Cell-Based Biosensor

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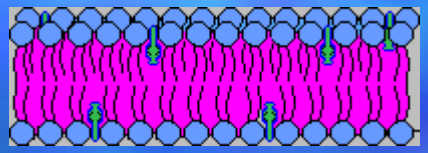
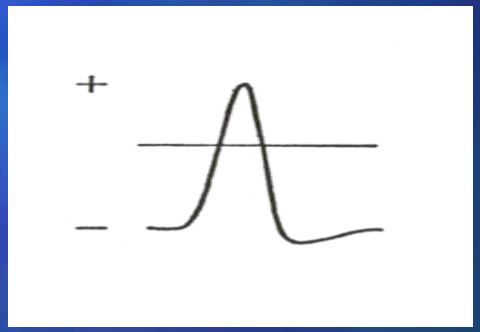
Long term goals for the sensor

- Fabrication of a biosensor that is compatible with cells and suitable to measure the changes in the electrical activity of cells
- Use in biomedical fields
- To provide information on how a large variety of factors can affect many different types of cells

Background on electrical activity of cells

- Action Potentials
  - Cells have an electrical potential caused by an ion concentration difference across membrane

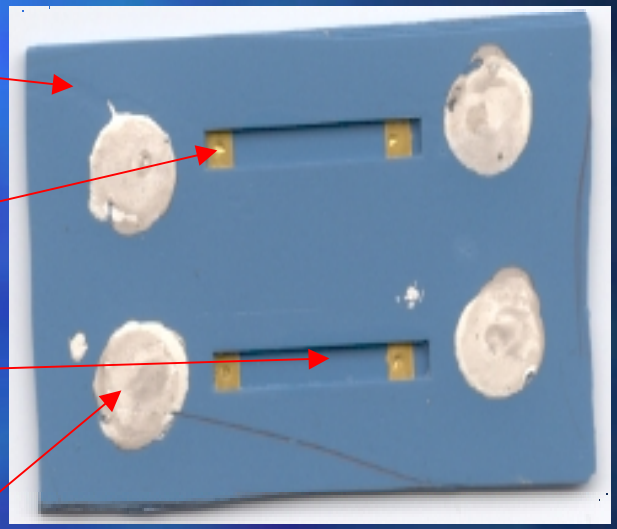




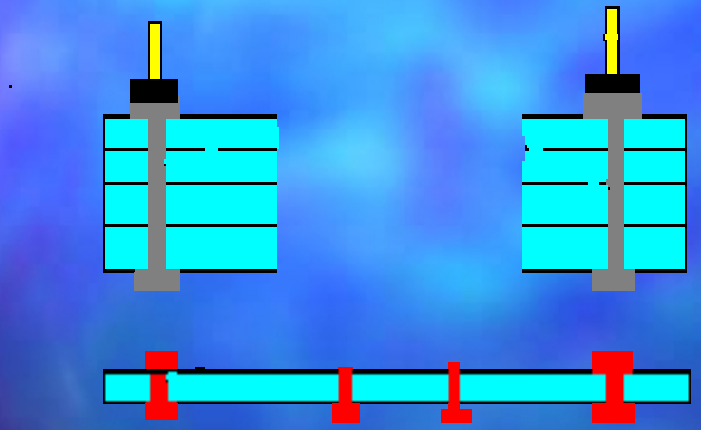
- Impedance
  - The membrane also acts as a capacitor and resistor in parallel

What does the biosensor looks like?

- First design
  - Material: DuPont Green Tape
  - Electrodes: DuPont gold paste
  - Substrate: Teflon
  - Area to interface the chamber with an outside amplifier
- Second design
  - Pure gold in chamber



How is this device actually fabricated?

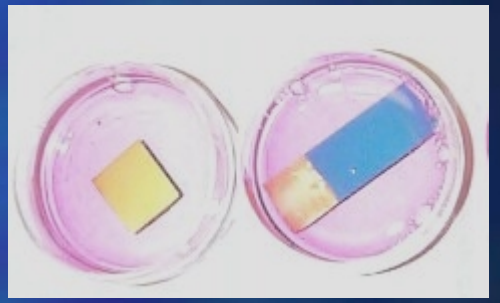


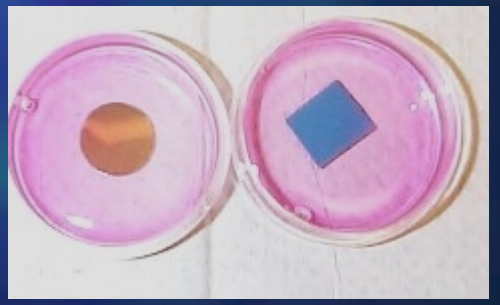
1. Layers laminated and chambers cut
2. Vias inserted
3. DuPont thick film material fills the vias
4. All layers laminated together and device is fired
5. Gold BNC pins attached to surface to interface with the amplifier

