MUSC Research Experience for Undergraduates in Tissue Engineering and Biofabrication

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Development of an REU to benefit and complement an ongoing NSF EPSCoR RII

2009 NSF EPSCoR RII in Biofabrication:

- Help South Carolina develop a competitive edge in the field of biofabrication.
- Biofabrication: Computer-aided synthesis of biological material for the purpose of engineering functional 3D tissues and organs.

Thrusts:

- Modeling and Computer-Aided-Design
- Pre-Processing / Bioink Design
- Biomechanical Testing of Constructs
- Processing & Assembly / Bioprinters
- Post-Processing / Maturation

MUSC-based Biofabrication Investigators


Roger Markwald


Chris Drake


Mike Yost


Ying Mei


Kelley Argraves


Rick Visconti

Development of an REU to benefit and complement an ongoing NSF EPSCoR RII

REU Funded through Scientific Advocate Network grants (EPSCoR) 2013-16

<u>REU Aims</u>:

- Provide training in lab practices and focused exposure to biofabrication.
- Be a positive educational experience for SC students interested in STEM.
- Promote participation of students from SC institutions categorized as ‘outreach’ by IDeA Networks of Biomedical Research Excellence (INBRE), and particularly under-represented minorities (URMs)
- Promote the pursuit of biomedical research careers.

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Biofabrication REU Overview

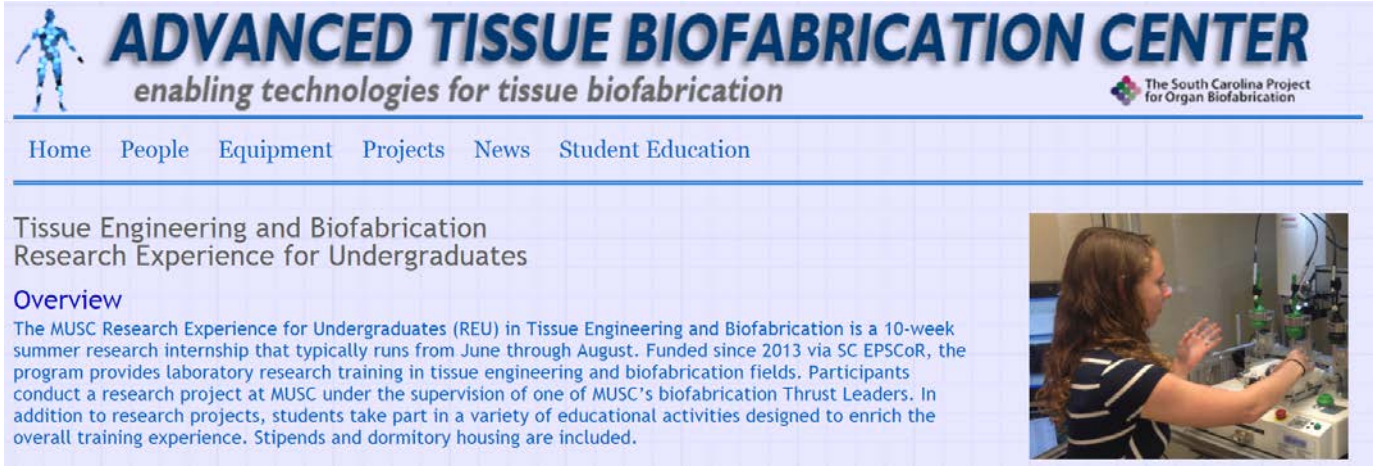
Dec - Feb	• Recruitment phase:
Mar - May	• Application acceptance and processing:

June - Aug	• 10-week research program:
	  • Basic activities
	  • Research projects
	  • Written Reports
	  • Oral Presentations at the MUSC SURP Closing Symposium
	  • Enrichment activities
	  • Biomedical topics lecture series
	  • Journal club
	  • 3D Bioprinting Challenge

Nov - Mar	• Meeting attendance (MUSC SRD, SC INBRE and EPSCoR annual meetings)

Recruitment

- Websites
  - ATBC
  - MUSC
- Newsletters (SC INBRE)



