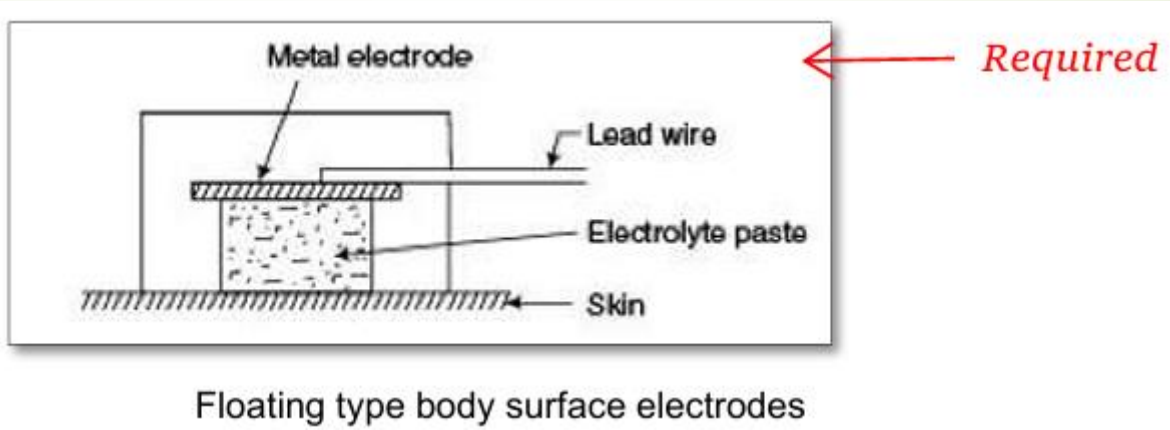
Micropipette microelectrode

Microelectrodes advantages : الايجابيات

1- Lower impedance
2- Infinite shelf life
3- Repeatable and reproducible performance
4- Easy cleaning and maintenance.

Body Surface Electrodes

These electrodes are designed to measure ECG, EEG, and EMG potentials from the surface of the skin. They are available in many forms and sizes. The larger electrodes are usually used for sensing of ECG. The common problem or the possibility of slippage or movement. These electrodes are sensitive to movements hence produce incorrect measurements on shifting. To avoid this problem, the floating electrodes are used. The principle of the floating electrode is to eliminate the movement artifacts (false signals) by avoiding any direct contact of the metal electrode with the skin. The contact between the metal electrode and skin is maintained by the electrolyte paste or jelly.

