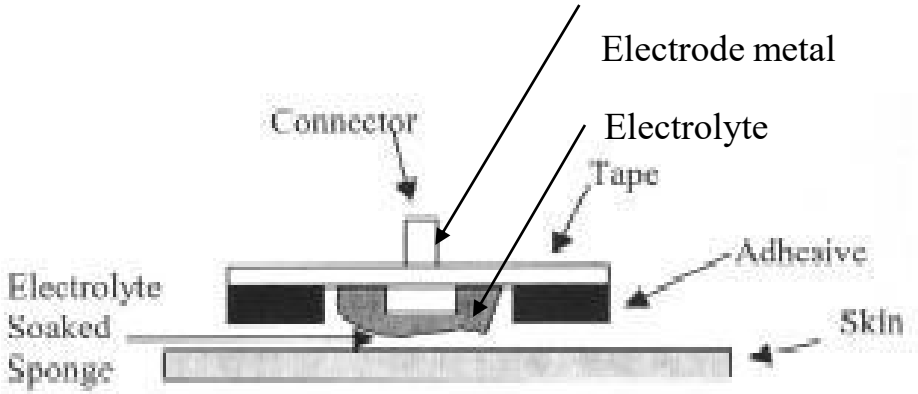
UNIT – 3

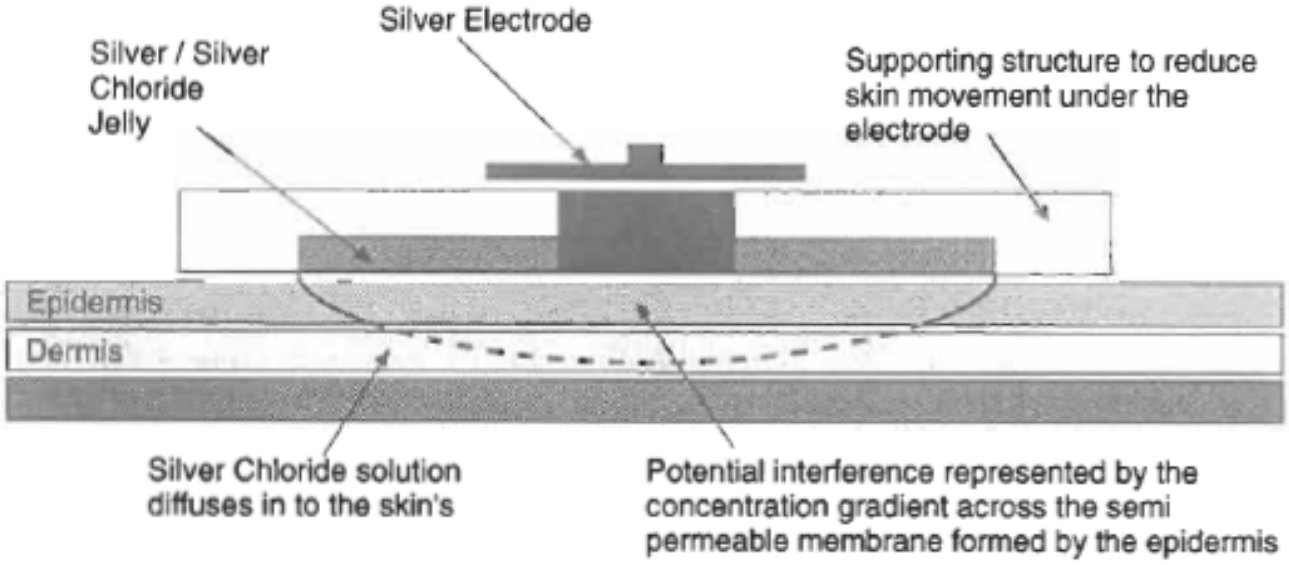
BIOPOTENTIAL ELECTRODES & CONFIGURATION

Types of electrodes

Body Surface Recording Electrodes

1. Metal Plate Electrodes
2. Suction Electrodes
3. Floating Electrodes
4. Flexible Electrodes

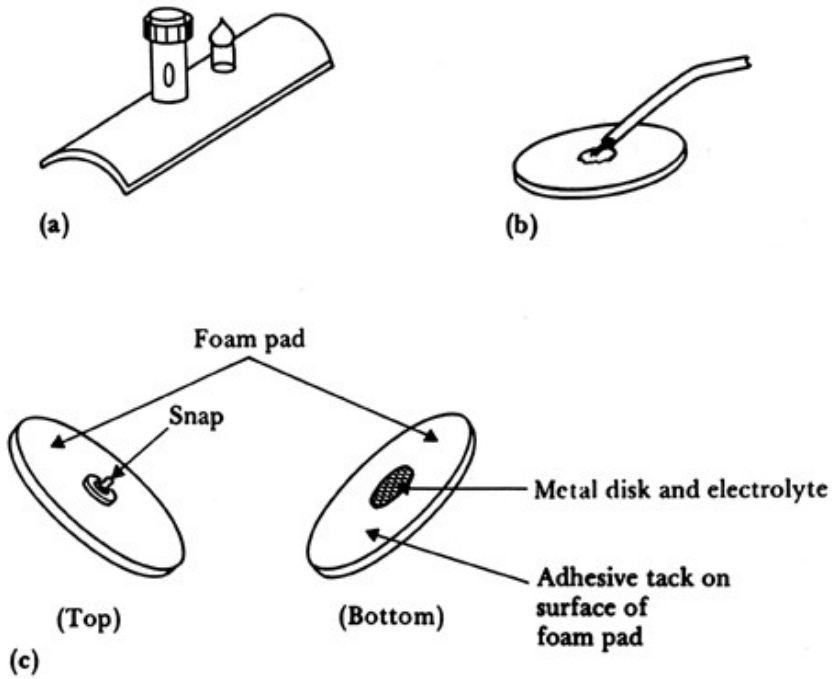




