

# VIGRE Funding Report

(due 30 days after semester of support)

Semester/Summer and Year:

Spring 2009

Name: Rebecca Vandiver

List the graduate courses you have taken this semester (including independent studies), your grades, and the instructors:

Course	Title	Grade	Instructor
Math920	Dissertation	S	Goriely

List the title, date and location of any talks you have given, either here or elsewhere:

Spring 2009: "Differential Growth and Residual Stress in Cylindrical Elastic Structures," Al Scott Lecture, University of Arizona.

Spring 2009: "Differential Growth and Residual Stress in Cylindrical Elastic Structures," Quantitative Biology Seminar, University of Arizona.

Summer 2008: "Schizogenous Aerenchyma Formation, Stem Hollowing, Elastic Cavitation and Differential Growth in Plants and Elastic Tissues" (poster), IUTAM Symposium on Cellular, Molecular and Tissue Mechanics, Woods Hole, Massachusetts.

Spring 2008: "Tissue Tension and Elastic Growth in Cylindrical Elastic Structures," Jacques Dumais Laboratory Seminar, Harvard University.

If you are working on your dissertation, include a one paragraph description of your research progress. If you have not yet begun dissertation research, describe your progress toward finding a dissertation topic and advisor and beginning that research.

Growth plays a key role in many fundamental biological processes. In many cylindrical structures in biology, residual stress fields are created through differential growth. We present a general formulation of growth for a three-dimensional nonlinear elastic body and apply it to specific geometries relevant in many physiological and biological systems. The goal of my work is to study the development of residual stress induced by differential growth of biological cylindrical structures and elucidate its possible mechanical role in modifying material properties. This past semester I finished my results on exploring the role of residual stress, axial stretch, and internal pressure on the stability of arteries.

List publications, if any.

Vandiver, R., Goriely, A. "Tissue tension and growth in cylindrical elastic structures." Accepted for a theme issue of the Philosophical Transactions of the Royal Society A, 2009.

Vandiver, R., Goriely, A. "Tissue tension and axial differential growth of cylindrical structures in plants and elastic tissues." Accepted for publication in Europhysics Letters, 2008.

Vandiver, R., Goriely, A. "Morpho-elasto-dynamics: the long-time dynamics of elastic growth." Accepted for publication in Journal of Biological Dynamics, 2008.

Check all activities you completed during the funded period:

Academics:

- Independent Study
- Oral Comprehensive Exam
- Commence Thesis Research
- Conference attendance
- Conference participation
- Complete PhD

Professional development and outreach:

- AP Calculus Visit
- High School Workshops
- Undergraduate Research Project
- Undergraduate Research Seminar
- Super TA
- Mentoring junior graduate students for the qualifying exams
- RTG (help organize)
- Research Seminar (help organize)

Other (please specify)

Attach a brief statment about your academic progress and professional development during the period of support.

## VIGRE REPORT

Rebecca Vandiver

Spring 2009

This past semester I successfully defended my dissertation titled “Morphoelasticity: The Mathematics and Mechanics of Elastic Growth.” My work studies the development of residual stress induced by differential growth of biological cylindrical structures and elucidates its possible mechanical role in modifying material properties.

This spring I received the Al Scott Prize and Lecture which is given annually to a senior student in the Program in Applied Mathematics. As a result, I had the honor of speaking at an Applied Mathematics Colloquia. My lecture was titled “Differential Growth and Residual Stress in Cylindrical Elastic Structures.” Cylindrical forms are one of nature's fundamental building blocks. They serve many different purposes from sustaining body weight to carrying flows. Their mechanical properties are generated through the often complex arrangements of the walls. In particular, in many structures that have elastic responses such as stems and arteries, the walls are in a state of tension generated by differential growth. In my talk, the effect of differential growth and residual stress on the overall mechanical response of the cylindrical structure was presented within the framework of morphoelasticity through an analysis of the buckling properties of residually stressed cylindrical tubes. I also gave a talk for the Quantitative Biology Colloquium.

In addition to finishing my dissertation, I accepted a Howard Hughes Medical Institute Post-Doctoral Fellowship in Applied Math. In addition to continuing my research, I will design and teach a math modeling course and work with math and biology faculty to help them develop curricular materials that combine mathematics and biology.