

## What is Bioengineering?

**Mark S. Redfern, Ph.D.**  
Associate Dean and Professor



Department of Bioengineering  
University of Pittsburgh



## Bioengineering - Pittsburgh



## What is Bioengineering?

- “Applying engineering knowledge and methods to solve biomedical problems.”
- Spans molecular to whole body
  - Tissue Engineering
  - Artificial Organs
  - Medical Instrumentation
  - Rehabilitation Engineering
  - Imaging



## What is Bioengineering?

- “Advances knowledge in engineering, biology and medicine, and improves human health through cross-disciplinary activities that integrate the engineering sciences with life sciences and clinical practice.”
- [Engineering applied to health]



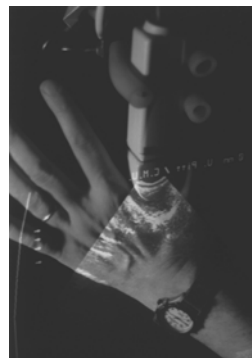
## Pediatric Ventricular Assist Device



Antaki, Borovetz, Wagner, Keller,  
Kormos and Webber



## Sonic Flashlight



Stetten & Chib



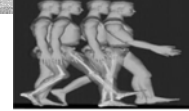
## Sonic Flashlight

Imaging the hand

Stetten & Chib



## Human Movement & Balance

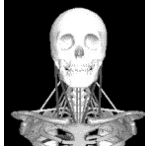


- Postural Control
- Slips and Falls

Mark Redfern & Rakie Cham



## Human Movement & Balance



<http://www.youtube.com/watch?v=aX9InPSPM6U>



## Rehabilitation Engineering

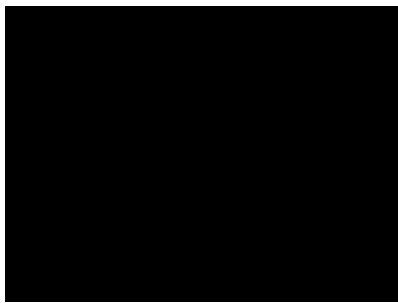


- Wheelchair evaluations and upper extremity injuries

Rory Cooper, Michael Boninnger, Alicia Koontz



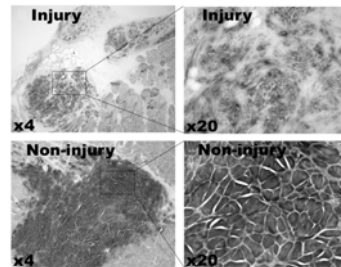
## Human Engineering Research Laboratory



<http://www.herlpitt.org/video.htm>



## Muscle Regeneration

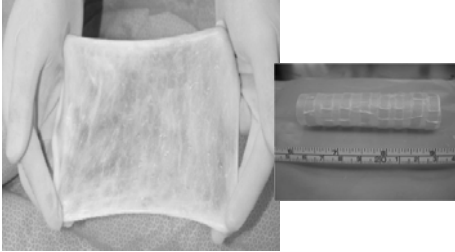


Yong Li & Johnny Huard



## **Biologic Scaffolds**

for Regenerative Medicine



Stephen F. Badylak, DVM, MD, PhD



## **Example of Bioengineering the Knee**

<http://www.youtube.com/watch?v=YvP-79z8v54>



## **Neural Engineering**

### **Neural Motor Lab**

-Andrew Schwartz



### **Rehab Neural Engineering Lab**

-Doug Weber

### **Neural Tissue Interface Lab**

-Tracy Cui



## **Neural Engineering: Motor Lab**



## **Motor Lab: Continuous Feeding**

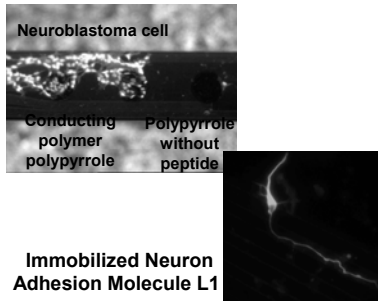


## **Neural Engineering: What do we need to know to do this?**

- Neuroscience (i.e. the brain)
- Electrode interface issues:
  - Material Science
  - Bio-compatibility
- Signal Analysis
- Computational modeling
- Control Systems
- Robotics & Mechatronics
- Veterinary Science



## Neural Tissue Engineering



Tracy Cui, Ph.D.



