



The Integration of Research and Education: **Getting Students Excited about Materials Science**

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UNM / Harvard PREM: Leadership in Biomaterials

NSF DMR-0611616





Motivators for Attracting Students to Research

- Tradition
- Prestige
- Curiosity
- Money
- Sex
- Concern
- • •

"Basing scientific inquiry in community-based problems may be a way to engage students of color in STEM since research suggests that people of color search for ways to connect with their communities through their education and tend to remain active in their home communities longer than whites. *Challenging Cultural Stereotypes of "Scientific Ability,"* M. Ong (2008).



Approaches to Retention of Interest in Research

- Create positive research experiences
- Alleviate non-academic stressors, especially financial
- Provide social support: fellow peers and faculty members from the same backgrounds
- Create sense of belonging and an institutional climate for diversity
- Provide monetary incentives

“The Characteristics and Experiences of Minority Freshmen Committed to Biomedical and Behavioral Science Research Careers,” Oseguera et al. *J. of Women and Minorities in Science and Engineering*, 2006

UNM / Harvard PREM

Strategic Plan



Develop formal, long-term, multi-investigator, collaborative research and education partnerships between UNM, groups that are underrepresented in STEM, and the DMR-supported Harvard MRSEC, NSEC and NNIN designed to:

- Develop materials technologies to tackle medical problems relevant to minority and low income populations
- Use these problem solving activities to provide a compelling context by which to engage under-represented groups in materials science
- Provide opportunities for students to foster research, academic and leadership potential in materials science
- Provide access and acclimation to environment and culture of top levels of academia

UNM / HU PREM Faculty and Focus Areas



New Materials Technologies for:

1. Diagnostics

UNM: Lopez,
Atanassov, Sibbett,
Graves

HU: Whitesides,
Stone, Weitz



Gabriel López
Professor and PI



Heather Canavan
Assistant Prof. / coPI

2. Regenerative Medicine

UNM: Canavan, Dirk,
Werner-Washburne

HU: Moony, Parker,
Weitz



Elizabeth Dirk
Assistant Prof. / coPI



Julia Fulghum
Professor, VP for
Research and Econ.
Development / coPI



Dimiter Petsev
Assistant Prof. / coPI

3. Genomics

UNM: Petsev,
Edwards

HU: Weitz



UNM Center for
Biomedical
Engineering

UNM / Harvard PREM DMR-0611616

High Performance Materials for Low Cost Diagnostics
PIs: López, Petsev, Sibbett, Whitesides, Stone

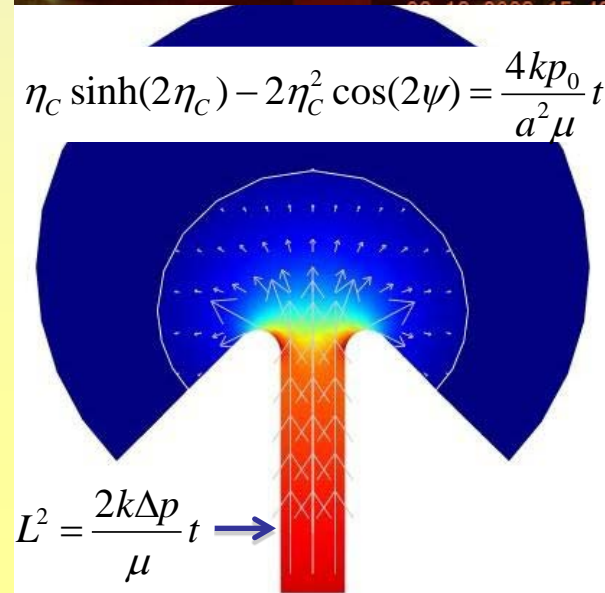
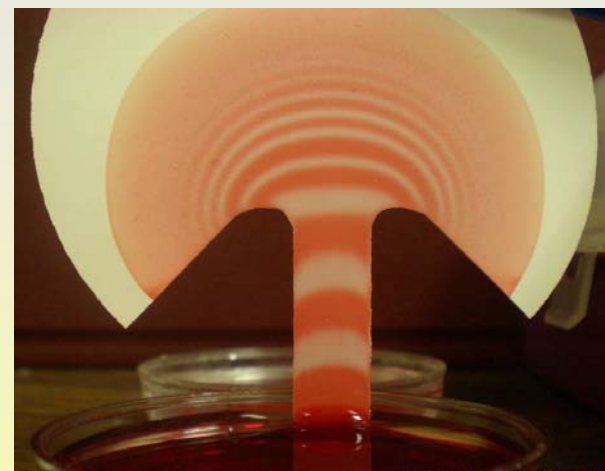


