III- BIOPOTENTIAL ELECTRODES

Medical Electronics, Basis of Bioelectric potential Bio potential electrodes, biomedical amplifiers, Characteristics of recording systems, Computer applications in medicine, Design of electro medical equipment.

1.1 BASIS OF BIOELECTRIC POTENTIAL

Electrode – Electrolyte Interface

General Ionic Equations

C<->Cn+ +ne-

A m-<->A +me -

- If electrode has same material as cation, then this material gets oxidized and enters the electrolyte as a cation and electrons remain at the electrode and flow in the external circuit.

- If anion can be oxidized at the electrode to form a neutral atom, one or two electrons are given to the electrode The dominating reaction can be inferred from the following :

- Current flow from electrode to electrolyte : Oxidation (Loss of e-)

- Current flow from electrolyte to electrode : Reduction (Gain of e-)

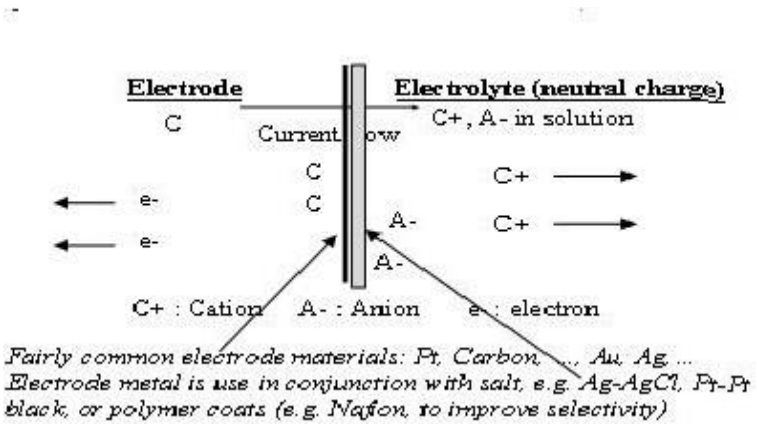

Figure 3.1: Electrolyte Interface

Half Cell Potential

Half cell potential cannot be measured without a second electrode.

The half cell potential of the standard hydrogen electrode has been arbitrarily set to zero. Other half cell potentials are expressed as a potential difference with this electrode

Reason for Half Cell Potential : Charge Separation at Interface

- Oxidation or reduction reactions at the electrode-electrolyte interface lead to a double-charge layer, similar to that which exists along electrically active biological cell membranes.

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Measuring Half Cell Potential

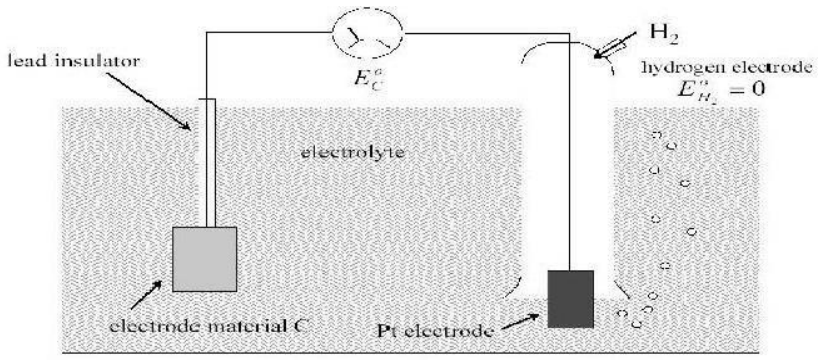


Figure:3.2: Half Cell Potential

Polarization

If there is a current between the electrode and electrolyte, the observed half cell potential is often altered due to polarization.

Polarizable and Non-Polarizable Electrodes

1. Perfectly Polarizable Electrodes: These are electrodes in which no actual charge crosses the electrode-electrolyte interface when a current is applied. The current across the interface is a displacement current and the electrode behaves like a capacitor.

Example : Ag/AgCl Electrode.

Perfectly Non-Polarizable Electrode:

These are electrodes where current passes freely across the electrode-electrolyte interface, requiring no energy to make the transition.

