Training the Next Generation of Biologists and Biologically Literate Citizens

AIBS/AAAS Education Summit

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University of Montana
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21st Century is the Age of Biology (and maybe a reunion of the life sciences?)

- One Biology, One Science because biology is the story of life on Earth
- Biology offers a vision for our planet’s future based on knowledge of the past and current adaptation by the living world to planetary change.
- Understanding life’s resilience and adaptation to change will require theoretical and computationally rich interdisciplinary efforts

Adapted from a presentation May 11, 2008 by Jim Collins, NSF Assistant Director, Directorate for Biological Sciences

C. Brewer, UMT, May 2008
Looking into the Future…

PEOPLE WHO WILL PUSH THE FRONTIERS IN THE BIOLOGICAL SCIENCES WILL BE THE ONES WHO CAN WORK ACROSS DISCIPLINES
Linking Research and Education: Leveraging Impacts Through Science Observatory Networks

→ National science research network infrastructure - opportunities to invigorate instruction and train students for new (interdisciplinary) career opportunities

→ Current and emerging research networks:
  - National Ecological Observatory Network (NEON)
  - Global Lakes Ecological Observatory Network (GLEON)
  - National Phenology Network (NPN)
  - Earthscope

→ Opportunities for research in basic science and education
Education Mission for Observatory Networks

- Preparing the scientific community to use observatory networks to the fullest
- Enhancing the science by enlarging and diversifying the research community
- Preparing and supporting the public to use and benefit from networks in order to understand and effectively address critical science questions and issues
The National Ecological Observatory Network (NEON)

→ Research and development of environmental sensors and sensor networks, cyberinfrastructure, and enabling technologies
→ Observing, modeling and analyzing a wide range of complex environmental systems.
→ Goal: Provide the capacity to forecast future states of ecological systems for the advancement of science and the benefit of society.
NEON Enabling Facilities & Platforms

- PAR—photosynthetically active radiation
- UV; solar radiation
- IR up/down
- Profiles (d[ ]/dz)
  - Temperature, Moisture, CO2, Soil temperature, Soil moisture
- Air temperature (1.5m, 9m)
- Relative humidity (1.5m)
- Wind speed and direction (2m, 9m, 10m)
- Barometric pressure
- Rainfall
- Soil temperature (10 cm below both natural sod cover and bare soil; 5 and 30 cm)
- Soil moisture (5, 25, 60 and 75 cm)
Embedded Sensor Networks

Source: D. Estrin, UCLA and James Reserve
**Example Robotic Deployment: Imaging as a Biological Sensor**

Scheduled robotic imaging of replicate branches allows comparisons of leaf production timing, numbers, sizes.

Image sequences also set the stage for automatic pre-processing, image analysis, and 3D modeling.

<table>
<thead>
<tr>
<th>Date</th>
<th>Image Description</th>
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<tbody>
<tr>
<td>17 May 2005</td>
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<td>Upper slope</td>
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<tr>
<td>13 June 2005</td>
<td>Lower slope</td>
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**Plant Growth Dynamics – Rhododendron (NIMS project)**

*From Deborah Estrin, CELS at UCLA*
NEON Frontier in Small-Organism Tracking

- mobile animals as bio-sentinels for environmental change
- forecasting biological invasions and emerging disease spread
- education, outreach and conservation

Source: D. Estrin, UCLA and James Reserve
Data Streams that are real-time…for science and education

- Sensor data, live and archived
- Image data, live, archived, and processed
- Remote sensing, GIS, and spatial models
- Available via www both in the field or lab

From Deborah Estrin, CELS at UCLA
How do we best connect teaching and learning in biology for students in the 21st century?

- The way we construct our courses must reflect the ever more interdisciplinary nature of science.

- We have to remember there are students who will not be scientists in our courses...so whatever we do that is good for biology learning for majors should also benefit future teachers, captains of industry, poets, artists,...especially at the introductory level.

- We don’t need another traditional textbook! The textbooks and learning communities of the future will be virtual...are we ready to meet and engage our students there?
The breadth versus depth dilemma…
get over it

One doesn’t need to know or be exposed to everything in order to be equipped to work in a discipline…

...Project Kaleidoscope
Knowledge and Skills Needed By the Next Generation of Professional Biologists

- Content Expertise
- Computational and Technological Literacy
- Know How to Learn in a Changing World
- Ask and Answer Questions in Scientific Tradition
- Communication Skills
- Teamwork Skills

Prepares students for an interdisciplinary future

Brewer 2001; Brewer and Gross 2003; Brewer and Maki 2005; Brewer et al. 2007
What Might Interdisciplinary Courses Look Like

- Blend of theory and practice with lots of good examples
- Open ended problems
- Students from across disciplines work together to address complex problems of local interest - perhaps in a lab setting
- Instruction includes how to collaborate, communicate, and be an effective team member

Brewer and Maki 2005
What We Value…Making the Scholarship of Teaching Central to Biology Curriculum

Potential Challenges Ahead...

- Faculty buy-in
- Student buy-in
- Institutional inertia
- Cost (e.g., facilities, time, equipment, technology, …)
- Professional development
- Sustaining change
- Rewards system on our campuses

C. Brewer, UM, May 2008
Some Information and Examples....

www.BioEd.org

Links to Programs Across the K-20 Continuum and Beyond

• Biology Curriculum Revision
• Ecologist - Teacher Partnerships
• Citizen Science (Project BUDBURST)
• Grad Student Training Grants and Short Courses