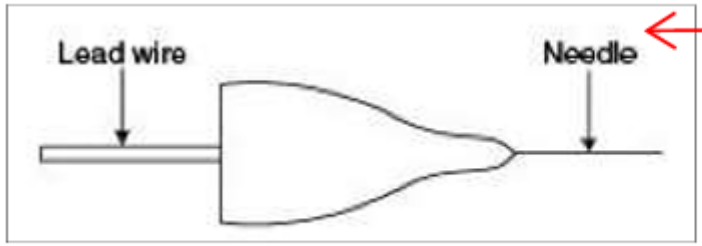


Floating type body surface electrodes

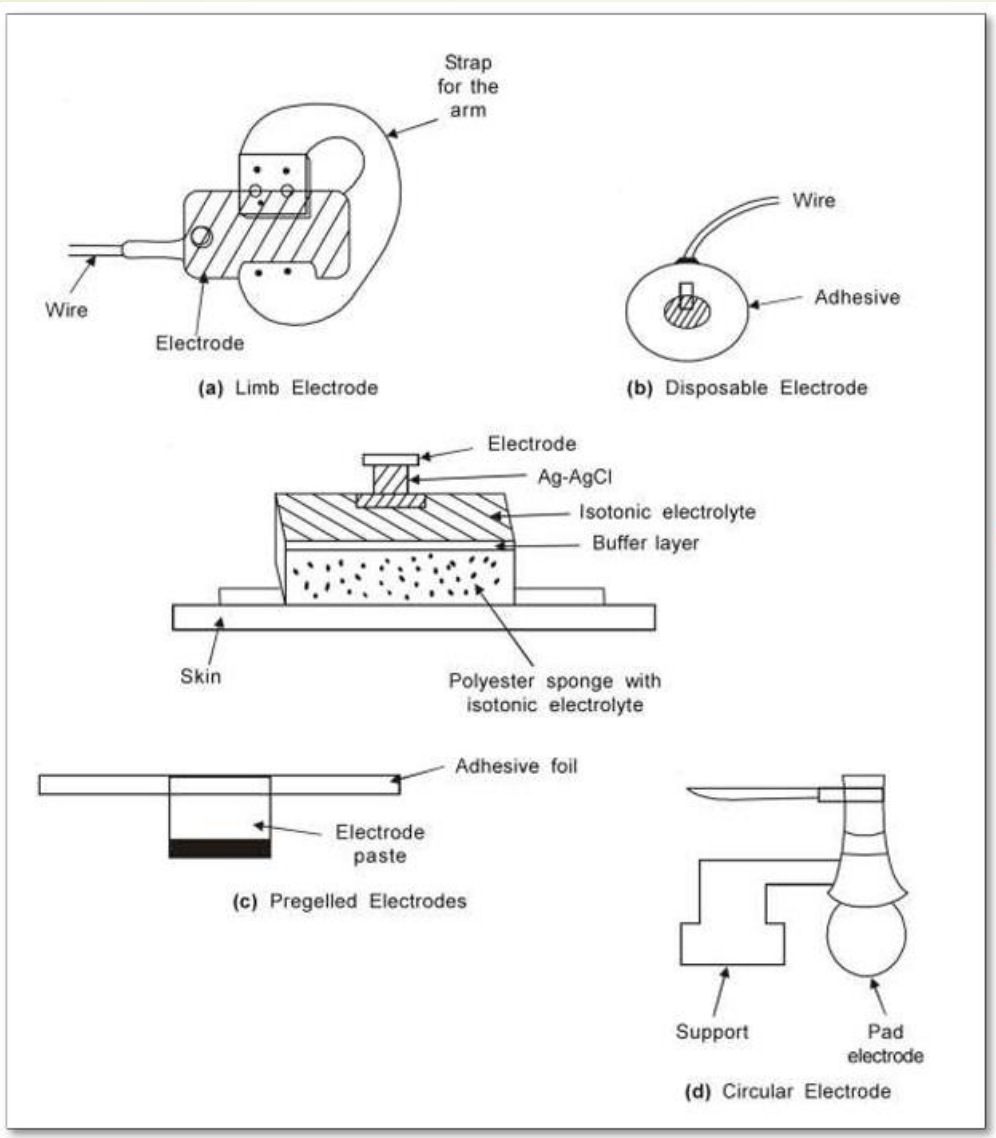
TYPES OF SURFACE ELECTRODES

1. Limb electrode
2. 2. Disposal electrode
3. 3. Pre-gelled electrode
4. 4. Circular electrode.

Needle Electrodes They are generally made of stainless steel. These electrodes are designed to penetrate the skin surface of the body to some depth to record EEG potentials of a region of the brain or EMG potentials of a muscle.



Needle electrode for EEG

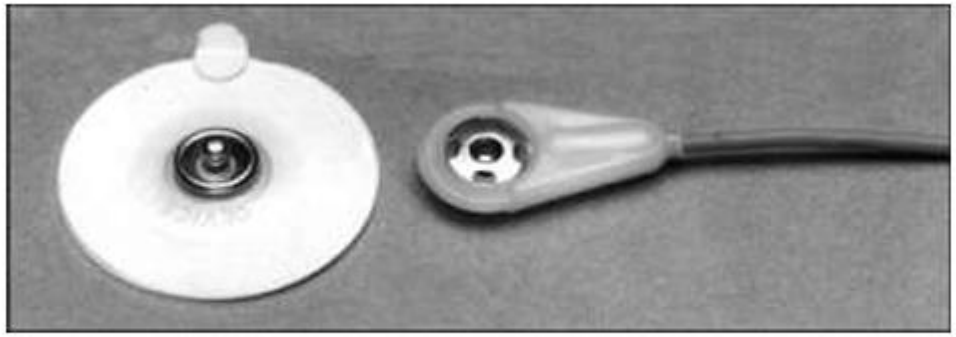


Types of Surface Electrodes used in Biomedical Instrumentation.