Commonly Used Biopotential Electrodes

Metal plate 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-pad: Cheap!

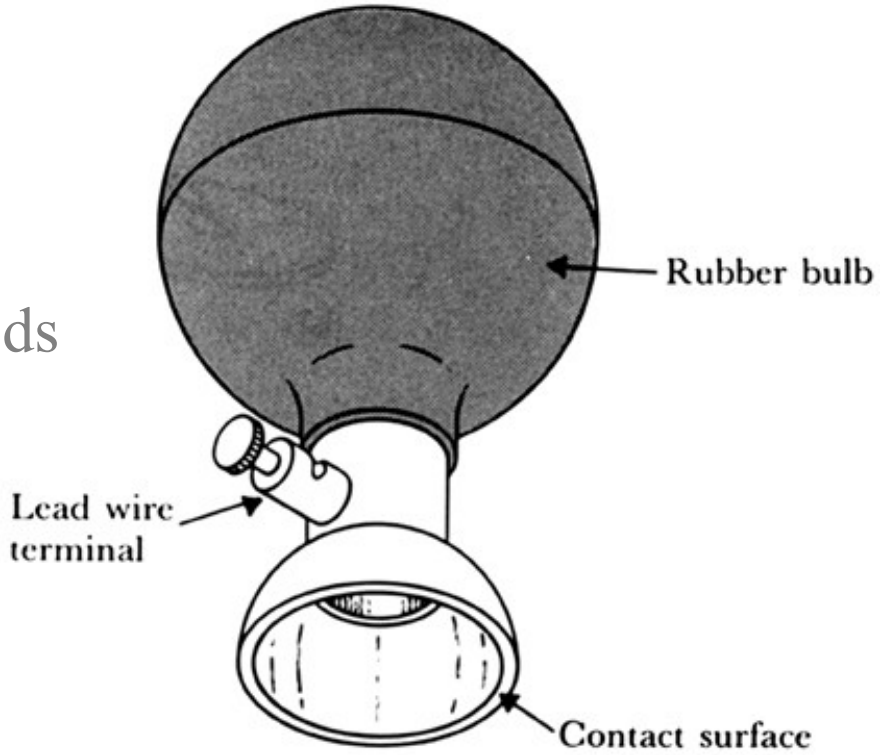


(a) Metal-plate electrode used for application to limbs.
(b) Metal-disk electrode applied with surgical tape.
(c)Disposable foam-pad electrodes, often used with ECG

