A New Biology Education for the 21st Century

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“From Galileo, who used the hollow stalks of grass to demonstrate the idea that peripherally located construction materials provide most of the resistance to bending forces, to Leonardo da Vinci, whose illustrations of the parachute are alleged to be based on his study of the dandelion’s pappus and the maple tree’s samara, many of our greatest physicists, mathematicians, and engineers have learned much from studying plants.”
And Much is New

Adam Summer’s Clingfish
Using nature to grow batteries

KOEHL LAB

• Fluid dynamics of odor capture by olfactory antennae
• Fluid dynamics of hairy little legs
• How do benthic organisms withstand moving water?
Who is the “New Biologist”? 

Importantly, the New Biologist is not a scientist who knows a little bit about all disciplines, but a scientist with deep knowledge in one discipline and basic “fluency” in several. One implication of this is that not all “New Biologists” are now, or will in the future be, biologists! (p. 35)
The transdisciplinary imperative of Convergence differs in fostering a more comprehensive synthetic framework such as the merging of engineering with physical and life sciences in areas such as integrative cancer biology, computational biology, and imaging technology.
Example:
Education needed in Genomics?
- Statistics
- Computing
- Nanotechnology
“Computer and mathematical science occupations are projected to add almost 785,700 new jobs from 2008 to 2018. As a group, these occupations are expected to grow more than twice as fast as the average for all occupations in the economy. Demand for workers in computer and mathematical occupations will be driven by the continuing need for businesses, government agencies, and other organizations to adopt and utilize the latest technologies.”

Biology – Integrating mathematics and computing

Geosciences – Building capacity in MSIs and community colleges

Engineering – Addressing social inequality in engineering education and practice
Curricular calls for convergence

- A Framework for K-12 Science Education and the Next Generation Science Standards
- New AP Biology Curriculum
- NSF/AAAS Vision and Change in Undergraduate Biology Education
- Scientific Foundations for Future Physicians
Starting with K-12

DIMENSION 2: CROSSCUTTING CONCEPTS THAT HAVE COMMON APPLICATION ACROSS FIELDS

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change
Three Dimensions Intertwined

What is new?

1. Central role of scientific practices
2. Organized around crosscutting concepts & core explanatory ideas
3. Organized in learning progressions
4. Ability to tap into the interdisciplinary nature of science:

Biology is an interdisciplinary science.

Integration among subfields in biology, as well as integration between biology and other disciplines, has advanced our fundamental understanding of living systems and raised a number of new questions. As exciting new areas of study emerge from the interstices, solid grounding in the sciences, including computer science and social science, can advance the practice and comprehension of biology. Accordingly, all students should have experience applying concepts and subdisciplinary knowledge from within and outside of biology in order to interpret biological phenomena.
Preparing for Postgraduate

Overarching Competency at the Time of Entry into Medical School:

Demonstrate both knowledge of and ability to use basic principles of mathematics and statistics, physics, chemistry, biochemistry, and biology needed for the application of the sciences to human health and disease; demonstrate observational and analytical skills and the ability to apply those skills and principles to biological situations.
Getting there:

1) Building the evidence-base
2) Using the evidence

“the problem in STEM education lies less in not knowing what works and more in getting people to use proven techniques.”
- James Fairweather, Promising Practices commissioned paper for the NRC Board of Science Education (2008)
Building upon and building our understanding of student learning

- Conceptual understanding and change
- Problem solving
- Use of representations
- Effective instructional strategies
- Non-cognitive skills and other emerging areas
Welcome to the PULSE Community

This site is an initial attempt to gather resources that can be used to aid departmental-level Vision and Change reform, It is being assembled by PULSE V&C Leadership Fellows, using input/suggestions from the greater PULSE community. Eventually, it will be fully annotated and will be served from a PULSE site. Please feel free to suggest page revisions, resource categories, or resource items on either the Spreading the PULSE (SIP) or Faculty Networks (F3) group pages, available in the "Featured Groups" section of the groups page on the PULSE web site. [http://www.pulsecommunity.org/groups].

Use the top menu to navigate to various resources.
Use the "Browse" options to view all resources within a particular category, with annotations.

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Funding possibilities

- Research at the Interface of the Biological, Mathematical and Physical Sciences (BioMaPS)
  - BioMaPS will accelerate the generation of bio-based materials and sensors, and the advanced manufacturing of bio-inspired devices and platforms.

- Improving Undergraduate STEM Education (IUSE)
NSF Investment Strategies

DUE is a division of learning engineers
Need for improvement in the first two years of college (not only a K-12 challenge)

Providing a quality STEM learning experience for a diverse population

Recognizing distinct disciplinary needs

Administration goal: “Graduate over one million additional students with degrees in STEM fields over the next 10 years.”
Recognizing that the preparation of a globally-competitive workforce, including future teachers, and a scientifically literate populace requires excellent STEM education, IUSE supports the improvement of the undergraduate STEM education enterprise through:

- Foundational and exploratory research
- Design and development research
- Impact research, including spreading effective STEM learning and teaching knowledge and practice

- Ideas Labs focused on specific disciplinary needs
Resource for PIs

DEscribing & Measuring Undergraduate STEM Teaching Practices

A Report from a National Meeting on the Measurement of Undergraduate Science, Technology, Engineering and Mathematics (STEM) Teaching

17–19 December 2013
Opportunities ahead

Preparing a globally competitive workforce, including:

- Future teachers and
- A scientifically literate populace

depends on our collective success in furthering a

- Robust research and
- Implementation infrastructure
Questions?

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