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UNL Life Sciences Initiative

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Abstract for DBER Group Discussion on 2013-09-26

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Title:
UNL Life Sciences Initiative

Abstract:
The Life Sciences curriculum consists of a two semester series of courses and associated laboratories covering the fundamentals of biology. It is intended to serve those students who intend on taking more advanced biology courses. We will discuss the development and implementation of the new life courses and laboratories.

Undergraduate Life Sciences Curriculum

Undergraduate Life Sciences Curriculum at the University of Nebraska-Lincoln

- UNL has defined the life sciences as an academic and research priority
- Opportunities:
  - Develop a community of scholar-educators in the life sciences
  - Develop an innovative, interdisciplinary, multi-college curriculum in the life sciences

Expected Outcomes and Attributes :

- Develop student learning outcomes/competencies;
- Prepares students well for a diverse array of academic and professional careers;
- Builds on the ACE program;
- Responsive to the changing environment of life sciences research and practice; and
- Flexible; provides a portal to multiple majors (e.g., lower division core that allows student movement across Life Sciences majors).

Three proposals to be developed:

- Life Sciences Student Learning Outcomes/Competencies—This proposal will identify overarching concepts and specific learning outcomes/competencies common to all undergraduate students in the life sciences at the University (introductory level).
- Life Sciences Program—This proposal will identify a framework and the initial set of courses and experiences that will help students achieve the Life Sciences Student Learning Outcomes/Competencies.
- Life Sciences Implementation Plan—This proposed plan will encompass:
  - preparation & distribution of a report on the Life Sciences teaching facilities;
  - proposal of a strategy for coordination of the Life Sciences curriculum; and
  - engagement of the Undergraduate Life Sciences Coordinating Council to coordinate, sustain, and review the undergraduate Life Sciences program which emerges from the process.

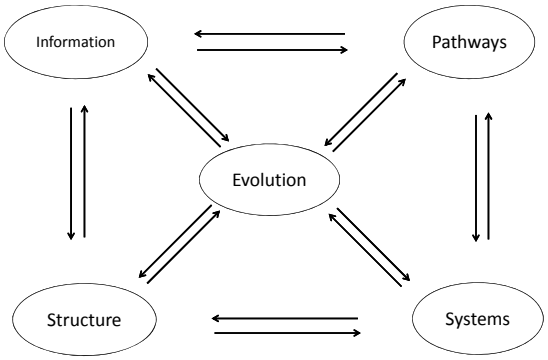
Proposal 1: Competencies

- Life Sciences Competencies—This proposal will identify overarching concepts and specific competencies common to undergraduate students in the life sciences at the University (introductory level).
- Completed:
  - Development of core themes and competencies for biology and supporting competencies in chemistry, physics, mathematics, and statistics
  - Modeled after Vision and Change report
  - Listening sessions & input from Life Sciences units
  - Approval by A&S, CASNR, CEHS (May 2012)

Procedure

- Define core concepts
  - Vision and Change report
- Define competencies
  - ABT reports
  - Input from colleagues
- Introductory level
- Maximize coverage
- Minimum competencies

Concept map



Evolution: The scientific theory and principles of evolution underpin all of biology

- Competency 1: microevolution: students should be able to explain how selection and drift affect allele frequencies.
- Competency 2: macroevolution: students should be able to explain models of speciation.
- Competency 3: students should be able to explain how biological information is used to generate a phylogenetic tree and how to interpret the relationships displayed on a tree.
- Competency 4: students should be able to explain the origin and scope of biological diversity (including humans).

Pathways and transformations of energy and matter: life processes in living systems organize and convert matter and energy

- Competency 1: students should be able to explain the biological significance of chemical bonds and free energy changes.
- Competency 2: students should be able to explain how energy is stored chemically and released by enzymes.
- Competency 3: students should be able to explain and connect fundamental metabolic pathways.
- Competency 4: students should be able to explain conversion of light energy into chemical energy.

Information flow, exchange and storage: Inheritance and expression of genetic material

- Competency 1: students should be able to explain how cell division generates new cells.
- Competency 2: students should be able to explain basic inheritance of genetic material.
- Competency 3: students should be able to explain DNA replication and gene expression.
- Competency 4: students should be able to explain how gene expression drives development and responds to environmental conditions.