Commonly Used Biopotential Electrodes

Suction electrodes

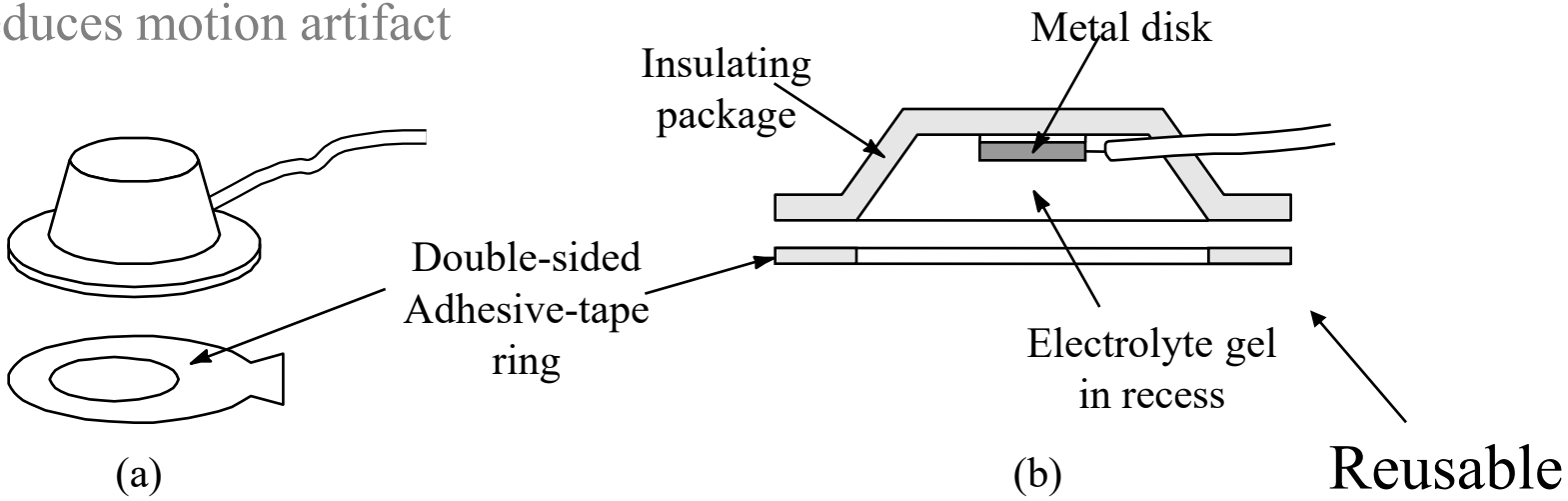
- No straps or adhesives required
- precordial (chest) ECG
- can only be used for short periods

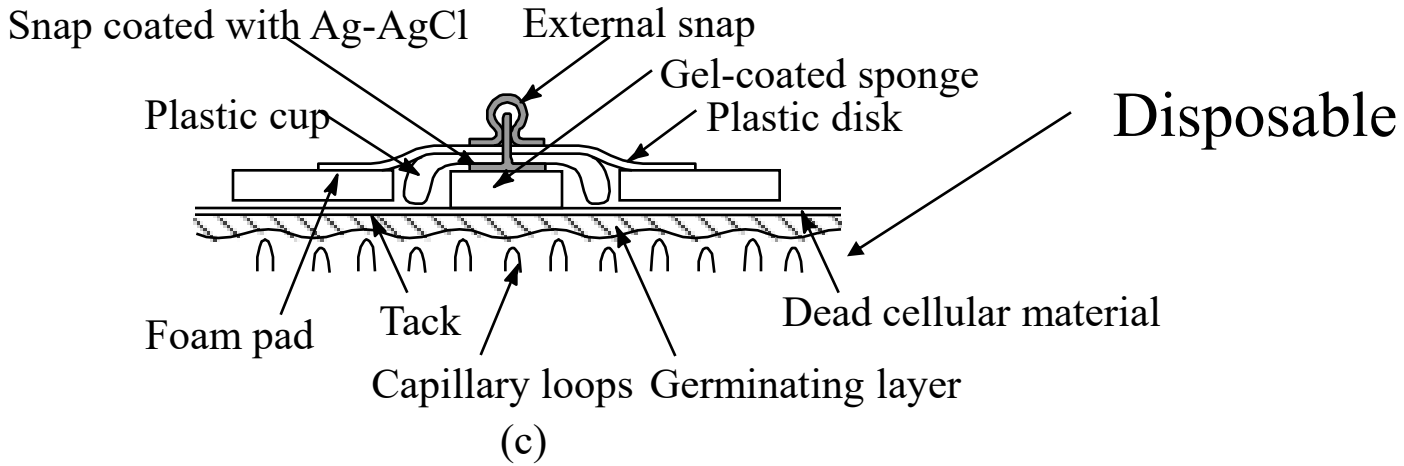


Suction Electrode

Floating electrodes

- metal disk is recessed
- swimming in the electrolyte gel
- not in contact with the skin
- reduces motion artifact

