IPRO 308

Developing the Artificial Pancreas

BACKGROUND

Insulin: Regulates glucose absorption into tissues for metabolic needs

- **Type 1 Diabetes**
- **Type 2 Diabetes**

All of these forms of Diabetes have one thing in common

Insulin deficiency

COMMERCIALIZATION

- **24 million Americans currently have diabetes while 6 million of them are undiagnosed***
- **Total annual economic cost of diabetes in 2007 $174 billion***
- **Fastest growing disease in the country***
- **Fifth deadliest disease in the United States***

*** Courtesy American Diabetics Association**

ADVANTAGES OF OUR TECHNOLOGY

- **Current Technology**
  - Causes pain
  - Needles discarded after single use
  - Requires supervision for use in kids
  - Manual testing required to detect any unsafe situation
  - Monthly expense for needles and strips
- **Our Technology**
  - No pain
  - Multi use disposable containers
  - Easy to use for all age groups
  - Automatic testing alerts user of possible dangers
  - One time expense for the machine

TEAM ORGANIZATION

SUB-GROUPS

TEAM LEADER: Bill Wakeman (Sr. ME)

SECRETARY: Anju Naveenan (Sr. EE)

Closed-Loop:

Bill Wakeman (Sr. ME)

Olufemi Sonoiki (Sr. ME)

Anju Naveenan (Sr. EE)

In Seok Sin (Sr. Bio)

Adam Kuuspalu (Jr. Bio Chem)

Measurement:

Allen Klug (Sr. EE)

Adam Kuuspalu (Jr. Bio Chem)

Adam Smith (Sr. Arch)

Bill Wakeman (Sr. ME)

Research:

Adam Smith (5th yr. Arch)

In Seok Sin (Sr. Bio)

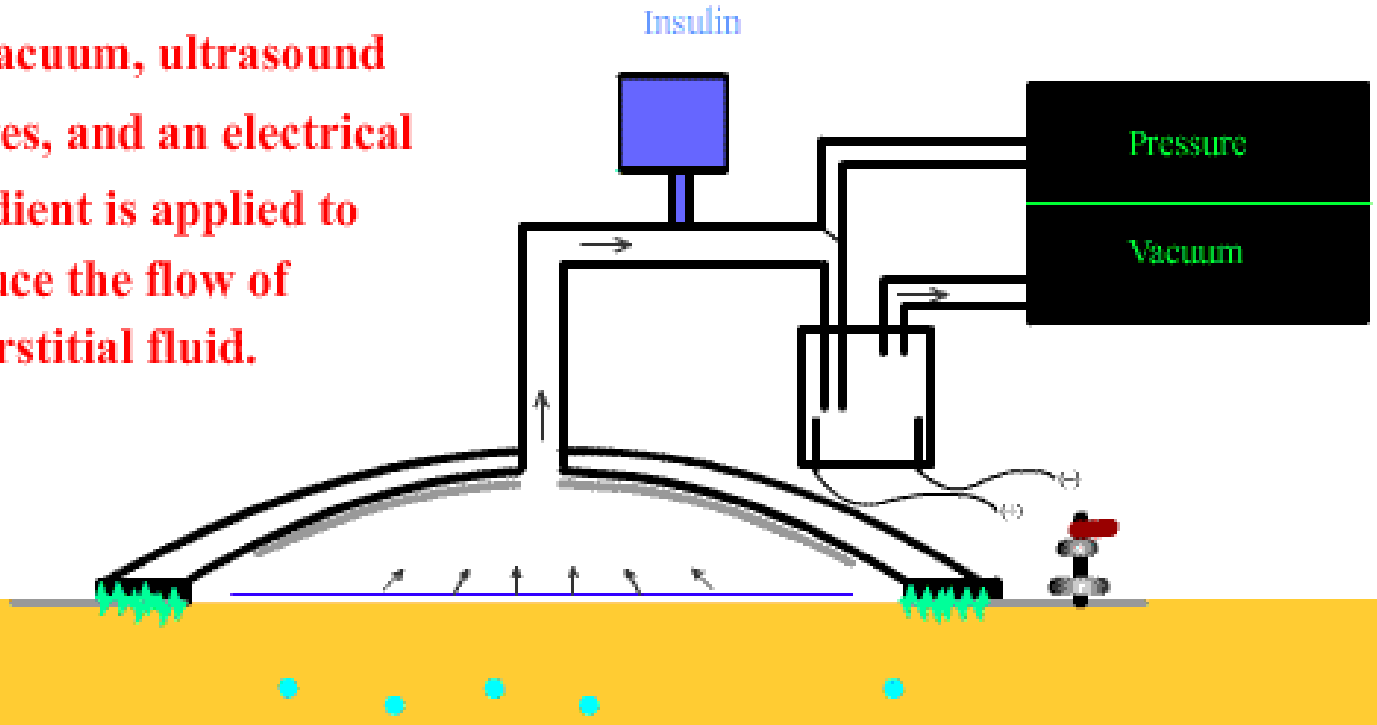
Olufemi Sonoiki (Sr. ME)