Modeling of 2D Capillary Networks for High Performance Low Cost Diagnostics

We have fabricated paper-based diagnostic devices that are shaped in two dimensions by a computer-controlled knife. The sustained liquid flow of a typical lateral flow point-of-care assay (e.g. a pregnancy test) can be mimicked by two-dimensional shaped, thin porous membranes, specifically rectangular membranes appended to circular sectors. In designing these fan-shaped devices, we have been aided by analytical equations and finite-element simulations. We have shown both mathematically and experimentally how a continuous increase in unwetted pore volume causes a deviation from traditional imbibition (Lucas-Washburne) and leads to quasi-stationary flow in the rectangular element. These analyses indicate how point-of-need diagnostic strips may be rapidly fabricated by cutting without the need to append an absorbent pad.

“Imbibition into Porous Membranes of Complex Shape: Quasi-stationary Flow in Thin Rectangular Segments,” Mendez, S.; Fenton, E.M.; Gallegos, G.R.; Petsev, D.N.; Sibbett, S.S.; Stone, H.A.; Zhang, Y.; Lopez, G.P. *Langmuir*, **2010**, *26*, 1380-1385.

- We thank G. Whitesides (Harvard) for inspiring this work and for fruitful discussions.
- PREM postdoctoral fellow S. Mendez is now a tenure track faculty member at California State University / Long Beach.
- E. Fenton is an undergraduate researcher at UNM.
- G. Gallegos is an Asst. Professor at NM Highlands University.
- During execution of this work, H. Stone was a member of the Harvard MRSEC.





Microfluidic Droplets for DNA Sequencing and Materials Synthesis

PIs: D.N Petsev,¹ D.A Weitz,² J. Edwards¹

Students: N.J. Carroll,¹ A. Ortiz,¹ P. Maksymiuk¹

¹University of New Mexico; ²Harvard University

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Oil, Water, and Surfactant Liquid
Mixtures Templated to Create
Hierarchically Porous Materials
(see p. 8A)



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Hierarchically bimodal porous structures were obtained templating silica microparticles with a specially designed surfactant micelle/microemulsion mixture. Tuning the phase state by adjusting the surfactant composition and concentration allows for the controlled design of a system where microemulsion droplets coexist with smaller surfactant micellar structures. The microemulsion droplet and micellar dimensions determine the two types of pore sizes. We also demonstrate the fabrication of carbon and carbon/platinum replicas of the silica microspheres using a “lost-wax” approach. Such particles have great potential for the design of electrocatalysts for fuel cells, chromatography separations, controlled delivery and other applications. Currently we are studying the kinetics of the formation of the mesoporous structures. Also surface tension analysis is planned to elucidate further the physics behind the phenomenon.

N. J. Carroll, S. Pylypenko, P. B. Atanassov and D. N. Petsev, **Bidisperse Nano-Porous Microparticles Derived by Microemulsion Templating**, *Langmuir*, **25** (2009) p. 13540.



Approaches to Outreach

2004 Survey of all K-12 Engineering Outreach Programs operating in the US

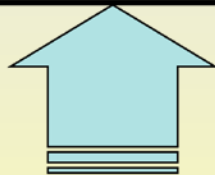
- Develop classroom material (including web-based)
- Conduct outreach activities on college campus (lab visits)
- Conduct outreach activities on K-12 campus ("road shows")
- Conduct/sponsor engineering contests
- Sponsor teaching fellows or offer service-learning courses
- Offer professional development

Outreach Partners and Collaborating Institutions



Enhanced Diversity in Material Science

UNM
Lobos



2-year College:
SIPI

University:
U. of New Mexico

MRSEC:
Harvard U.