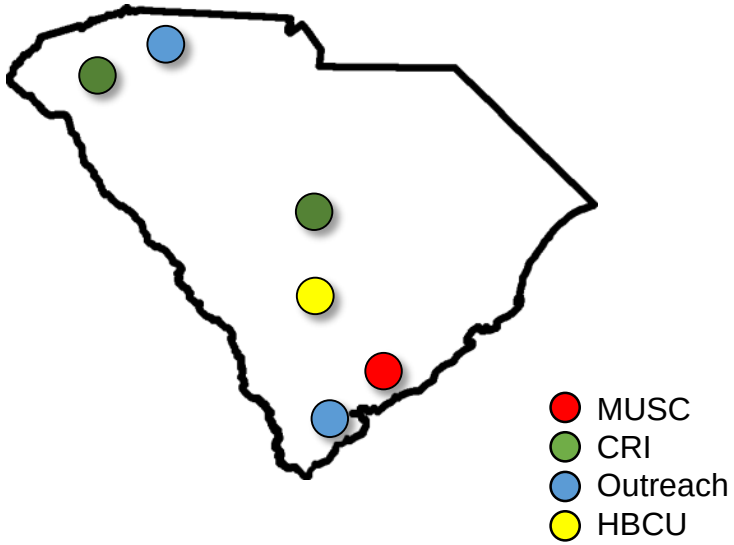
- Personal contact with investigators at target institutions.
  - Personal emails and phone calls to educators with the opportunity to describe the program to students in a classroom setting.
  - Investigators/Institutions included larger SC institutions as well as PUIs and HBCUs:
    - SC State University, USC Beaufort, Voorhees College, Claflin College, Furman University, Clemson University, and University of South Carolina.

Student Support

- Stipends: $4000
- Housing: Dorms at the College of Charleston $2000
- Travel: Trips at start/end of program; other scientific meetings $200
- Supplies: Support for cost of experimentation $500

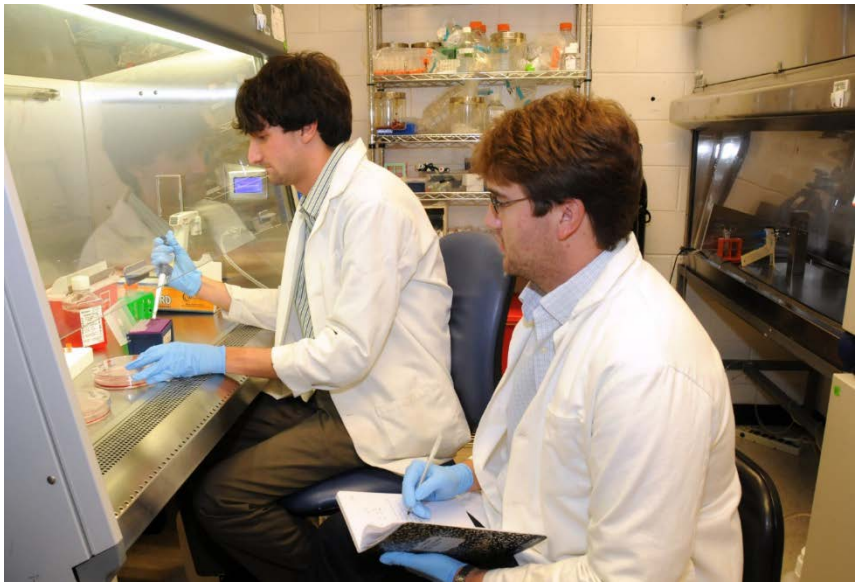
Participants: 2013 - 2016

- 21 Students
  - 2 Comprehensive Research Institutions
  - 2 Outreach Institutions
  - 1 HBCU



Basic Activities:

- Research Projects: Performed in labs of mentors based on expressed research interests and available projects.
- Lecture Series: Lectures in current methodologies and biological research topics given by MUSC faculty.
- Written Reports: Journal-format paper
- MUSC Summer Student Symposium: 15 min presentations (powerpoint) to fellow students.



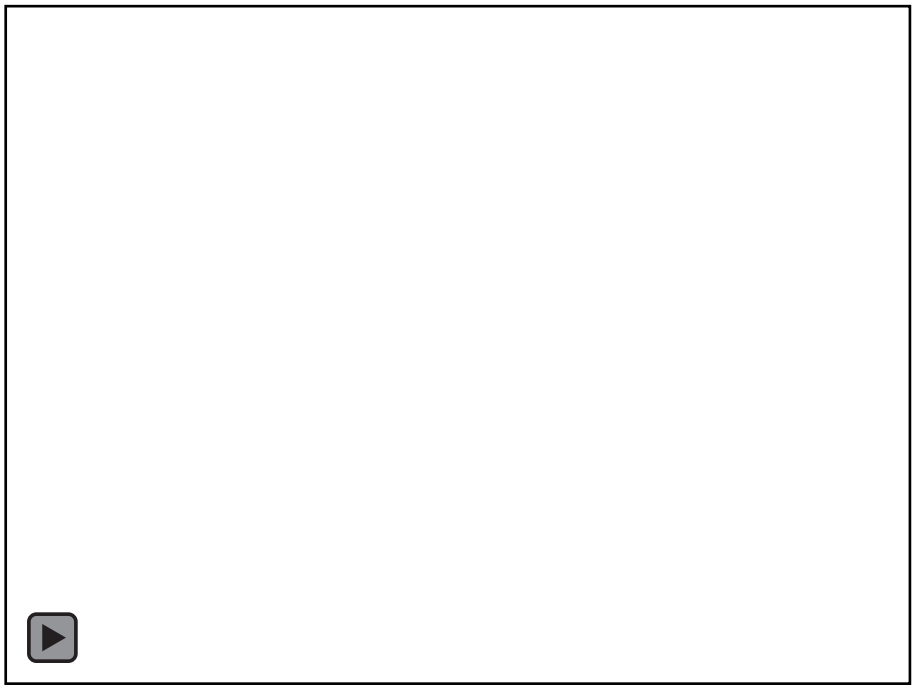
- Benefits:
  - Education and technology training
  - Reading and scientific journals
  - Critical thinking
  - Social Development: Building social and academic networks with one another and with members of the university community

