Biology Assessment Plan Spring 2019

Task: Revise the Biology Program Assessment plans with the goal of developing a sustainable continuous improvement plan. In order to revise the program assessment plan, we have been asked by the university assessment committee to revise our Students Learning Outcomes (SLOs) and Program Learning Outcomes (PLOs).

Proposed revisions
Approach: A large community of biology educators have converged on a set of core biological concepts with five core concepts that all biology majors should master by graduation, namely 1) evolution; 2) structure and function; 3) information flow, exchange, and storage; 4) pathways and transformations of energy and matter; and (5) systems (Vision and Change, AAAS, 2011). Aligning our student learning and program goals with Vision and Change (V&C) provides many advantages. For example, the V&C community has recently published a programmatic assessment to measure student understanding of vision and change core concepts across general biology programs (Couch et al. 2019). They have also carefully outlined student learning conceptual elements (see Appendix A). Using the proposed assessment will allow us to compare our student learning profiles to those of similar institutions across the country.

Revised Student Learning Objectives

SLO 1. Students will demonstrate an understanding of core concepts spanning scales from molecules to ecosystems, by analyzing biological scenarios and data from scientific studies. Students will correctly identify and explain the core biological concepts involved relative to: biological evolution, structure and function, information flow, exchange, and storage, the pathways and transformations of energy and matter, and biological systems.

- More detailed statements of the conceptual elements students need to master are presented in appendix A.

SLO 2. Students will select and competently use laboratory equipment, field equipment, and technologies to collect and manage data, consistent with professional expectations in the biological sciences.

SLO 3. Students will demonstrate the ability to ask and answer questions in the biological sciences by applying the process of science to designing and conducting experiments. To this end, students will appropriately use models and simulations, construct explanations based on evidence derived from the analysis of data, and explain the interdisciplinary nature of science as appropriate.

SLO 4. When given problems or proposing, designing and analyzing biological research questions, students will demonstrate competency in critical thinking, quantitative, analysis and oral and written communication skills essential to career development in the biological sciences by presenting their work both orally and in writing in a manner consistent with professional expectations.

ASSESSMENT:
Assessment: In the spring of every academic year, the assessment committee will propose and the department will vote to approve the following: one of the core competencies to be assessed the following year, 2) the course(s) from which the data will be collected (which are expected to vary depending on the specific skill chosen). Data will be collected using university approved rubrics for critical thinking, quantitative skills, information skills, and communication skills.

SLO 1. Students will demonstrate understanding of core biological concepts by analyzing biological scenarios and data from biological studies to correctly identify and explain the core biological concepts involved, spanning scales from molecules to ecosystems, relative to biological evolution; structure and function; information flow, exchange, and storage; the pathways and transformations of energy and matter; and biological systems.

Courses where SLO is addressed. Every course in the program contributes to this SLO.

Assessment: Every year we will assess students in our program at three time points: at the beginning of the introductory series for majors, at the end of the introductory series for majors, and in an upper level course typically taken near graduation.

Pre-program: Beginning of Bio 1210 (every fall)
End of introductory series: End of Bio1220 (every spring)
Before graduation (every spring) every year in one of the following courses.

- Bio 4320/L Molecular Biology Techniques
- Bio 4460 Physiology II
- Bio 4020 Developmental biology
- Bio 4380 Bioinformatics
- Bio 4480 Plant physiology
- Bio 3250/L Ecology lab

Assessment tool: GenBio-MAPS: A Programmatic Assessment to Measure Student Understanding of V&C Core Concepts across General Biology Programs. (Couch, Brian A., Christian D. Wright, Scott Freeman, Jennifer K. Knight, Katharine Semsar, Michelle K. Smith, Mindi M. Summers, Yi Zheng, Alison J. Crowe, and Sara E. Brownell. "GenBio-MAPS: A Programmatic Assessment to Measure Student Understanding of Vision and Change Core Concepts across General Biology Programs." CBE—Life Sciences Education 18, no. 1 (2019): ar1). See Appendix C for the assessment.

SLO 2. Students will select and competently use laboratory equipment, field equipment, and technologies to collect and manage data, consistent with professional expectations in the biological sciences.