## Orthopaedic Biomechanics



- Ligament, Tendon and Muscle Function

Savio L-Y. Woo, Richard Debski, Steven Abramowitch



Carnegie Mellon



## HeartLander OMNI

Pete Allen

Advisors:  
Dr. Cameron Riviere, PhD  
Dr. Nicholas Patronik, PhD



## The Current Problem

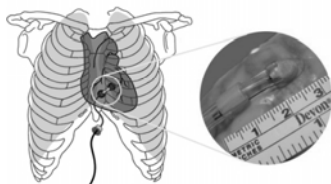


- Open Heart Surgery Today
  - Median Sternotomy
  - General Anesthetic
  - Tissue Stabilizers
- Minimally Invasive Surgery Today
  - Lung Deflation
  - Inability to reach backside of heart

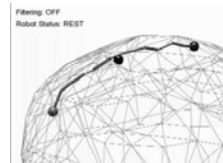
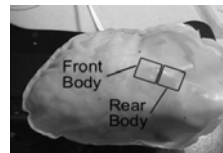


## Introducing the Solution: HeartLander

- HeartLander Robot
  - Crawling Robot
    - » 2 Feet (6.5 mm height)
    - » Inchworm-like Locomotion
    - » Crawls on Heart Surface
    - » Tethered
  - Surgical Purposes
    - » Minimally Invasive Cardiac Surgery
      - Ablation
      - Injection of Chemical Therapies
      - Electrode Pacing Lead Placement
      - Vision via ICE Catheter



## Advantages

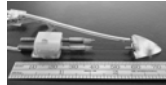
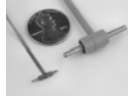


- Minimally invasive approach
  - No median sternotomy or general anesthesia
- Allows for beating heart surgery
  - No need for tissue immobilizers
- Access to back of heart
- Subxiphoid, intrapericardial approach
- Obviates lung deflation



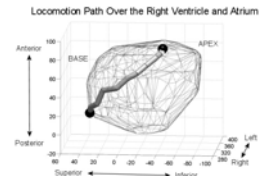
## HeartLander OMNI

- Motors
  - Ultrasonic Piezoelectric Motors
    - » Compact
    - » High Axial Load
    - » Flexible Tether
    - » Programmable
    - » Durable
- Too Long
- No tracking



## microBIRD

- DC Magnetic Field Transmitter
- Tracks location and orientation of robot



## Off the Beaten Path... working at the FDA



Sara Doll and Katie O'Callaghan  
Pitt Alumni!

...and...  
Biomedical Engineers and Scientific  
Reviewers  
@ FDA – Office of Device Evaluation

## Who Are We?

### Sara

BS: Bioengineering  
→ Systems/Signals  
Concen  
→ ECMO Tech at  
Children's  
→ IAESTE Internship

Minor: Neuroscience  
→ NIMH Fellowship

Study Abroad  
Engineering World  
Health

### Katie

BS: Bioengineering  
→ Hybrid  
Concentration  
→ Intramural  
Internship  
→ Industrial  
Internship

BA: German  
→ Dual Degree  
Program  
→ Study Abroad

## Who Are We?

One year after graduation...

- Full-time employees at the FDA
- Sara: Surgical and Neurological devices
- Katie: Cardiovascular devices

## ACTIVE Education

- Hybrid Concentration
- Minor
- Double Major
- Double Degree Program
- ...just take a lot of interesting classes!

## Practical Work Experience

- Internships
  - Intramural
  - Industrial
  - Other: INROADS, NIH, programs through other universities
- Fellowships (NIMH, MDFP)
- Co-op



## I've got my degree, now what?



## Why We Joined FDA

- *BROAD* perspective (the field, the process, the game)
- *RELEVANT* Bioengineering experience
- *INTERSECTION* of medicine, engineering, critical thinking & writing...
- Regulatory knowledge?
- (Not ready to specialize)
- (Not ready to commit)



## Why We Love Our Job

- The People
- Work Environment
- New challenges and projects
- Ssshhhhh! I can't tell you!
- Liaison
- Sense of Ethical Purpose
- *Real* responsibility
- *Real* influence
- Secure
- Flexible working hours
- Washington, DC



## What is FDA?

### United States government *regulatory agency*

- Our mission is to:
  - » Promote the public health
  - » Protect the public health

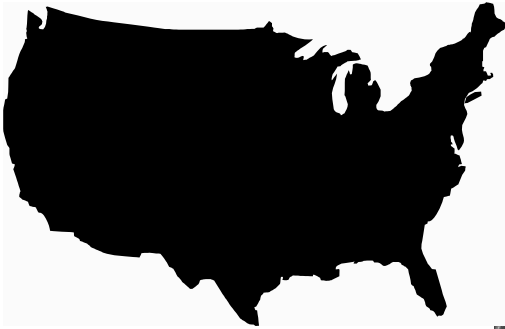


## What is FDA?

- Food and Cosmetics
  - Labeling, supplements, cosmetic safety
- Veterinary Medicine
  - Vet drugs, animal feeds
- Biologics
  - Vaccines, blood supply, human tissues, gene therapy
- Drugs
- Devices – CDRH



## What does CDRH do?



## What does CDRH regulate?




*We don't regulate medical procedures.*




We regulate the products, but not how doctors choose to use them.