Required

ELECTRODES FOR ECG

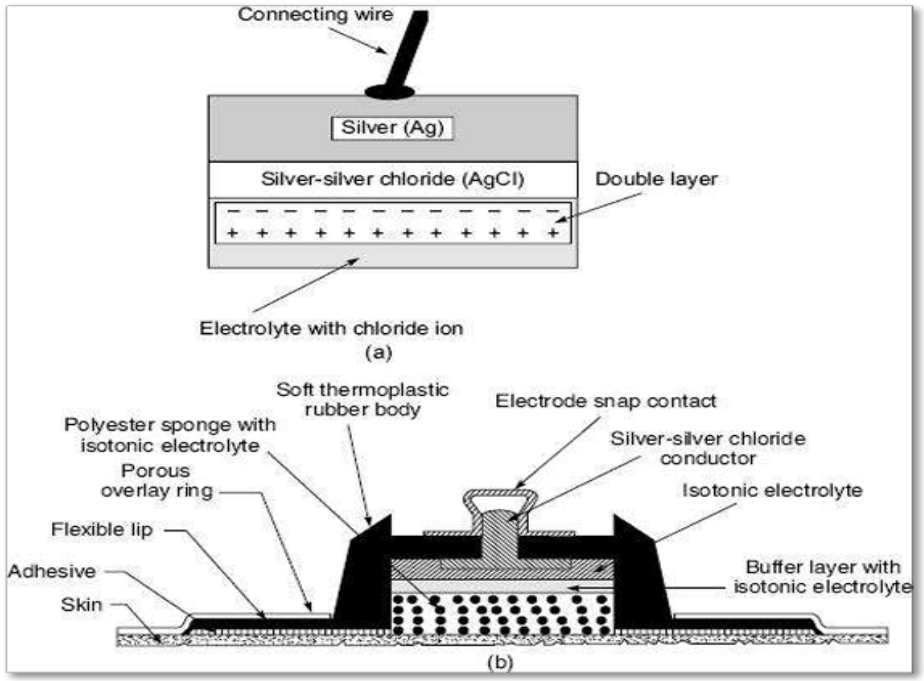
1. Limb Electrodes: Limb electrodes generally suffer from what is known as motion artefacts caused due to the relative motion at the interface between the metal electrode and the adjacent layer of electrode jelly
2. Welsh Cup Electrode
3. Floating Electrodes: The interface can be stabilized by the use of floating electrodes in which the metal electrode does not make direct contact with the skin. This makes them ideal for use in monitoring the ECG of exercising subjects and aeroplane pilots as they give rise to minimal motion artefacts.



Light-weight floating electrode with press stud for long term monitoring of ECG.

Pregelled Disposable Electrodes

Electrodes which are employed in stress testing or long term monitoring, present additional problems because of the severe stresses. The main design feature of these electrodes which that helps in reducing the possibility of artefacts, drift and baseline wandering is the provision of a high-absorbency buffer layer with isotonic electrolyte. This layer absorbs the effects of movement of the electrode in relationship to the skin, and attempts to maintain the polarization associated with the half-cell potential constant. Since perspiration is the most common cause of electrode displacement, the use of an additional porous overlay disc resists perspiration and ensures secure placement of the electrode on the skin even under stress conditions



Required

(a) Principle of pre-gelled ECG electrode made of silver-silver chloride. The electrode has electrolyte layers that are made of a firm gel which has adhesive properties. The firm gel minimizes the disturbance of the charge double layer. (b) Cross-section of a typical pre-gelled electrode

Capacitive Electrodes:

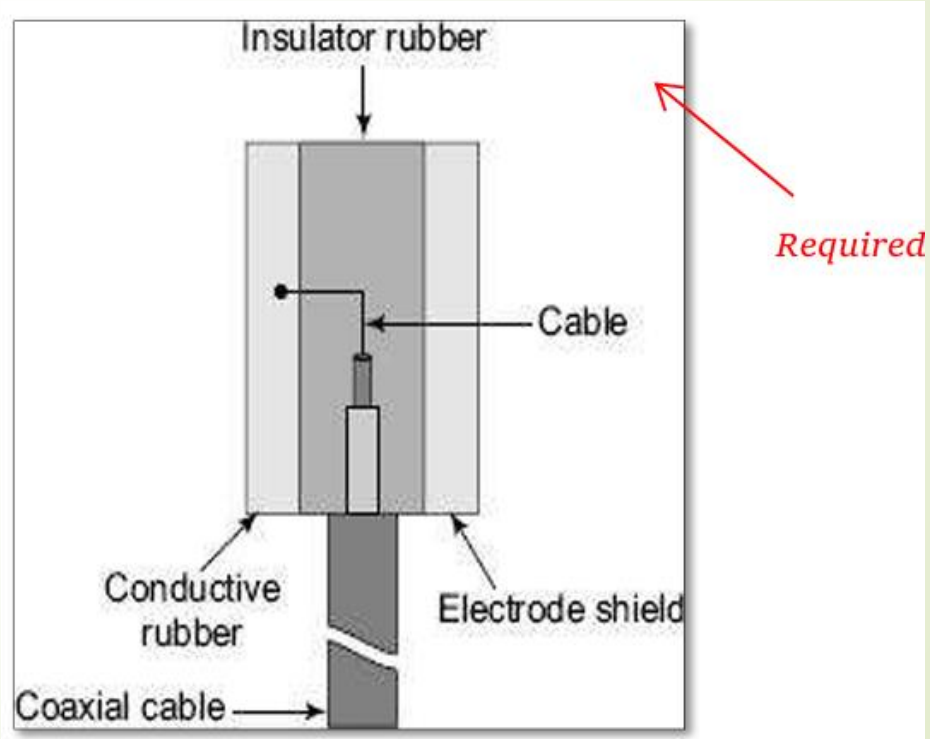
A metal plate electrode in direct contact with the skin though makes a very high resistive contact and has a considerable capacitive contact too with the skin. By using a very high input impedance amplifier, it is possible to record a signal through the tissue electrode capacitance.