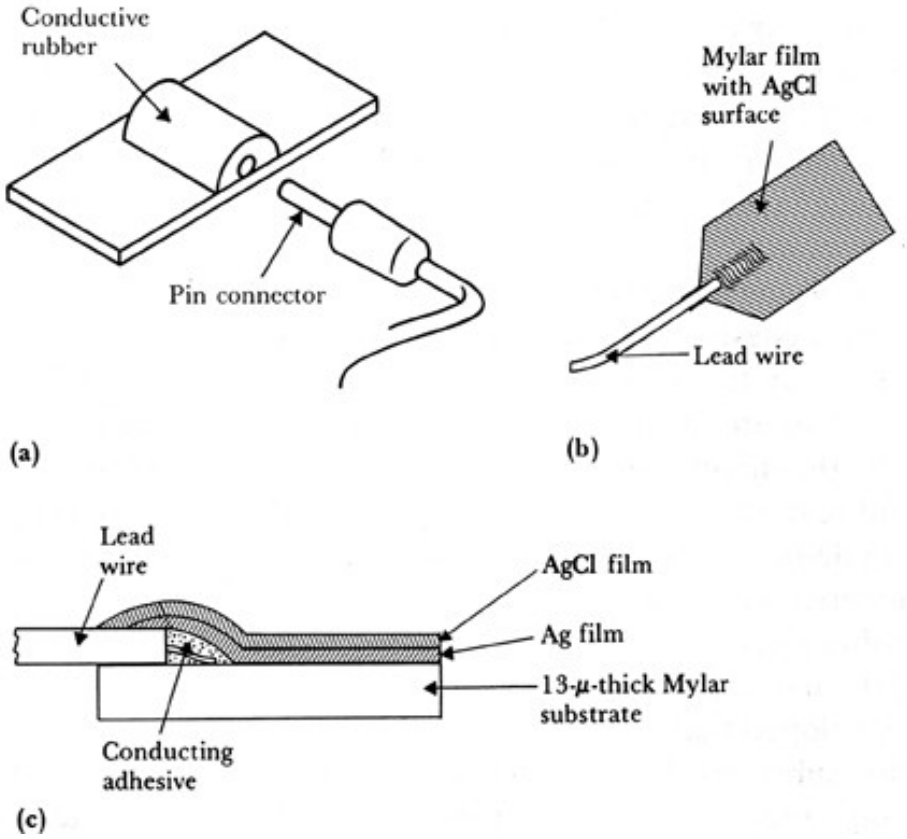




Flexible electrodes

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

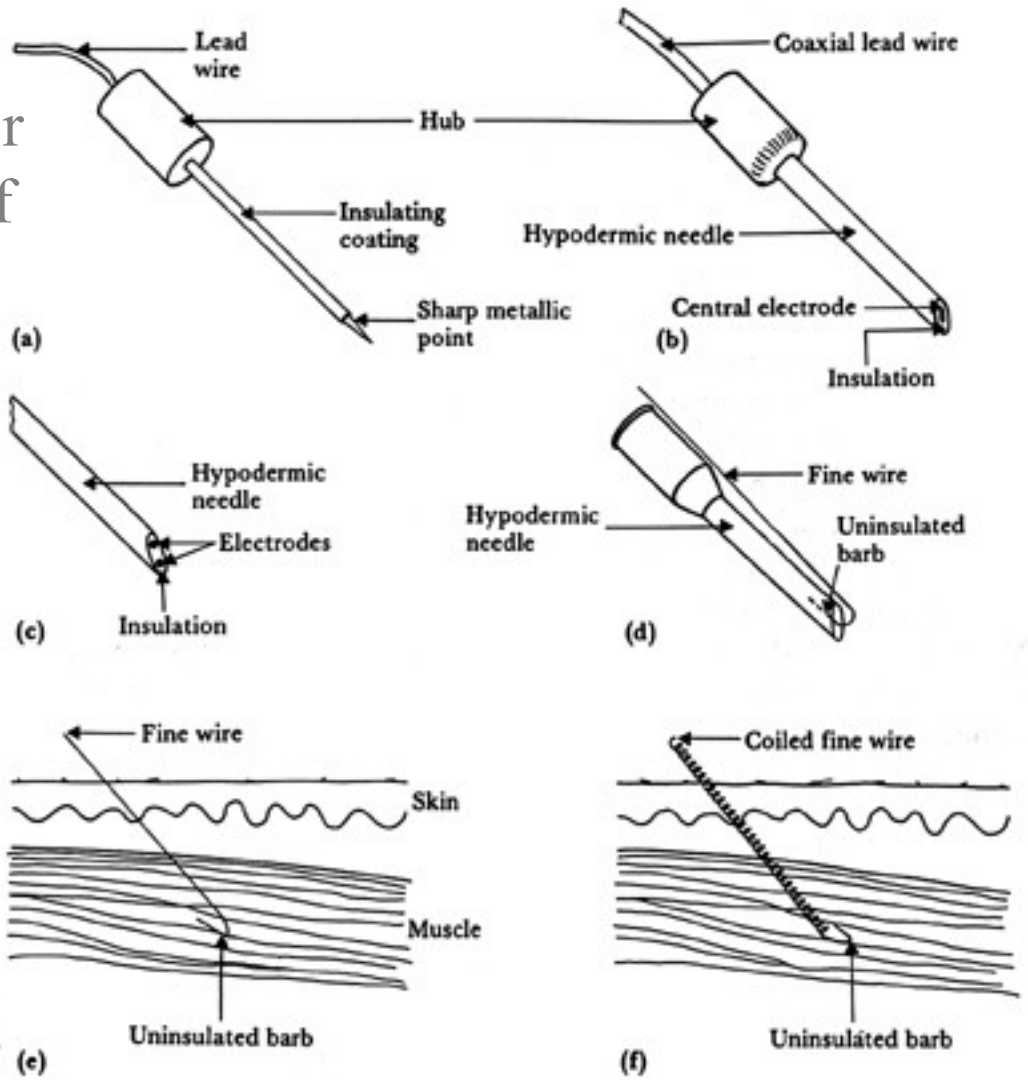
- Material :
- Polymer or nylon with silver
- Carbon filled silicon rubber (Mylar film)



