Accelerated Integrated Science Sequence (AISS)

A National Call for Science Integration

"One goal of this project is to provide greater flexibility in the premedical curriculum that would permit undergraduate institutions to develop more interdisciplinary and integrative science courses, as recommended in the BIO 2010 report. Achieving economies of time spent on science instruction would be facilitated by breaking down barriers among departments and fostering interdisciplinary approaches to science education. Indeed, the need for increased scientific rigor and its relevance to human biology is most likely to be met by more interdisciplinary courses."


"The essence of the New Biology is integration – re-integration of the many subdisciplines of biology and the integration into biology of physicists, chemists, computer scientists, engineers, and mathematicians to create a research community with the capacity to tackle a broad range or scientific and societal problems."

– National Research Council Committee, 2009
A New Biology for the 21st Century

(emphasis added)
What is AISS?

AISS presents biology, chemistry, and physics at an introductory level in an integrated format.

2005 National Science Foundation-funded initiative

2011 Received further support from the S. D. Bechtel Foundation

Goals of AISS

Strategic
- Increase recruitment
- Increase retention
- Raise profile of Keck Science

Pedagogical
- Encourage broad, integrated understanding of nature
- Prepare students for research that straddles multiple disciplines
- Prepare students for all possible science majors
- Accelerate introductory course
  - Additional electives
  - Study abroad

Target Student Group
- First-year students with broad, interdisciplinary scientific interests and strong math backgrounds
Structure of AISS

Double course sequence spanning two semesters
- 12 class hours per week
- combined lecture/discussion/lab/fieldwork
- 4 semester courses annually

Prepares students to major in biology, chemistry, or physics or other, integrated majors
- Accelerated: 6 credits of intro done in 4

Taught by 3 faculty: 1 each in biology, chemistry, and physics
- Emphasizes common fundamentals and focal points for integration of the disciplines

Limited enrollment
- First year students only
- By application
- 28 students

What does it mean to be integrated?

**Serial**
One discipline at a time, each building a foundation for next step

*e.g. forces to membranes*
  Atomic matter
  Fundamental forces
  Intermolecular forces
  Lipid bilayer membranes

**Parallel**
multiple expressions of a shared topic

*e.g.  Negative feedback*
  simple harmonic oscillator
  Le Chatelier's Principle
  Diffusion
  Population dynamics
### What does it mean to be integrated?

#### Common tools

**Mathematics**
- Descriptive statistics
- Graphical presentation
- Calculus
- Systems of differential equations

**Computer modeling**
- Maple / MATLAB
- Odyssey & Spartan
- Databases

#### Shared Fundamentals

**Experimental Methods**
- Data acquisition
- Data analysis
- Experimental error
- Data presentation
- Modeling

### Implementation

#### Randomness

- Entropy
- 2nd Law of Thermodynamics
- Diffusion
- Osmosis

#### Structure

- Physical properties of atoms and molecules
- Forces and fields
- Proteins
- Lipids
- Cells

#### Energy

- Quantum Mechanics
- Orbital and Molecular Thermodynamics
- ATP and Photosynthesis

#### Dynamics

- Discrete systems: population
- Continuous systems: chemical kinetic, infection rates, physical dynamics, evolution, electrodynamics
What works well?

Integration leads to ...
• shared fundamentals
• deepened understanding as topics are revisited
• unexpected student epiphanies
• open questioning in class of statements and beliefs
• Increased interest in undergraduate research

Faculty growth and development
• Detailed knowledge of other intro courses
• Ripple effects on upper division courses

Pedagogy and Science Education
• seamless lecture/discussion/lab
• AAMC-HHMI report

Cohort building
• Creates Productive Culture of Learning
• Confident, inquiring attitude
• Expectation of seeing larger picture

Why is it worth doing?

Integration
• Reflects current and future state of science and big problems

Creates Productive Culture of Learning
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Future of undergraduate science education?
• AAMC-HHMI report, NRC report
b. Project Summary

... expand the pool of undergraduates who complete a major in biology, chemistry, physics, or related interdisciplinary fields

... extend opportunities for first- and second-year students to participate in interdisciplinary research projects.

... the centerpiece of a renewed effort to recruit students to science majors

... give students more flexibility in their undergraduate curriculum

... develop of the integrated introductory course sequence ... featuring an interdisciplinary treatment of biology, chemistry, and physics and investigative laboratory work

... case study approach will provide the framework for substantive interaction of the three disciplines

... taught in parallel with our current introductory courses in biology, chemistry, and physics allowing detailed evaluation of the new approach in comparison to a more traditional approach

... dissemination will include formation of a library of case studies that will be made available to others

... the educational experience of the classroom and teaching lab will be connected with the research lab by linking the integrated introductory course with new opportunities for undergraduate research

... the participation of women in science will be enhanced because one of the participating colleges, Scripps College (the women's college in the Claremont consortium), promotes science education and research as key contributors to the implementation of its mission

... this program will prepare students to work at the interface of traditional scientific disciplines where many of the future problems in science are likely to reside.