

QB I Overview

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Emory University

QUANTITATIVE BIOLOGY: CURRICULUM AND INSTITUTIONAL TRANSFORMATION AT THE MATH/BIOLOGY INTERFACE mini-grant goals

- Form a consortium of institutions to explore how to implement various aspects of Quantitative Biology
- Establish a steering committee to plan the summer institutes and coordinate the consortium
- Convene institutes 2007 and 2008
- Assemble the results of the summer institutes into white papers
- Develop materials that are required for this effort
- Establish a repository white papers, materials, datasets
- Develop a continuing schedule of regional summer institutes

Towards Bio2020: Educating Biologists, Mathematicians, and Computer Scientists Collaborating to Redesign Education: Content and Pedagogy

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Department of Mathematics
Truman State University

Why we're here!

- we have recognized the importance quantitative biology in the undergraduate curriculum
- we want to identify and share best practices and resources
- we want to work together to create new materials
- establish a community of educators who will continue advancing this effort for many years to come
- properly done, quantitative methods must be part of the first biology courses an undergrad takes (and biological concepts in early mathematical courses, too)

To do list

- efforts must be scalable and sustainable (from fiscal and human resource perspectives)
- activities should count toward graduation
- must include research or research-like experiences
- We must make efforts to push the adoption curve forward
- make our work visible to those outside this community
- persuade others that our innovations work prepares students (assessment!)
- give others the tools and support that will guarantee their success

Additional Challenges

- Increasing STEM undergraduate degree production
- Increasing participation of traditionally underrepresented groups
- Involve pre-K thru 12 and community college teachers in “the revolution”

Bio 2010

Theory meets Reality

David Usher & John Pelesko
University of Delaware

HHMI

HOWARD HUGHES MEDICAL INSTITUTE



Bio 2010

Recommendations

- ❖ Biology education should be interdisciplinary with a strong emphasis on developing quantitative skills.
- ❖ Laboratory courses should focus on developing critical thinking skills.
- ❖ Students should pursue independent research.
- ❖ Teaching methods should be examined.
- ❖ Resources must be adequate.
- ❖ Faculty should be rewarded.

Interdisciplinary Education Challenges

1) Faculty

- Cultural Barriers
- Disconnect between research and teaching
- Resist change away from a "Comfort Zone."
 - "What's in it for me" attitude

2) Department Administrative Barriers

- Resource Issues
 - Department Budgets are static & seats in courses limited
 - Promotion and tenure

3) Curricular Issues

- Majors

Rethinking Calculus

- ❖ Constraints: Consider local and global issues
 - Local: "Bio-Calc" must be open to all majors
 - Global: Must meet requirements of graduate and professional schools
- ❖ Goals: Why revise calculus?
 - Ensure all biology majors have right tools
 - Integrate and inspire
- ❖ Approach: Realign and revise
 - Calc sequence realigned to early transcendental
 - Special section created using biological examples
- ❖ Details: How to revise?
 - Connect calculus with first year biology sequence
 - Slowly create new library of examples and projects

Incorporating Biology into Math Courses at the University of Richmond

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New Math Courses at UR

- Two-semester science-based calculus: **Scientific Calculus I - II**
- One-semester Upper-division biomedical modeling course: **Mathematical Models in Biology and Medicine**

Main Goals

- **Sci Calc:**

- Rethink and revise course content to underscore relevance to the sciences
- Help science students understand and utilize the role of math modeling in scientific investigation

- **Modeling:**

- Teach students to construct and analyze math models of scientific processes



BioQUEST



Lifelines OnLine:
 Investigative Case-Based Learning

*Funded by the National Science Foundation
 DUE - 9952525*

Multidisciplinary Collaboration: Lessons Learned by “Mathematical Biology” Educator

John R. Jungck

International Union of Biological Sciences

Society for Mathematical Biology

BioQUEST Curriculum Consortium

Beloit College



<http://chemlinks.beloit.edu>

Using The Culture
Of Science To Learn
How To Teach Science

Edward F. Redish
University of Maryland



July 4, 1998



Project CALC



Pro

“SYMBIOSIS”

ETSU-HHMI-2007



<http://mc2.cchem.berkeley.edu>

Two Challenges
for biologists and mathematicians

Deluge of data

Working together,
Working apart

Challenges for 2020 STUDENTS

Multivariate

Multicausal

Multidimensional

Nonlinear

Multi-scale

Analyses of Complex Data

Where are we now?

- General biology texts:
- have less than 3 equations
- Rarely have quantitative data
- Graph complexity primarily linear
- No quantitative problems

Where do we need to go?

- Biology education that uses calculus, discrete mathematics, & statistics
- Quantitative problem solving throughout
- Modeling top down, bottom up, nonlinear feedback
- Deal with complexity of terabytes of data per day

Central role of problem-solving environments:

- Powerful tools that develop professional skills
- Interactive
- Open-ended
- Challenging
- Research-related
- Depth of analysis
- Empowering
- Lend themselves to collaborative learning

Mathematics can help biologists with problems that are

- Too big-biosphere
- Too slow-macroevoolution
- Too remote in time-early extinctions
- Too complex-brain
- Too small-molecular structure
- Too fast-photosynthesis
- Too remote in space-life at extremes
- Too dangerous or unethical-epidemiology of infectious agents

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Breakout sessions

- Identification of resources for teaching modules, lab modules, datasets, examples, resources, etc. What's available? What's missing?
- Changing the way we teach science and mathematics: Challenges and solutions
- How do you foster biology & math interaction between universities?
- How do you get interdisciplinary interactions started within a university?
- Mathematics in upper division Biology classes
- Developing mathematics research projects for biology students and biology research projects for mathematics students.
- How do you integrate math with biology in the classroom?
- Pedagogy and Active Learning
- Challenges

Results!

- Working groups
- Whitepapers
- Resource collections
- Listserv
- Wiki- site
- Exciting posters
- New friends
- Post-meeting topics survey

Planning group

Ann Findley

Karl Joplin

Tuajuanda Jordan

Joe Watkins

Robert Manning

Pat Marsteller

Claudia Neuhauser

Kaci Thompson

David Usher