Fabric-based Electrodes:

Dry electrodes suffer from noise interference. Noise is typically generated from motion artefacts and power line interference. A common solution used to suppress noise in dry electrode signals is a buffer amplifier.

ELECTRODES FOR EEG

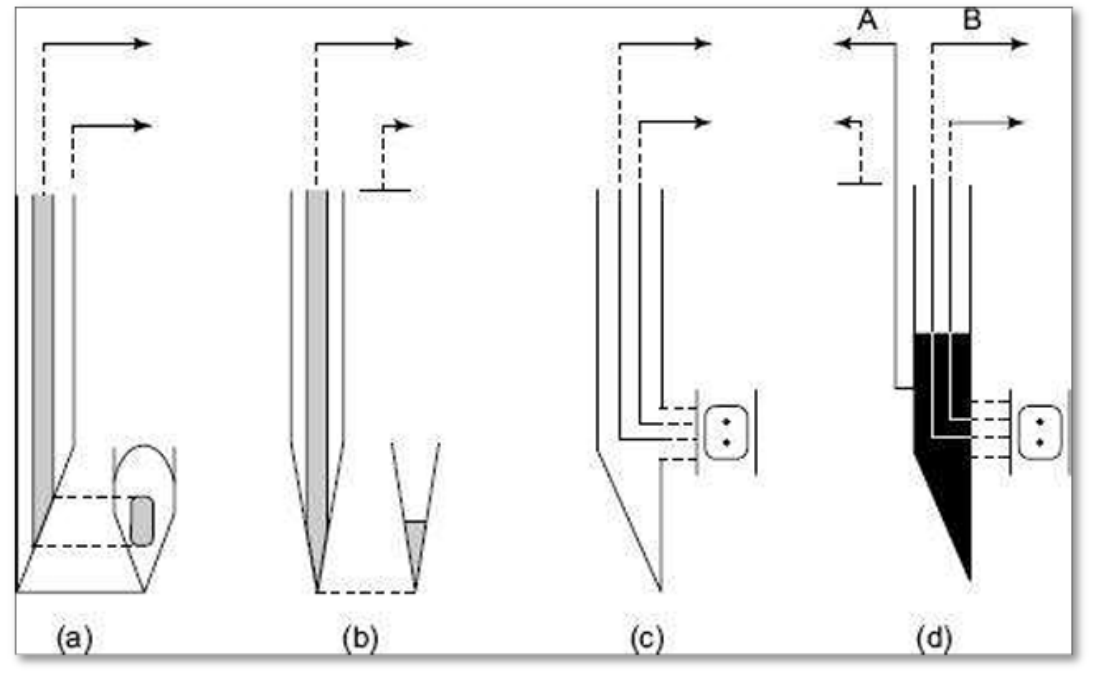
Small metal discs usually made of stainless steel, tin, gold or silver covered with a silver chloride coating are generally used for recording EEG. They are placed on the scalp in special positions. These positions are specified using the International 10/20 system. Each electrode site is labeled with a letter and a number. The letter refers to the area of brain underlying the electrode e.g. F Frontal lobe and T-Temporal lobe. Even numbers denote the right side of the head and odd numbers the left side of the head. Figure 19 shows EEG cables with disc electrodes to which electrode gel is applied to maximize skin contact and allow for a low resistance recording of EEG from the subject's scalp.



Construction of EEG dry electrode

ELECTRODES FOR EMG

Electrodes for electromyographic work are usually of the needle type. Needle electrodes are used in clinical electromyography, neurography and other electrophysiological investigations of the muscle tissues underneath the skin and in the deeper tissues. The material of the needle electrode is generally stainless steel. In spite of the fact that stainless steel is unfavourable electrode material from the point of view of noise, it is preferred in EMG work due to its mechanical solidity and low price. Bipolar (double coaxial) needle electrodes contain two insulated wires within a metal cannula. The two wires are bared at the tip and provide the contacts to the patient. The cannula acts as the ground. Bipolar electrodes are electrically symmetrical and have no polarity sense. A concentric (coaxial) core needle electrode contains both the active and reference electrode within the same structure. It consists of an insulated wire contained within a hypodermic needle.



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