(a) Carbon-filled silicone rubber electrode.
(b) Flexible thin-film neonatal electrode.
(c) Cross-sectional view of the thin-film electrode in (b).

Internal Electrodes

Needle and wire electrodes for percutaneous measurement of biopotentials



(a) Insulated needle electrode.
(b) Coaxial needle electrode.
(c) Bipolar coaxial electrode.
(d) Fine-wire electrode connected to hypodermic needle, before being inserted.
(e) Cross-sectional view of skin and muscle, showing coiled fine-wire electrode in place.

The latest: BION – implanted electrode for muscle recording/stimulation
Alfred E. Mann Foundation

Microelectrodes

Why

Measure potential difference across cell membrane

Requirements

- Small enough to be placed into cell
- Strong enough to penetrate cell membrane
- Typical tip diameter: 0.05 – 10 microns

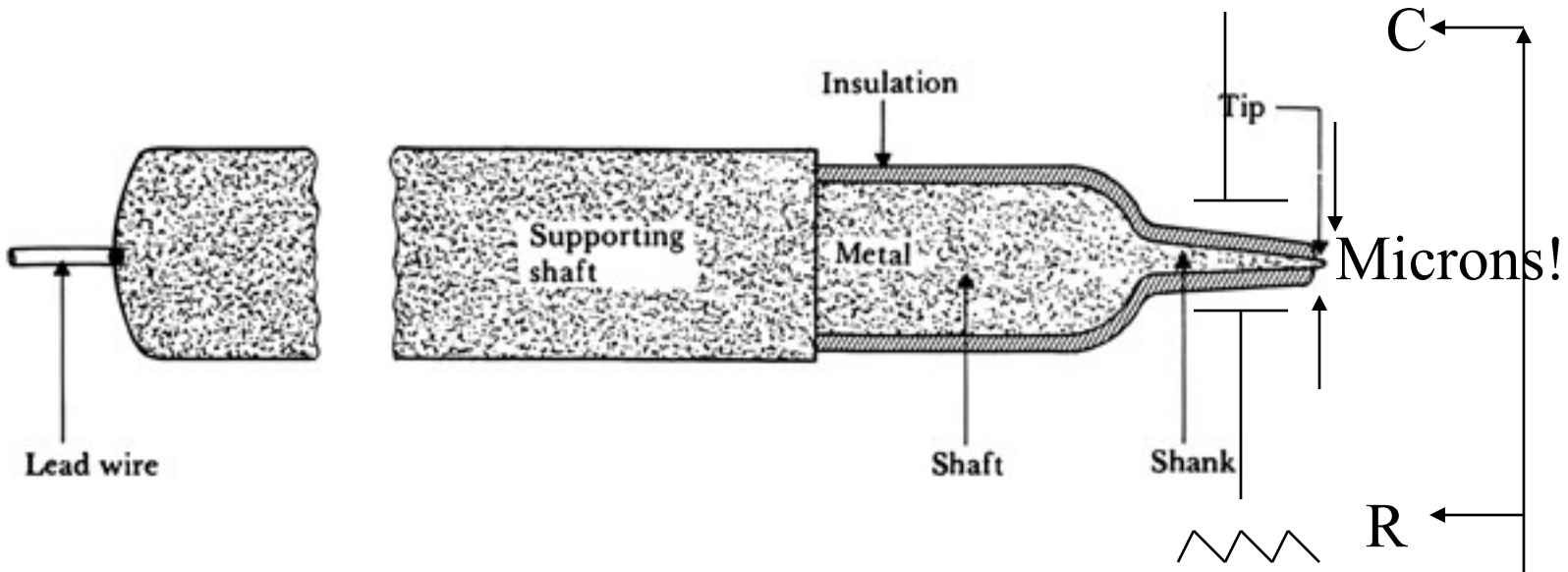
Intracellular

Extracellular

Types

- Solid metal -> Tungsten microelectrodes
- Supported metal (metal contained within/outside glass needle)
- Glass micropipette -> with Ag-AgCl electrode metal