Enrichment Activities: Journal club

- Students chose research papers relevant to their program and presented them in the form of a PowerPoint presentation
- Presentation:
  - ~30 min
  - Background
  - Results
  - Future directions
- Benefits:
  - Education
  - Presentation skills

Enrichment Activities: 3-D Printing

- Students were given a challenge to print a 3D object that was thematically representative of their program.
- Students received instruction in 3D design (from Dr. Tom Trusk, MUSC) and were shown how to operate the MakerBot 3D desktop printer
- Group competition versus another REU at MUSC with a final presentation of products: “Makerbot Challenge”



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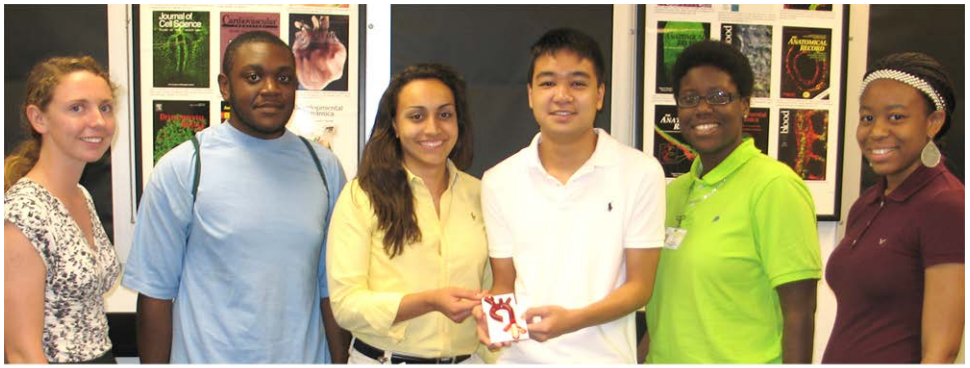
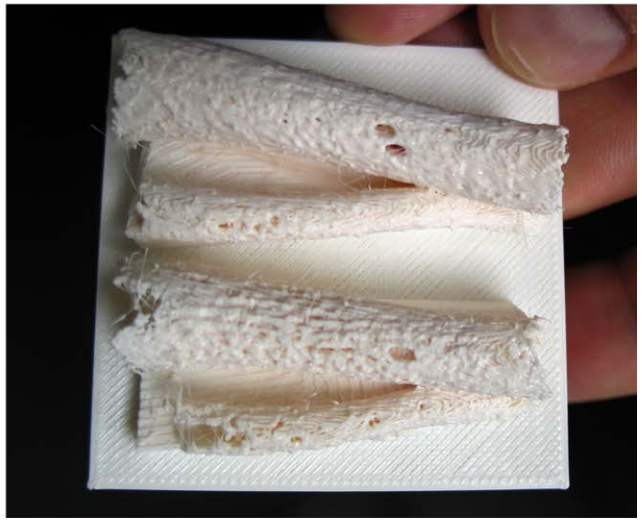




Enrichment Activities: Bioprinting Exposure

- The Palmetto Printer is an automated bioprinter designed by MUSC and Clemson researchers. It has three interchangeable dispensers; sensing lasers detect the print biomaterials along x,y,z coordinates.
- Students received instruction in Palmetto Printer operation and capabilities from members of Dr. Mike Yost's laboratory.
- Benefits:
  - Education
  - Leading-edge technology exposure

Outcomes 1: Lab training and exposure to biofabrication

- Laboratory training
- Computer and technical training
- Presentation skills
- Leading-edge technology exposure
- Reading and interpreting scientific papers
- Critical thinking
- Social Development