What is “Closed-Loop”?

```
D:\Java_Dev\WEB\java2s>java LabeledWhile
Outer while loop
i = 1
continue
i = 2
i = 3
continue outer
Outer while loop
i = 4
i = 5
break
Outer while loop
i = 6
i = 7
break outer
```


THE PROCESS

1.)Vacuum, ultrasound waves, and an electrical gradient is applied to induce the flow of interstitial fluid.



CLOSED LOOP TECHNOLOGY

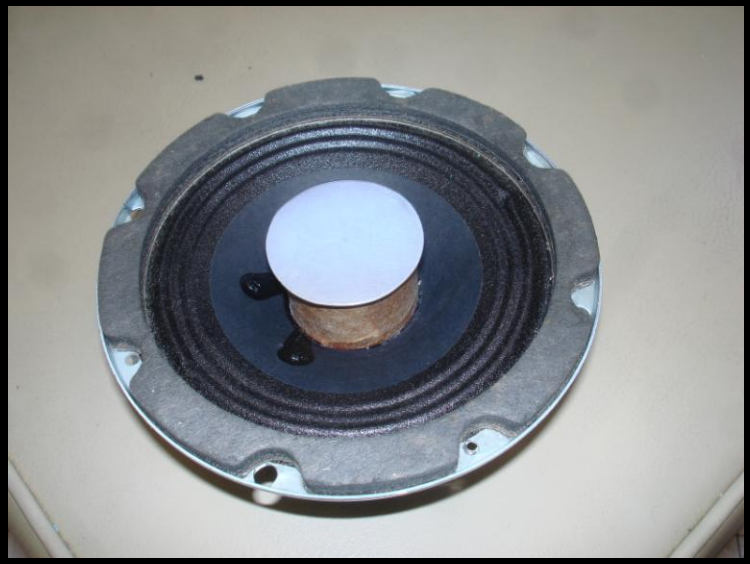
Spring ’08 Proposal

- Vacuum
- Sonophoresis
- Reverse Iontophoresis

CLOSED LOOP TECHNOLOGY

Current Prototypes:

Vacuum



Sonophoresis

CLOSED LOOP TECHNOLOGY

Experimental Procedure:

Solution of Green dye and D.I. water

Porcine skin

CLOSED LOOP TECHNOLOGY

Testing Results:

Focused on ISF extraction requirements

Maximum test times included:

- 4 hours Vacuum
- 1 hour Sonophoresis, 3 hours Vacuum

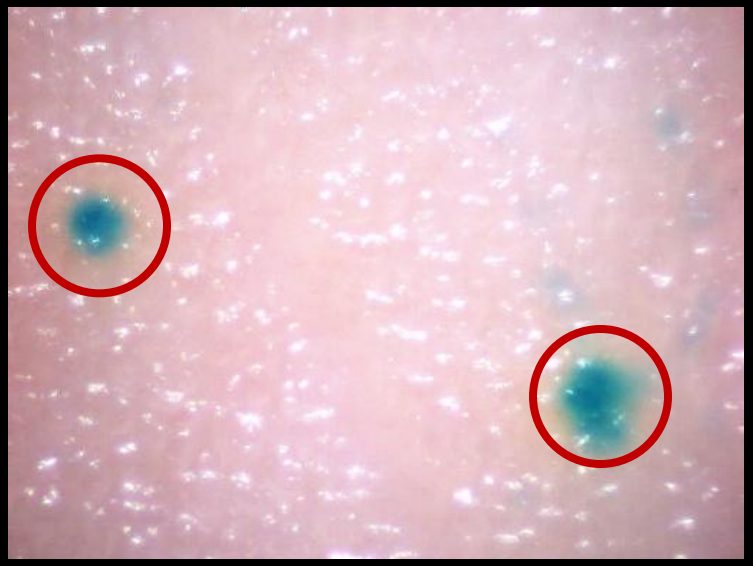
Visible spots on pores sites

Splatter spots (micro droplets) on skin due to vibration of speaker and movement of skin sample