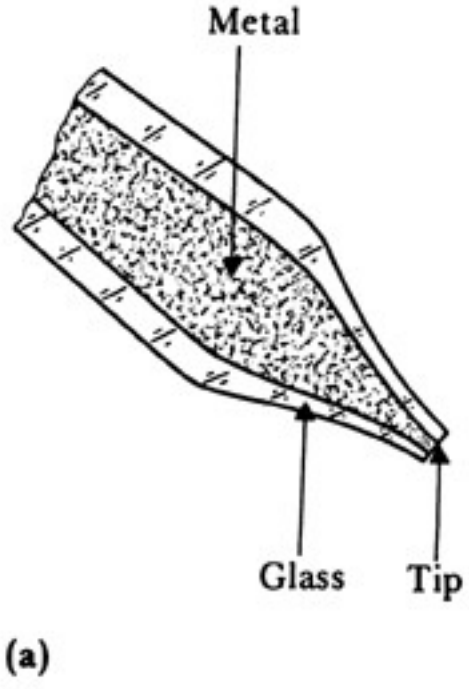
Metal Microelectrodes

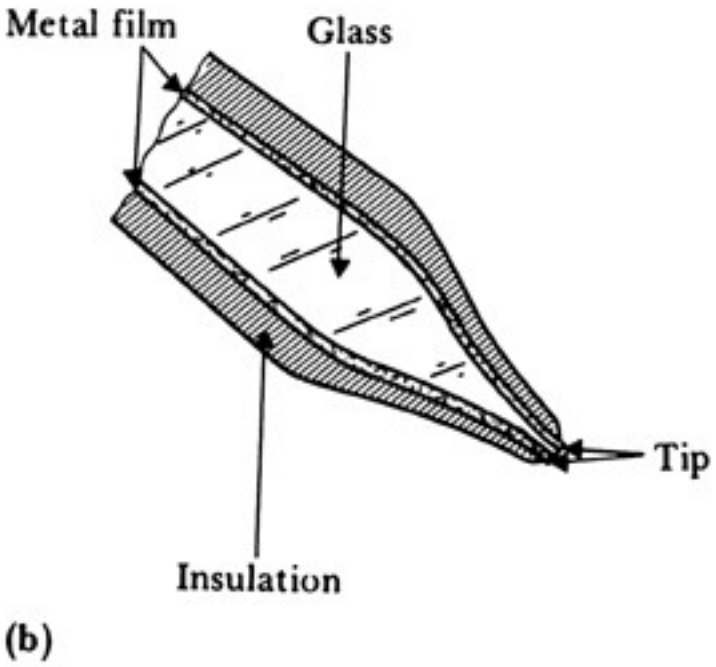


Extracellular recording – typically in brain where you are interested in recording the firing of neurons (spikes).

Use metal electrode+insulation -> goes to high impedance amplifier…negative capacitance amplifier!