Initial testing of the material

- Human kidney cells have been used in order to test for adequacy of the chamber materials

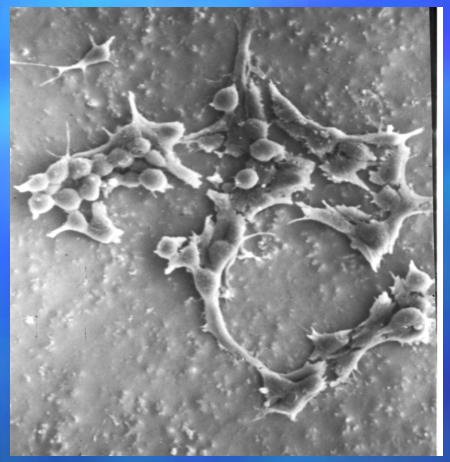
Bare Ceramic	Living Cells
Teflon covered Ceramic	Living cells
Gold paste on ceramic	Dead cells
Pure gold on ceramic	Living cells
Pure gold on glass	Living cells

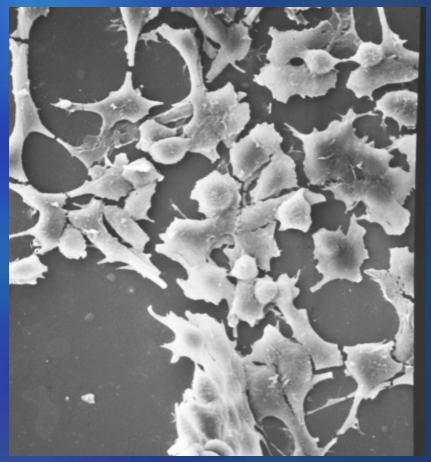




Pictures of the cells on the samples

- The scanning electron microscope was used to visualize the cells



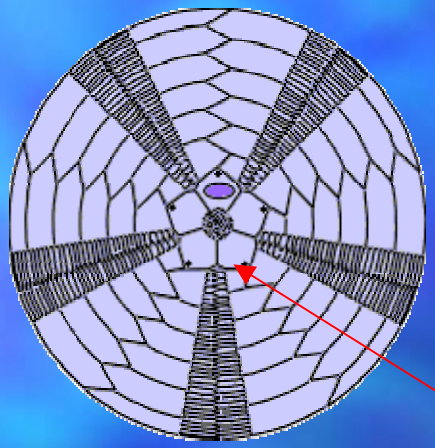


- Left: Cells attached to pure gold on ceramic
- Right: Cells attached to pure gold on glass
- Magnification: 640 times

Conclusions from test and pictures

- DuPont Gold paste is the cause of death of cells most likely due to the diffusion of metal oxides from the ceramic into the gold during cofiring
- Pure gold does not kill the cells
- Cells do in fact stick to the pure gold
- The electrodes in the chamber should be made from pure gold

Sea Urchin Eggs



- Sea urchin eggs are heartier and larger than the kidney cells
- Eggs are extruded out of gonopores by adding a small current to sea urchin
- Jelly layer around egg removed to expose the egg's membrane

Testing the biosensor

- Tested for a change in resistance when sea urchin eggs were added to the chamber
- Resistance with only seawater = 50 kΩ
- No change in resistance with eggs
- Expected resistance of eggs approximately 1000 Ωcm^2

Problems

- Teflon may be porous
- The exposed electrode area is too large
- The jelly coat of the eggs not properly removed
- Eggs not attaching to electrodes

Recommendations for continued research

- Definitely use pure gold as electrode material
- Coat the electrode with protein layer to enhance attachment
- Explore other insulating materials
- Find method of exposing the proper amount of electrode surface such as a laser
- Can also look into different designs that are compatible with impedance measurements
- Make electrical measurements by applying different types of stimuli

. . . and in the future?

- Hopefully this device can be perfected
- It will apply to many different testing situations
- Much information will be gained about how cells respond in different environments