Over potentials. Example: Platinum electrode

Example: Ag-AgCl is used in recording while Pt is use in stimulation

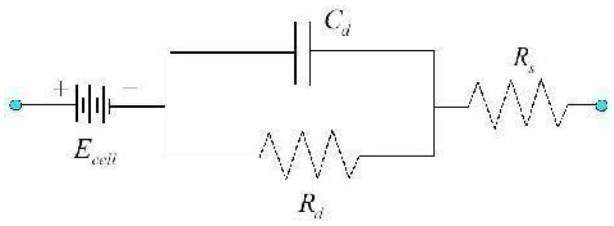


Figure:3.3 Equivalent Circuit

Cd : capacitance of electrode-eletrolyte interface

Rd : resistance of electrode-eletrolyte interface

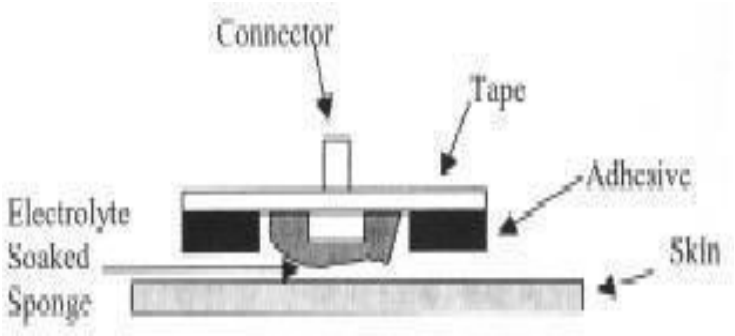
Rs : resistance of electrode lead wire

Ecell : cell potential for electrode

Electrode Skin Interface

Motion Artifact

- When the electrode moves with respect to the electrolyte, the distribution of the double layer of charge on polarizable electrode interface changes. This changes the half cell potential temporarily.
- If a pair of electrodes is in an electrolyte and one moves with respect to the other, a potential difference appears across the electrodes known as the motion artifact. This is a source of noise and interference in biopotential measurements. Motion artifact is minimal for non-polarizable electrodes



- Figure 3.4 Body surface Recording Electrodes

1.2 BIO POTENTIAL ELECTRODES

Commonly Used Biopotential Electrodes Metal Plate Electrodes are

1. Suction Electrodes
2. Floating Electrodes
3. Flexible Electrodes

Large surface: Ancient, therefore still used, ECG

– Metal disk with stainless steel; platinum or gold coated

– EMG, EEG

– smaller diameters

– motion artifacts

– Disposable foam

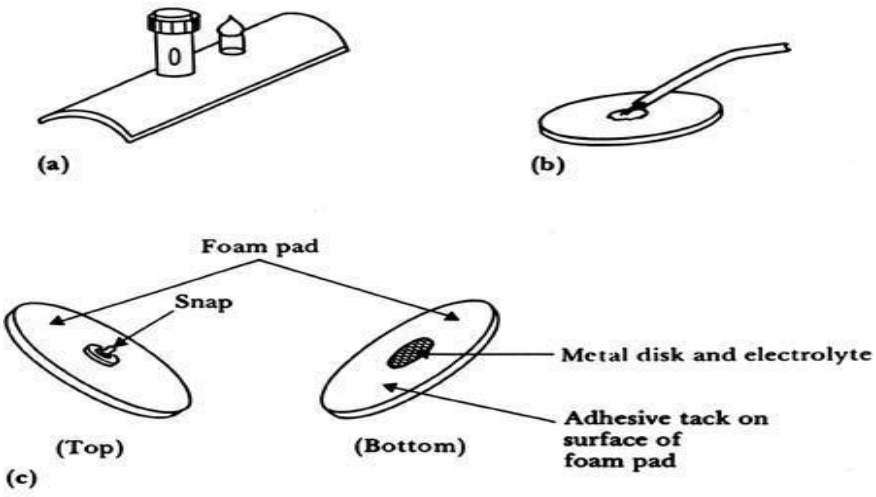


Figure 3.5 Metal plate Electrode

Suction electrodes

- No straps or adhesives required
- precordial (chest) ECG
- can only be used for short periods