Metal Supported Microelectrodes



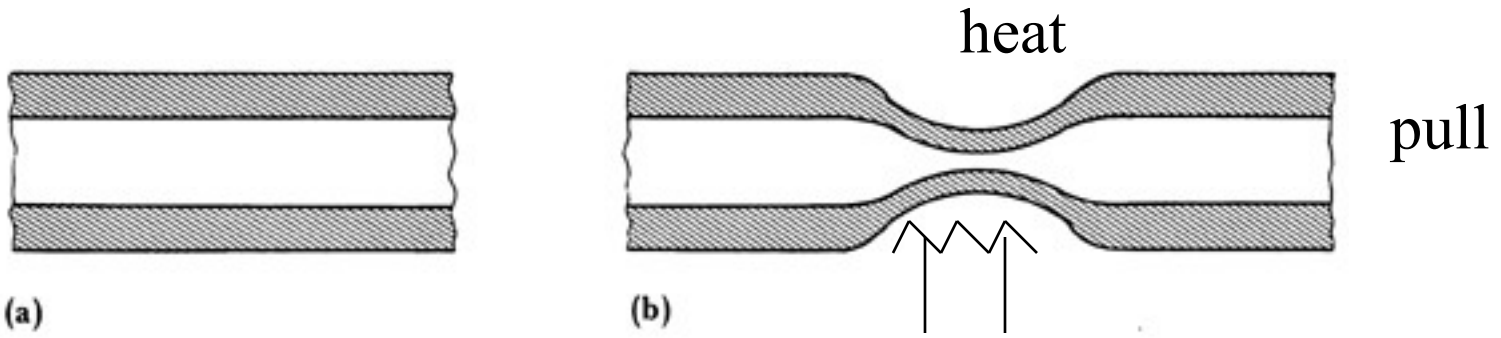


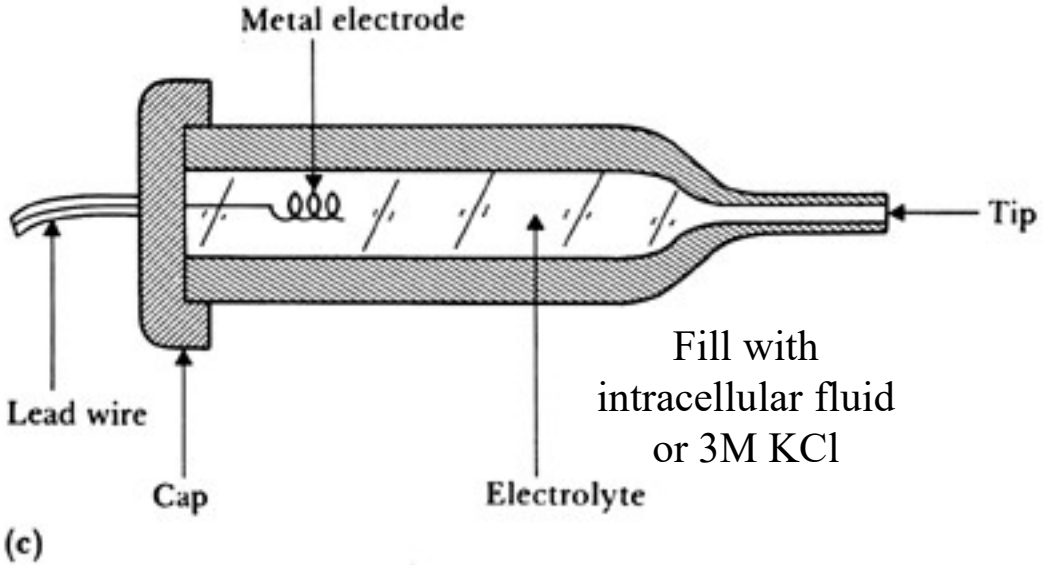
(a) Metal inside glass

(b) Glass inside metal

Glass Micropipette

Ag-AgCl wire+3M KCl has very low junction potential and hence very accurate for dc measurements (e.g. action potential)





A glass micropipet electrode filled with an electrolytic solution
(a) Section of fine-bore glass capillary.
(b) Capillary narrowed through heating and stretching.
(c) Final structure of glass-pipet microelectrode.

Intracellular recording – typically for recording from cells, such as cardiac myocyte

Need high impedance amplifier…negative capacitance amplifier!

Stimulating Electrodes

Features

– Cannot be modeled as a series resistance and capacitance (there is no single useful model)
– The body/electrode has a highly nonlinear response to stimulation
– Large currents can cause
  – Cavitation
  – Cell damage
  – Heating

