

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

NATIONAL ACADEMIES SUMMER INSTITUTES ON UNDERGRADUATE EDUCATION IN BIOLOGY Special Session for MARC Curriculum Improvement Planning Grant Recipients

<http://www.AcademiesSummerInstitute.org/marc/>

January 7-11, 2005
Chaminade • Santa Cruz, California

Agenda

Unless otherwise noted, all meeting sessions will be held in the *Natural Bridges Room*.

Friday, January 7, 2005

- 5:00 p.m. Registration (*Natural Bridges Room*)
Participants may pick up their agenda books and leave material for the resource table at this time.
- 6:00 p.m. Seafood Buffet Dinner (*The Library*)
- 7:00 p.m. Introductory session (*Natural Bridges Room*)
This session will include welcomes to the MARC Winter Institute, an overview of the program, and logistical information to help you get oriented.
- 7:20 p.m. Opening Keynote: Julius H. Jackson (Michigan State University)
“Quantitative Trends in Education for 21st Century Biological Research”
I will address some of the nuts and bolts issues of how to engage mathematophobic biology students to recognize and adapt to quantitative demands of biological research in the genomic era. Three focal points guiding this talk include: (i) mathematical preparation of biology students and biological preparation of mathematical students; (ii) dispersion of fears; and (iii) administrative and faculty support for a new adventure. This talk will present ideas on the kinds of mathematical preparation 21st Century biological scientists will need and what new courses and modification of extant courses may help. Drawing upon my own experiences, I will engage participants in a discussion about how to collaborate across disciplines, at the student level and at the faculty level. A core issue is how to disperse the common fears of biologists about the computational and conceptual difficulty in application of mathematics in biology, and the fears of mathematicians about the mind-numbing complexity of biological systems that makes them seem intractable for construction of useful and simple models. The concluding discussion addresses the administrative and academic environment and support needed to encourage refocusing biology education at the undergraduate level.
- 8:30 p.m. Welcome mixer (*Seacliff Lounge & Terrace*)
A cash bar with beer, wine, soda, and mineral water will be available.

Saturday, January 8, 2005

- 8:00 a.m. Breakfast (*Sunset Dining Room*)
- 9:00 a.m. Team introductions (*Natural Bridges Room*)
Each team will not only introduce the members but give a very brief discussion of their preliminary thinking for implementation, the steps they are already taking, and what they hope to take away from this Institute.
- 10:30 a.m. Break (*Linwood's*)
- 10:45 a.m. Terry Derting (Murray State University) & Kathy Williams (San Diego State University)
“Active Learning and Scientific Teaching in College Science Courses”
We base our presentation on current research about undergraduate science curriculum reform, how students learn, and how assessment improves student learning. We will focus on teaching both large and small courses and address the *hows and whys* to (1) actively engage students in learning in classroom and laboratory environments, (2) use cooperative learning, (3) develop assessments based on goals that provide multiple kinds of data about student learning, (4) analyze and use assessment data to improve instruction, (5) develop questions and problems to diagnose student misconceptions and inform teaching, and (6) engage in research and proposal development about undergraduate teaching and learning.
- 12:15 p.m. Lunch (*Sunset Dining Room*)
- 1:15 p.m. Terry Derting (Murray State University) & Kathy Williams (San Diego State University)
“Active Learning and Scientific Teaching in College Science Courses” (continued)
Continues from the morning session.
- 3:00 p.m. Break (*Linwood's*)
- 3:15 p.m. A. Malcolm Campbell and Laurie J. Heyer (Davidson College)
“Quantifying Gene Expression with DNA Microarrays”
The DNA microarray, a high-throughput method for measuring gene expression levels, is an important modern research tool. We will discuss both experimental and computational aspects of the DNA microarray method, and lead participants through hands-on exercises that will encourage them to incorporate microarrays in their research and teaching.
- 4:45 p.m. Break for work, relaxation, or recreation
- 6:30 p.m. Buffet Dinner (*Seascape Room*)
- 7:30 p.m. Jay B. Labov (National Research Council)
“Expectations and Realities in Undergraduate Science Education: A K-16 Perspective”
Improving undergraduate science, mathematics, and engineering education is integral to enhancing science education in other sectors of the education system. However, the quality of undergraduate education is dependent on other parts of the education system in the U.S. This presentation will provide an overview of the national trends, foci, and challenges in K-12 and undergraduate education and will emphasize the importance of establishing K-16 connections.