CLOSED LOOP TECHNOLOGY

Applied Sonophoresis and Vacuum Results:

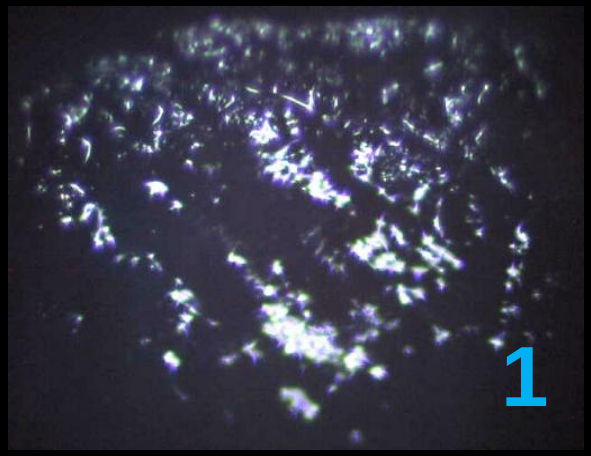
No Sonophoresis and Vacuum

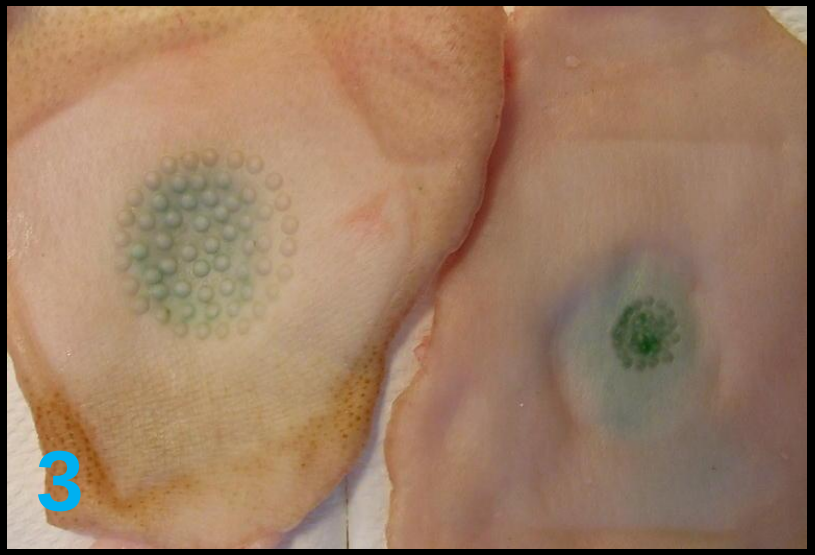


After Sonophoresis and Vacuum

CLOSED LOOP TECHNOLOGY

Applied Sonophoresis and Vacuum Results:





1: Random splatter outside of affected areas

2: Saturation of green dye into pig skin

3: Porcine Samples from extended Sonophoresis and Vacuum

CLOSED LOOP TECHNOLOGY

Analysis of Porcine Skin Samples from Test Results:

- Porcine skin was not fresh
- Scything the skin may have blocked pore holes and reduced the oils causing it to contract
- Dead skin created a static system
- Internal pressures needed to achieve optimal flow rate
- Skin produced translucent appearance causing green bleed through
- Projected time period proved inaccurate for extraction