Structure and function: Structures of cells and multicellular systems are related to their function

- Competency 1: students should be able to explain how membranes form and function.
- Competency 2: students should be able to explain basic cellular structures and their corresponding functions.
- Competency 3: students should be able to explain the similarities and differences of the three domains of life (*Bacteria, Archaea and Eukarya*).
- Competency 4: students should be able to explain the basic functions of multi-cellular systems.

Systems: Understanding biological systems requires both reductionist and holistic thinking because novel properties emerge as simpler units assemble into more complex structures

- Competency 1: students should be able to give examples of structural complexity and information content at the cellular, organismal, population and ecosystem levels.
- Competency 2: students should be able to explain the flow of energy, materials and information among cells, organisms, populations and ecosystems.
- Competency 3: students should be able to give examples of homeostasis at the cellular, organismal, population and ecosystem levels.
- Competency 4: students should be able to connect specific biological systems to the Earth's ecosystem as a whole.

Integration with ACE

- ACE 4: Use scientific methods and knowledge of the natural and physical world to address problems through inquiry, interpretation, analysis, and the making of inferences from data, to determine whether conclusions or solutions are reasonable.
- Reinforcements contribute to skill set.

Supporting Competencies

- Chemistry
- Physics
- Mathematics
- Statistics

Supporting Competencies

Chemistry

- Competency 1: Students should be able to demonstrate an understanding of the major systems of nomenclature used in chemistry, to know the basic functional groups of inorganic and organic chemistry, to have a vocabulary of basic types of chemical reactions, and to use this information to make rational chemical predictions.
- Competency 2: Students should be able to apply the basic principles of chemistry in a wide variety of contexts, especially the relationship of the properties of atoms, molecules, and ions to chemical and physical behavior.
- Competency 3: Students should be able to understand how to calculate reactant concentrations and reaction stoichiometry.

Supporting Competencies

Physics

- Competency 1: Students should be able to identify the physical laws and principles applicable to a variety of physical situations.
- Competency 2: Students should be able to develop and analyze mathematical models in order to better understand complex systems.
- Competency 3: Students should be able to articulate elements of introductory classical mechanics, electricity, thermal phenomena, electromagnetism, and atomic and nuclear phenomena to explain, analyze, and predict a variety of natural phenomena.

Supporting Competencies

Mathematics

- Competency 1: Students should be able to provide accurate interpretations of information presented in mathematical forms such as graphs, formulas, and data tables.
- Competency 2: Students should be able to convert quantitative information into an appropriate mathematical portrayal, using graphs, tables, and simple formulas that describe relationships between quantities.
- Competency 3: Students should be able to use quantitative analysis of data as the basis for reasonable and appropriately-qualified conclusions.
- Competency 4: Students should be able to think critically and logically about mathematical problems.

Supporting Competencies

Statistics

- Competency 1. Students should understand that variability is natural, predictable, and quantifiable.
- Competency 2. Students should understand sampling distribution and how it applies to making statistical inferences based on samples of data (including the idea of standard error).
- Competency 3. Students should be able to interpret numerical summaries and graphical displays of data and the concept of statistical significance, including significance levels and p-values.
- Competency 4: Students should be able to interpret statistical results in context.

Proposal 2: Framework

- Life Sciences Program—This proposal will identify a framework and the initial set of courses that will help students achieve the Life Sciences Competencies.
- Completed:
  - Approval of proposal to develop an initial set of courses and experiences that will help students achieve the Life Sciences competencies (May 2012)
  - Course Development Committee
  - Approval of LIFE 120, 120L, 121 and 121L by colleges (September 2012)
  - Final approval by UCC and ACE certification (Dec 2012)

Proposal 3: Implementation Plan

- Preparation & distribution of a report on the Life Sciences teaching facilities;
- Proposal of a strategy for coordination of the Life Sciences curriculum; and
- Engagement of the Undergraduate Life Sciences Coordinating Council to coordinate, sustain, and review the undergraduate Life Sciences program which emerges from the process.