- 8:30 p.m. Phillip Ortiz, Juliette B. Bell, and J. Ellis Bell (ASBMB)
 Three representatives from the American Society for Biochemistry and Molecular Biology (ASBMB) will discuss a workshop they are preparing and their plans for arranging it.
- 9:00 p.m. Remainder of evening free for work, relaxation, or recreation

Sunday, January 9, 2005

- 7:30 a.m. Breakfast (*seating in Cowell, buffet available in Linwood's*)
- 8:15 a.m. Meghan Burke (Kennesaw State University)
 “Vertical Integration of Biological Applications into the Undergraduate Mathematics Curriculum”
 In order for biology students to understand and appreciate the role of mathematics in the life sciences, it is essential that they see the same biological application explored repeatedly at various levels of mathematical sophistication. By revisiting a biological system at the precalculus, differential calculus, integral calculus, and differential equation level, the students are drawn into the mathematics gradually, with intuition about the system to guide them.
- 9:30 a.m. Ishrat Khan (Clark Atlanta University)
 “Nanobiotechnology. An Example of the Changing Nature of Research and Immersion of Students into a Culture of Interdisciplinary Learning”
 Nanobiotechnology, a term coined at Cornell, represents an exciting scientific and technological opportunity to create novel devices and address important biological questions. Examples of research and education from the nanobiotechnology community will be presented and connected to the changing methods and approaches to 21st century research and education.
- 10:45 a.m. Sunday Brunch (*seating in The Library, buffet available in Sunset Dining Room*)
 Isiah M. Warner (Louisiana State University)
 “Mentoring, Education, and Research: Pathways to Student Success in the Quantitative Sciences”
 In my thirty-plus years in academics, I have found many students who, by natural academic ability, interest, and work ethic, should have performed well in the sciences, but performed poorly. In recent years, I have come to better understand this problem: many of these students are operating at the bottom rungs of Bloom’s Taxonomy (Ladder),¹ *i.e.*, using rote memorization. We as college professors need these students to operate at the upper rungs of this ladder, *i.e.* synthesis and evaluation. Unfortunately, many students graduate from high school, and even college, without realizing that levels of thinking above memorization and basic comprehension exist. In my office of Strategic Initiatives at Louisiana State University, we have two grants that focus on providing the needed skills for success in college science, technology, engineering, and mathematics (STEM) courses early in the college careers of such students. We believe that we can more effectively assist these students by promoting development of fundamental science reasoning skills as well as proficiency in study and time management techniques. In my Howard Hughes Medical Institute (HHMI) Grant, we are focusing special efforts on undergraduate students who have made it through the K-12 system without the learning tools and strategies needed for success in STEM. In my NSF/Research Corporation Grant, we are reinforcing these skills among very high ability students. The focus of this talk will be on the mentoring, research, and educational approaches that we are employing to rapidly prepare these students for outstanding careers in the STEM areas.

¹Bloom, B.S. (Ed.), (1956). *Taxonomy of educational objectives. The classification of educational goals.* Handbook I: Cognitive domain. New York, NY: David McKay.

- 1:00 p.m. Free afternoon; Bus leaves for Monterey and whale watching trip
The whale watching trip will cost \$25 per person. You're also welcome to visit the Monterey Bay Aquarium (\$19.95 per person), walk around beautiful and historic city of Monterey or enjoy a free afternoon at Chaminade or in the city of Santa Cruz.
- 7:30 p.m. Dinner (*Sunset Dining Room*)
Remainder of evening free for work, relaxation, or recreation.