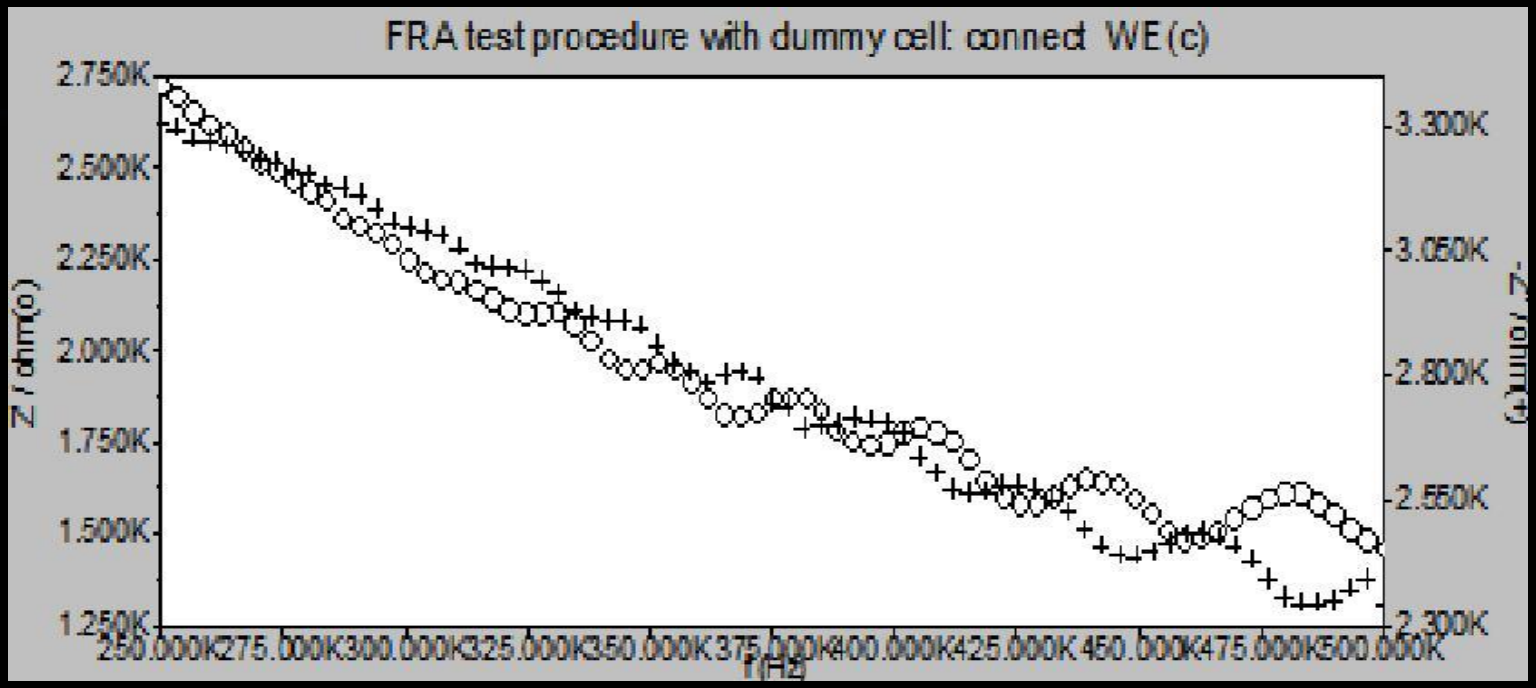
Future Options

- Mechanical Sieves
- Operating Prototype at Optimal parameters and specifications
- Animal (rat) Testing
- Comparative Patent Design Analysis
- Focus on Administration of Insulin

GLUCOSE MEASUREMENT

- Spring 2008 –Measurement using glucose oxidase reaction
- Current Semester – Impedance Spectroscopy
  - Using the resonant frequency of glucose, measure its concentration
  - Look for a predictable difference in the impedance graph due to a chance in the concentration of glucose.
  - The advantage of impedance spectroscopy is that there are no chemicals needed to do the measurement.
  - Previous semester's IPRO scanned from 1-100 KHz. This semester we scanned up to 1Mhz

MEASUREMENT RESULTS



- **Above 500Khz the results became erratic.**

- **We could not find a significant difference in the impedance graphs for the four different concentrations we tested.**

FUTURE OPTIONS

- **Further testing with Impedance Spectroscopy**
  - The inconsistent measurements could have been caused by the way we set up our capacitor.
- **Nuclear Magnetic Resonance**
  - Might have problems with accuracy on a small NMR device.

RESEARCH

- **Researched existing patents**
  - Echo Therapeutics
  - Pendra
- **Alternate methods**
  - Micro needles
  - Photoacoustic measurement
- **Submitted deliverables**
  - Project plan, Final report
  - Poster, Brochure

ETHICS STATEMENT

- In class discussion held in free format
- Ethics statement was prepared with every class members input and participation.
- Issues raised include:
  - Animal testing
  - Tampering with results
  - Lab conduct
  - Respectful interaction

SUMMARY

- **Deconstructed closed loop prototype elements**
- **Exhausted the current medium for testing**
  - Calibrate prototype to match existing parameters set by research
- **Focus on Impedance Spectroscopy for glucose measurement**
- **Found existing patents for non-invasive glucose measurement**
- **Implication of successful development of the closed loop technology for the lifestyle of diabetic patients**
- **Commercialization potential of the technology**

SPECIAL THANKS TO

-Dr Dhar
-Dr Derwent
-Dr Gottlieb
-Mr Jacobius
-Mr DeBoth
-Dr Opara
-Ms Patel
-Dr Rousche
-Mr Kubisco

QUESTIONS?