High School:
Albuquerque High School



AHS
Bulldogs

Middle School:
Jefferson, Washington

Elementary Schools:
Longfellow, Lew Wallace, E. San Jose, Eugene Field, Dolores Gonzales



Longfellow
Prairie Dogs

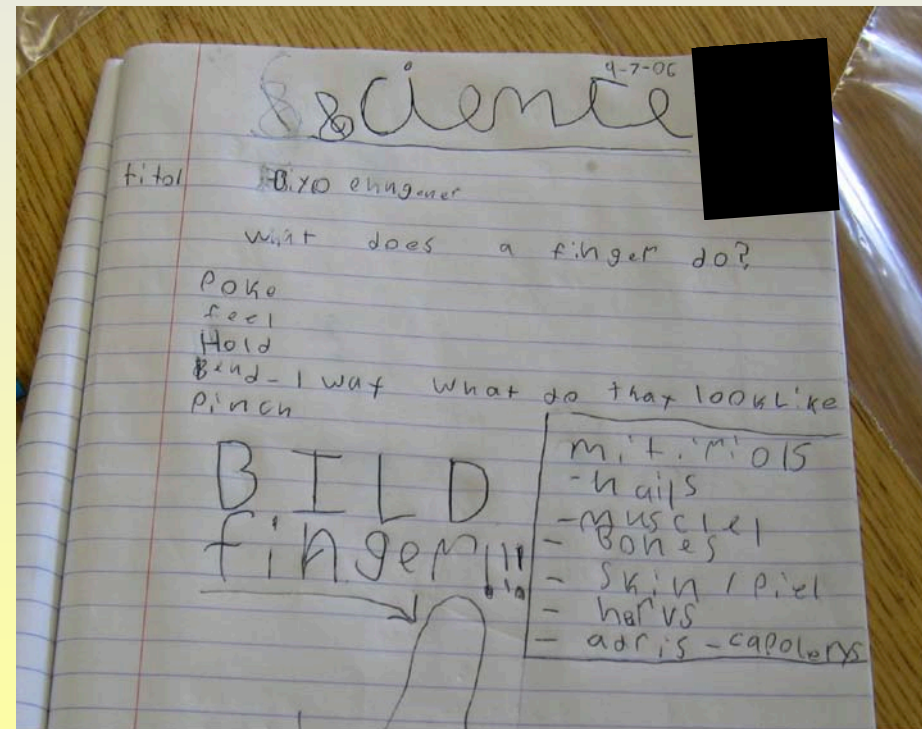
Research and Education Collaborations

- UNM Gallup
- San Juan College
- New Mexico Tech
- New Mexico Highlands University
- University of Washington
- Swinburne University
- Duke University
- UNM Health Science Center (Pathology, Cancer Center, Internal Medicine, Molecular Genetics & Microbiology)
- UNM Biology
- UNM Chemistry
- UNM Center for High Tech Materials
- University of Sheffield
- Center for Integrated Nanotechnologies
- Los Alamos National Lab
- Sandia National Labs
- North Carolina State University
- TriCore Reference Laboratories

Elementary School Module



- Introduction to Bioengineering and Biomaterials
 - “Finger Kit” hands-on activity
- Pathway to UNM discussed
- Hands-on activity addresses NM and AAAS benchmarks
- Presentation is bilingual
- UNM students provide role models
- Dissemination includes workshops, website downloads, and publication in *Chem Eng Ed*.





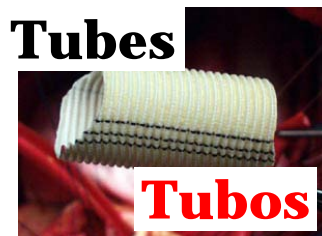
*The 5th Grade Classes
are Bilingual...
Las clases son
bilingües...*



- What is materials science?

- Qué es la ciencia de materiales?

- What are biomaterials?



- Qué son materiales biológicos?