Outcomes 2: Promoting participation

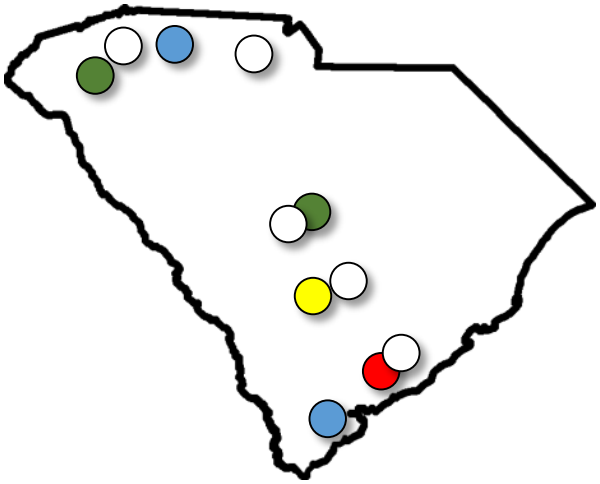
Demographics

REU Category	Number	Percentage
Students	21	100
Male	11	52
Female	10	48
Caucasian	12	57
African American	5	24
Non-Hispanic	19	90
Hispanic or Latino	2	10
Total URM	7	33

Demographic	SC (%)*
White	63.9
African American	27.9
Native American	0.5
Asian	1.5
Hispanic	5.3
Pacific Islander	0.1
Two or More Races	1.7

*USC Office of Diversity and Inclusion

Participant Institutions

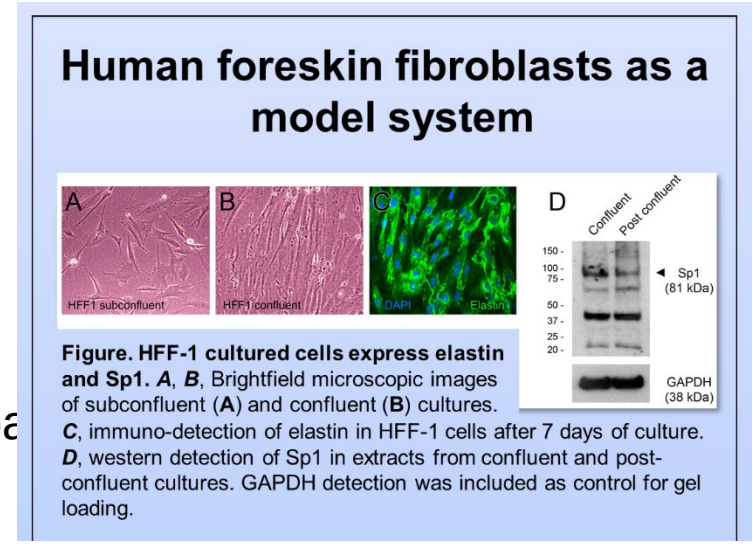


- MUSC
- CRI
- Outreach
- HBCU
- Missed personal targets

Outcomes 3: Additional Participation

- Scientific meetings:
  - MUSC meetings: 2
  - State or other regional meetings: 7
  - National meetings: 0

- Publications: 2 pa



- Career paths (12 completed baccalaureates):

Type	Number
Graduate program (MS or PhD)	5
Medical program	2
Research/biomedical technologist	4
Other	1

Summary

- Training: The REU has provided 21 training opportunities that included substantial educational and professional development experience.
- Career Path: Among 12 graduates, 5 are pursuing graduate degrees and 4 careers in biomedical technology – 75%.
- Meetings and Publications: There was modest participation in meetings and publications.
- Minority Participation: Rates approximated SC averages but additional efforts could be made to reach other PUIs and HBCUs, particularly through personal contacts.
- Areas For Growth:
  - Recruitment:
    - Better URM recruitment and participation rate.
    - Broader contact networks that reach more PUIs and HBCUs.
  - Post-summer participation:
    - Meetings

Acknowledgements

- NSF EPSCoR
- Roger Markwald (Institutional PI)
- John Wheeler (Interim SC EPSCoR)
- W. Scott Argraves
- Tom Trusk and the Advanced Tissue Biofabrication Center

- Other MUSC Mentors:
  - Michael Yost
  - Ying Mei (Clemson-MUSC)
  - Richard Visconti
  - Kelley Argraves
  - Chris Drake

Concluding Activities:

- Oral Presentations at the MUSC SURP Closing Symposium: Students prepared and gave oral presentations describing their projects. The presentations were approximately 15 minute talks prepared with PowerPoint slides and given to other summer students and attending faculty.
- Written Reports: each student prepared a written paper describing his/her research problem and the results. The format was modeled on short article in a scientific journal.
- Benefits:
  - Education
  - Scientific Writing
  - Presentation skills