Monday, January 10, 2005

- 7:45 a.m. Breakfast (*Sunset Dining Room*)
- 8:30 a.m. John R. Jungck (Beloit College)
“Ten Equations that Changed Biology (and that Should Change Biology Education)”
Mathematics has played exceptionally important roles throughout the history of biology; these include at least five Nobel Prizes in Physiology and Medicine in the 20th century that involved direct contributions from mathematics. A succinct list of achievements that represent the power of mathematics in biology and a brief description of their historical importance are presented here with BioQUEST www.bioquest.org software instantiations in order to: first, draw attention to a variety of mathematical models that have been intrinsic to significant discoveries in biology and, second, to illustrate that the tools are currently available for engaging students in active investigation of biological phenomena and the development of systematic strategies for biological problem solving.
- 10:30 a.m. Time available for work
- 12:00 p.m. Lunch (*Sunset Dining Room*)
- 12:45 p.m. Lee Gass (University of British Columbia)
“Interdisciplinary approaches to undergraduate education: Finding the essence”
This session will consider interdisciplinary program-building from the coupled perspectives of pedagogy, curriculum, administration, and sustainability, beginning from the existing science programs at UBC and generalizing to other disciplines and institutions. There will be lots of opportunity to consider ideas from participants.
- 2:00 p.m. Break (*Linwood's*)
- 2:15 p.m. Carlos Castillo-Chavez (Arizona State University)
“Collaborative Learning with Students’ Driven Research Agenda: the case of the Mathematical and Theoretical Biology Institute”
The lack of diversity in the mathematical sciences is taken for granted. Nevertheless, despite the data there are now dramatic large scale success stories. Here, I will describe one of them. MTBI provides sequential research experiences for undergraduate students in a research environment that involves graduate students, postdocs and faculty but where the research agenda is driven by the students. What are the consequences of such an approach? Why is it important to give ownership of the research agenda to students? How will such an approach benefit the faculty involved?

- 3:30 p.m. Eric Marland (Appalachian State University)
 “The Subtleties of Subversion”
 In addition to giving an overview of our own program, its goals, and motivations, this talk will focus on some of the more practical issues we have encountered in making changes to the curriculum. Some of these subtle issues seem to require more time and effort than the “more important” issues and never seem to go away. I will also talk about how some very small changes can have a huge impact on your program.
- 4:45 p.m. Amy Chang (American Society for Microbiology)
 “Five Tips for Preparing New Curriculum Proposals”
 Practical applications for preparing a proposal to enhance the undergraduate curriculum at one's institution will be presented. The interactive session will provide initial steps for preparing a proposal. Participants should come to the session prepared to describe their greatest need to enhance their institutions' curriculum, including measurable learning goals and defined audiences. Consider the question, “What is it that students must know and/or be able to do in order to deem the curriculum module effective?”
- 5:30 p.m. Break for work, relaxation, or recreation
- 6:30 p.m. Banquet dinner and wine-tasting (*Capitola Room*)
 Randall Grahm (Founder, Bonny Doon Vineyards)
 We are honored to be joined by Randall Grahm, founder of the Bonny Doon Vineyard, for what is sure to be an entertaining presentation on wine and wine-making. Please check out the Bonny Doon website for an experience not to be missed: <http://www.bonnydoonvineyard.com/>. And, yes, there will be tasting of several varieties for those so inclined!

Tuesday, January 11, 2005

- 8:00 a.m. Breakfast (*Sunset Dining Room*)
- 9:00 a.m. Team reports and discussion (*Natural Bridges Room*)
 Each team will update the group on its current implementation plans and the next steps it will take. What will your action plan be? What practical steps will you take to put it into practice? What tools and resources will be necessary? How will you assess your success?
 We also hope that each team and participant will also be able to discuss possible solutions to the challenge(s) they identified before participating in the Institute. We also look forward to feedback on the Institute itself.
- 12:00 p.m. Lunch (*Sunset Dining Room*)

Time listed for each session includes presentation, questions, and discussion. Evenings and times not listed are available for group working time. Speakers will be available to meet with groups during those times, in addition to during formal discussion times.