- In-class project

- Actividad en clase

*...the presentation is too
...la presentación es también*



NM Benchmarks Addressed by Finger Kits



- **Strand I/Standard I/Benchmarks I & II (Scientific Thinking & Practice):**
 - Learn the scientific method from observation/experimentation on model, and analysis using rubric.
 - Learn to communicate their findings during the class discussion at the end of the event, and learn that conclusions are subject to peer review.
- **Strand II/Standard I/Benchmarks II & III (Physical Science):**
 - Learn about forces and motion from discussions and observations of how muscles and tendons interact to move finger.
- **Strand II/Standard II/Benchmarks III (Life Science):**
 - Understand how the properties of a living thing are related to the behavior of the entire organism.
- **Strand III/Standard I/Benchmarks I (Science & Society):**
 - Understand how technology affects the lives of individuals, esp. machines engineered to aid human health.
 - Development of prosthetics illustrates how discoveries, inventions, and knowledge are influenced by individuals/society.

Also addresses AAAS Benchmarks 3A, B & C; 6 C, 8F, 11A, 12C,

Dissemination of 5th Grade Module



- Teacher workshops, including:
 - Navajo Nation Teacher's Workshop
 - Harvard RET Workshop
- Publication in *Chemical Engineering Education*
 - Canavan, H.E.; Stanton, M.; López, K.; Grubin, C.; Graham, D.J., " 'Finger Kits': An Interactive Demonstration of Biomaterials and Engineering for Elementary School Students," *Chemical Engineering Education*, 42 (3), 125-131 (2008).
- Manuscript currently highlighted on *Annals of Research on Engineering Education* website:
 - <http://www areeonline.org/>
- UNM PREM outreach website:
 - <http://www.unm.edu/~prem/education.htm>
 - Monolingual & bilingual presentation
 - Materials required to perform activity

VIEW

★ Paper Diagnostics - CSI Overview

last edited by [Kathryn Hollar](#) 11 months ago

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You have read-only access to this page.

Purpose:

The purpose of this investigation is twofold:

- 1) To use the skills of scientific inquiry to uncover the most likely perpetrator of a crime, and
- 2) To employ a paper diagnostics tool as a forensics device for chemically determining whodunit.

Time required:

Two 50-minute class periods

Level:

Techniques, materials, and equipment are appropriate for grades 8-10 life science and/or general science curricula.

Teacher Background:

Television dramatic series including Law and Order and CSI exhibit widespread appeal among high school students because of their close imitation of actual crime investigations. Fictional crime scene scenarios, therefore, can serve as effective instructional tools for engaging students in the process of scientific inquiry. This activity requires students to work in teams of 4 in order to solve a crime. Each member of the group is randomly assigned to play either one of three suspects or the detective. As the crime scene scenario is explored, students are challenged with determining who within the group is the most likely perpetrator.

Files:

For teacher:	For Students
Teacher Guide	Crime Scenario
Paper Diagnostic Key	Suspect Organizational Chart
Student Answer Key	Wound Chart
	Lead Investigator's Report
	Student Guide
	Cast Cards

Comments (0)

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• Paper Diagnostics - CSI Overview

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options

SideBar

This is your SideBar, which you can edit like any other wiki page.

This SideBar appears everywhere on your wiki. Add to it whatever you like -- a navigation section, a link to your favorite web sites, or anything else.

Recent Activity

EP - Freshman- Immediate Post-Activity Survey CORE_engineering.doc
uploaded by Marc

NNIN Write-up.doc
uploaded by

Prelab questions version 2.doc
uploaded by rebekah ravgiala

Prelab questions version 1.doc
uploaded by rebekah ravgiala

Prelab answers version 2.doc

Questions?



¿Preguntas?

Dear Dr. Dirk,

2-27-07

I just wanted to thank you for teaching us about a Biomedical man or woman. Also how they make so many things like legs, breathing and feeding tubes, hearing aids, arms, joints, and fingers for people who desperately need them. You are an inspiration to so many people. I also wanted to thank you for letting our class make a model finger. It would be so cool to be a Bio medical woman when I grow up.

Sincerely,

GRACIAS **THANK YOU**

gplopez@unm.edu

Francisco

Queridos ingenieros y biólogos gracias por venir a nuestra clase y enseñarnos a hacer un dedo. Nos hubiera gustado que estuvieran más tiempo en nuestra clase y gracias por venir.

Me hubiera gustado que hubiéramos hecho una mano o un brazo o dos pero yo nunca lo hubiera echo sine el señor ni lo hubiera terminado apenas me alcanse hacer un dedo.

GRACIAS