## Division of Cardiovascular Devices

- Ventricular Assist Devices
  - Heart Valves
  - Drug Eluting Stents
  - PFO Occluders
  - Pacemakers
  - Defibrillators (External and Implantable)
  - Balloon catheters; other percutaneous cardiology devices
- 

## Division of General, Restorative, Neurological Devices

- Transcranial magnetic stimulators
  - Silicone breast implants
  - Deep brain stimulators for Parkinson's
  - Computer-aided surgery devices
  - Orthopaedics
- 

## Getting a Bioengineering Education

- Degrees in Bioengineering

Or

- Degrees in other Engineering Field with application to biomedicine
- 

## BioE Educational Objectives

- **Fundamentals in Engineering & Biology**
- **Broad base of knowledge**
- **Education Beyond the Classroom**
- **Provide an individualized education for students specific to their post-graduate goals (i.e. industry, graduate school or medical school)**
- **....not a terminal degree**

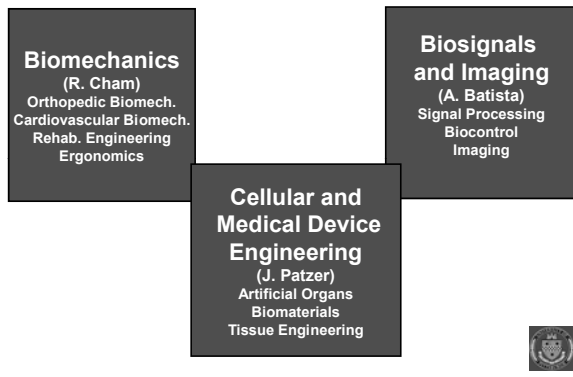


## B.S. in Bioengineering

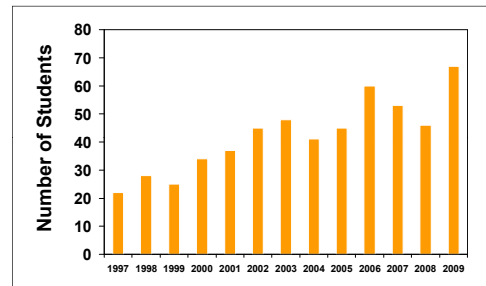
- **Basic Sciences**
  - Mathematics
  - Chemistry
  - Physics
- **Engineering**
  - Mechanics
  - Materials
  - Electronics
- **Humanities**
  - Literature
  - Communication
  - Ethics
- **Biological Sciences**
  - Biology
  - Physiology
- **Bioengineering**
  - Core Courses
  - Concentration
  - Internships
  - Design



## Concentration Areas



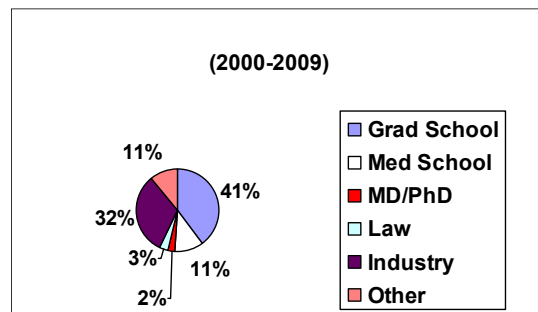
## Bioengineering Students



2009 → AVG GPA = 3.4 in freshman year



## Bioengineering Graduates



## Graduate Schools - Pitt Graduates

- Berkeley
- CMU
- Drexel
- Duke
- Georgia Tech
- Georgetown
- Johns Hopkins
- Marquette
- Maryland
- Northwestern
- Ohio State
- Univ. of Michigan
- Univ. of Wash. (MD/PhD)
- Penn
- Stanford
- SUNY Buffalo
- Univ. of Pittsburgh
  - BioE
  - Rehabilitation Science
  - Chem E
  - EE
  - Computer Science
- Wisconsin
- Vanderbilt
- Virginia Tech



## **Sample – Company Placements**

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- Cook Vascular Inc.
- Enson, Inc.
- Rehab. Inst. of Chicago
- ALung
- Vicon Peak
- Visible Genetics, Inc.
- Flexuspine
- Medrad
- Stryker Medical
- Dept. Rheumatology
- Cellomics
- Cardiac Assist
- Presbyterian Hosp. (ECMO)
- Respironics
- Membrane Systems, Inc
- FDA



## **Summary**

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- **Bioengineering - application of engineering to solve biomedical problems**
- **Bioengineering - expanding in Pittsburgh region**
- **Curriculum provides breadth & depth**
- **Graduates attend graduate schools, medical schools and industry**