Proposal 3: Implementation Plan

- Preparation & distribution of a report on the Life Sciences teaching facilities
- Brace Hall renovation
- Manter Hall renovation/Life Sciences addition

Proposal 3: Coordination of Curriculum

- Life Sciences Curriculum Committee:
  - 2 Faculty & 1 Associate Dean from A&S, CASNR, CEHS
  - Responsibilities: Curriculum Oversight; Assessment; Review of Instructors, Facilities, TAs
  - Associate Deans: Liaison among colleges and curriculum advisory committee
- Life Sciences Undergraduate Curriculum Coordinator:
  - John Osterman
  - Responsibilities: Coordination of teaching FTEs, facilities and TAs; budget; curriculum development/revisions; scheduling; assessment; recruitment
- Curriculum Committee and Coordinator report to Deans of CEHS, A&S, and CASNR

Life Sciences 2013-2014

Life Sciences Teaching Teams:

LIFE 120/120 L

John Osterman	Jack Morris
Steve Harris	Mark Lagrimini
Brian Larkins	Brian Couch
Chi Zhang	Peter Angeletti

LIFE 121/121 L

Chad Brassil	Robert Cortinas
Joe Dauer	Jenny Dauer
SBS hire - TBD	

Transformation of First-Year Biology Experience

- Co-teaching model of instruction (aligns with the goal of bringing the two campuses together and the Vision and Change recommendations)
- Student-centered, interactive learning model for LIFE 120 and 121 (aligns with the Vision and Change recommendations).
- Learning Assistant (LA) Model for LIFE 120 and 121 – (Learning Assistant Program, University of Colorado Boulder)
- Discovery-based laboratories led by a lead faculty member (Harris – LIFE 120L, Brassil – LIFE 121L). Adopting a discovery-based laboratory approach aligns with ACE 4 and the Vision and Change recommendations.
  - All LIFE 120/121 labs will be delivered as structured or guided inquiry
  - Graduate students serve as the teaching assistants for LIFE laboratories. This represents a shift in the model of instruction for the LIFE laboratories from undergraduate students to graduate students.

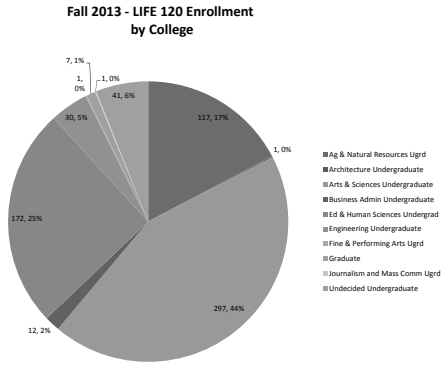
Enrollment – Fall 2013

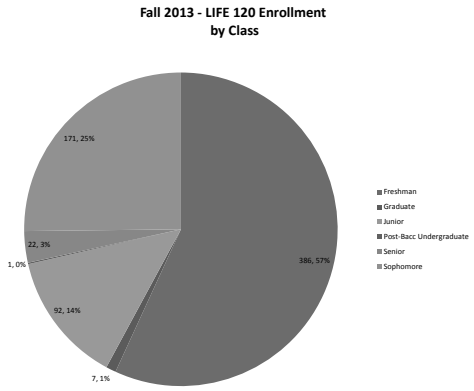
- LIFE 120: 679 students (3 lecture sections, 29 lab sections)
- LIFE 121: 255 students (1 lecture section, 11 lab sections)

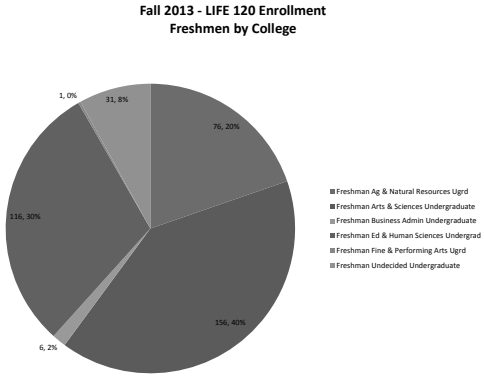
Enrollment – Fall 2012

BIOS 102 – 397 students

BIOS 103 – 255 students







Next Steps

- Professional development workshops/seminars
  - NSF grant to provide Scientific Teaching workshops for STEM faculty and study faculty's adoption of the practices taught during the workshop (Stains – lead PI)
  - NSF WIDER grant. The goal of this grant is to expand the workshops series and engage departments in transformation of their teaching evaluation protocols (Stains, Arthurs, Golick)
- Howard Hughes Medical Institute Undergraduate program – grant in preparation
- Discipline-based education research:
  - Brian Couch, Jenny Dauer, Joe Dauer

Questions