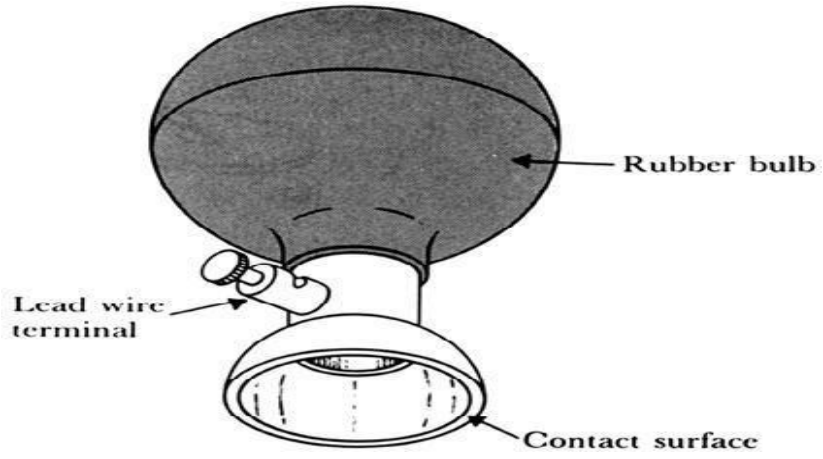


Figure:3.6: Suction Electrode

Floating electrodes

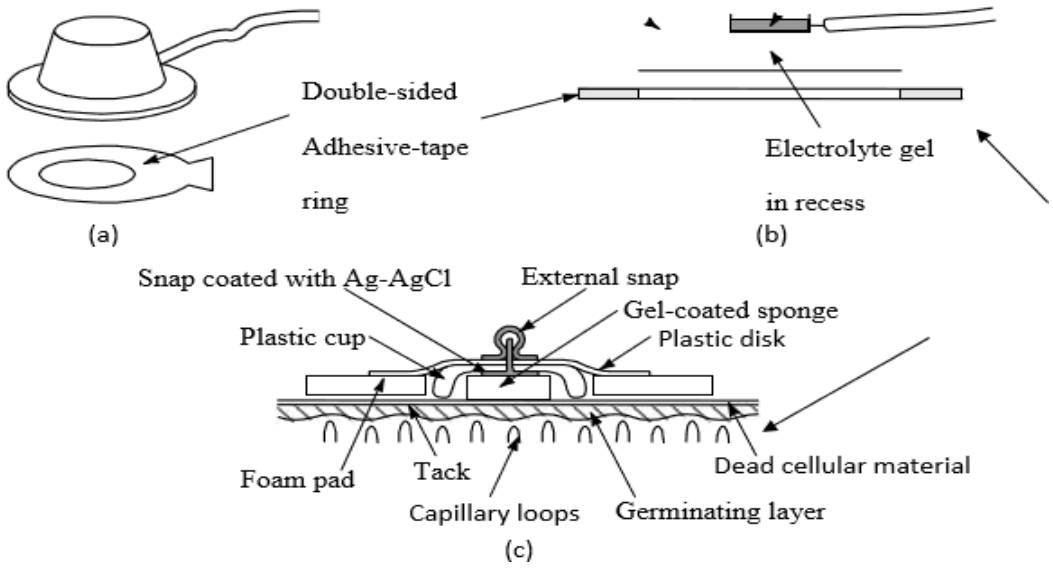


Figure:3.7-Floating Electrodes

Flexible electrodes

- Body contours are often irregular
- Regularly shaped rigid electrodes may not always work
. - Special case : infants
- Material : -

Polymer or nylon with silver

- Carbon filled silicon rubber (Mylar film)

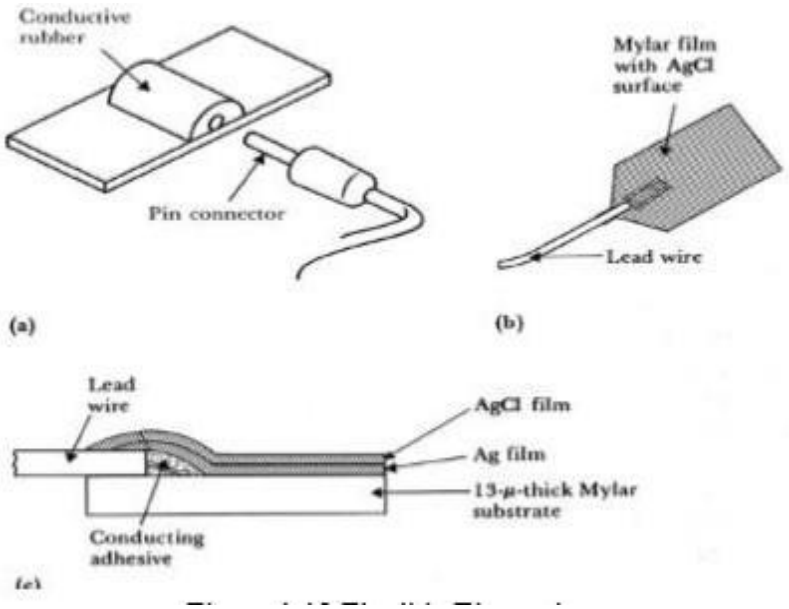


Figure:3.8- Flexible Electrodes

(a)Carbon-filled silicone rubber electrode.

(b)Flexible thin-film electrode.

(c) Cross-sectional view of the thin-film electrode in (b).