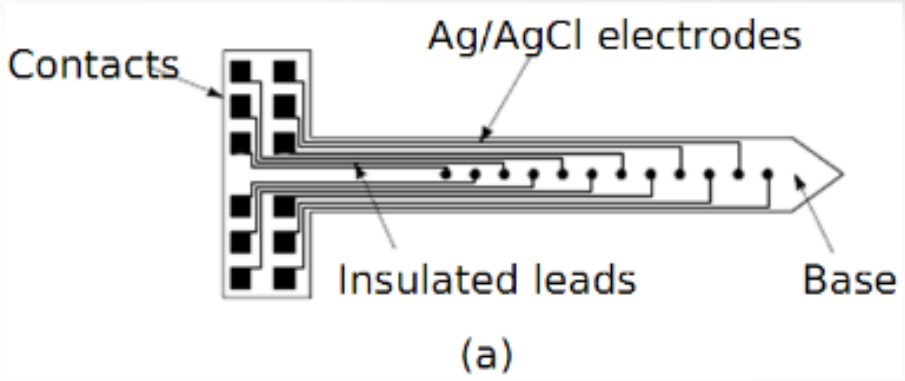
Types of stimulating electrodes

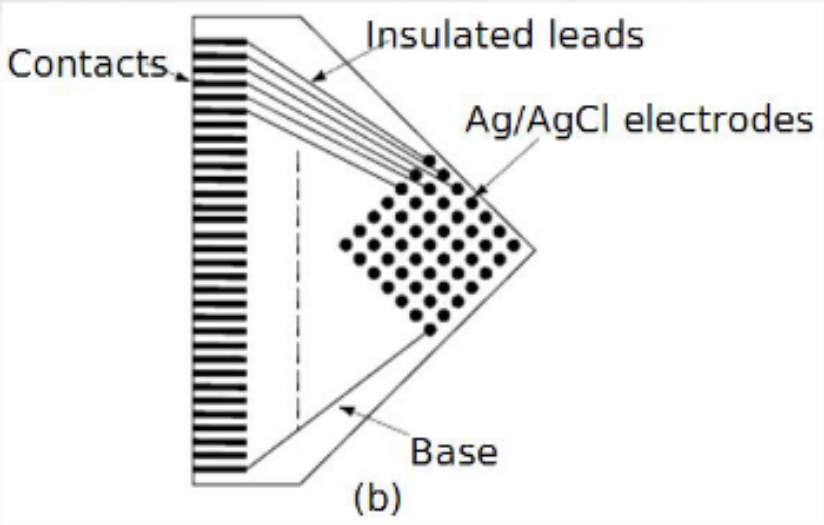
1. Pacing
2. Ablation
3. Defibrillation

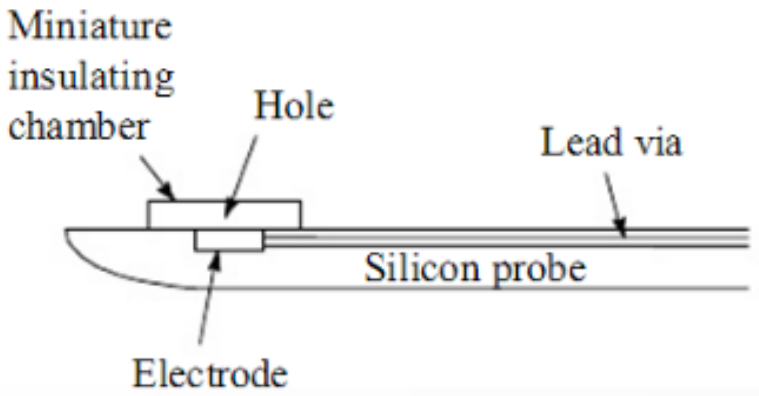
Platinum electrodes: Applications: neural stimulation

Modern day Pt-Ir and other exotic metal combinations to reduce polarization, improve conductance and long life/biocompatibility

Steel electrodes for pacemakers and defibrillators



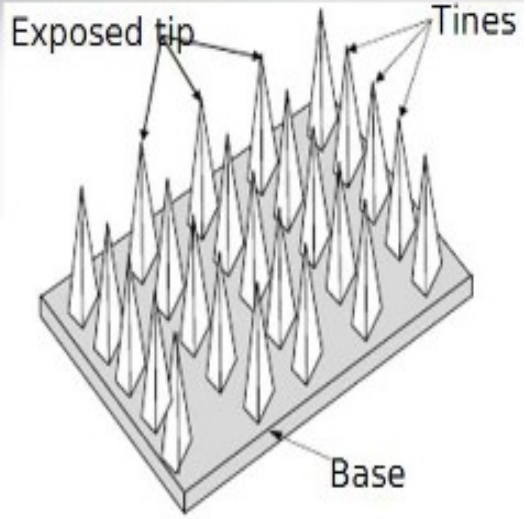




(a) One-dimensional plunge electrode array.

(b) Two-dimensional array

(c) Three-dimensional array



(c)

Power receiving coil (Au) on polyimide with ceramic ferrite backing

Integrated circuit with neural amplifiers, signal processing, and RF telemetry electronics

SMD Capacitor

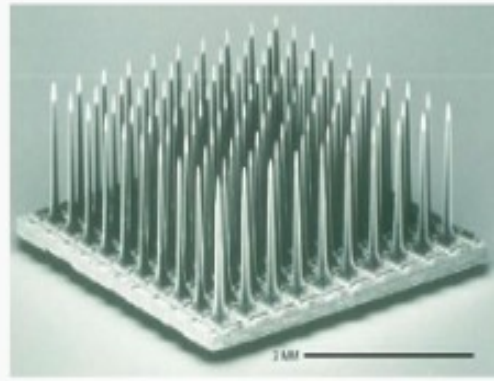
1.2 mm

400 µm pitch

Utah Microelectrode Array

Bulk micromachined silicon with platinum tips and glass isolation between shanks

Entire assembly coated in parylene and silicon carbide



Utah Microelectrode array. Courtesy of University of Utah and Cyberkinetics Inc.