Courses where SLO is addressed. Every course in the program with a laboratory designation contributes to this SLO.

Every three years, collect data to assess this SLO from the classes, below.

- Bio 4180/L - Marine Ecology
- BIO 4320/L Molecular Biology Techniques
- Bio 4450/L- Physiology I

- Bio 4480/L Plant physiology
- Bio 4020/L Developmental biology
- BIO 4490/L Marine Botany
- BIO 4570/L Plants and the Environment
- BIO 4800/L Entomology
- BIO 4820/L Biology of Fishes
- BIO 4680/L Microbial Ecology

Assessment tools: University-approved rubrics for Core competencies and Strategic Vision and a rubric similar to the Rubric for General Education Outcome IIa (Scientific Reasoning). Scored by instructors for ~25% of randomly selected students. Instructors of these courses will receive training on assignments that can be used for the assessment and training on the rubric.

SLO 3. Students will demonstrate the ability to ask and answer questions in the biological sciences by applying the process of science to designing and conducting experiments. To this end, students will appropriately use models and simulations, construct explanations based on evidence derived from the analysis of data, and explain the interdisciplinary nature of science as appropriate.

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- Bio 4480/L Plant physiology
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Assessment tool: University-approved rubrics for Core competencies and Strategic Vision and a rubric similar to the Rubric for General Education Outcome IIa (Scientific Reasoning). Scored by instructors for ~25% of randomly selected students. Instructors of these courses will receive training on assignments that can be used for the assessment and training on the rubric.

SLO 4. When given problems or proposing, designing and analyzing biological research questions, students will demonstrate competency in critical thinking, quantitative, analysis and oral and written communication skills essential to career development in the biological sciences by

presenting their work both orally and in writing in a manner consistent with professional expectations.

Every three years, collect data to assess this SLO from the classes, below.

- Bio 4180/L - Marine Ecology
- BIO 4320/L Molecular Biology Techniques
- Bio 4450/L- Physiology I
- Bio 4480/L Plant physiology
- Bio 4020/L Developmental biology
- BIO 4490/L Marine Botany
- BIO 4570/L Plants and the Environment
- BIO 4800/L Entomology
- BIO 4820/L Biology of Fishes
- BIO 4680/L Microbial Ecology

Assessment tool: University-approved rubrics for Core competencies and Strategic Vision. Exit survey from students applying for graduation. The survey will ask students about the extent to which they think the program prepared them for a future in the biological sciences. The assessment committee will develop this new survey.

Proposed Revised Program Learning Objectives

Program Learning Outcome Biological Science, B.S.	Student Learning Outcome
PLO1: Graduates will demonstrate mastery in understanding and applying major biological concepts.	SLO 1. Students will demonstrate an understanding of core concepts spanning scales from molecules to ecosystems, by analyzing biological scenarios and data from scientific studies. Students will correctly identify and explain the core biological concepts involved relative to: biological evolution, structure and function, information flow, exchange, and storage, the pathways and transformations of energy and matter, and biological systems.
PLO2: Graduates will be able to competently apply scientific knowledge and skills to new problems and challenges, including conducting biological inquiries, and apply the processes of science consistent with professional expectations.	SLO 2. Students will select and competently use laboratory equipment, field equipment, and technologies to collect and manage data, consistent with professional expectations in the biological sciences.
	SLO 3. Students will demonstrate the ability to ask and answer questions in the biological sciences by applying the process of science to designing and conducting experiments. To this end, students will appropriately use models and simulations, construct explanations based on evidence derived from the analysis of data, and explain the interdisciplinary nature of science as appropriate.
PLO3: Graduates will pursue careers or advanced degrees in biological sciences, or degrees in related disciplines, leading to professional careers.	SLO 4. When given problems or proposing, designing and analyzing biological research questions, students will demonstrate competency in critical thinking, quantitative, analysis and oral and written communication skills essential to career development in the biological sciences by presenting their work both orally and in writing in a manner consistent with professional expectations.

Appendix A. From "Conceptual Elements: A Detailed Framework to Support and Assess Student Learning of Biology Core Concepts" Cary and Branchaw, 2017

Core Concepts	Conceptual Element
Pathways and transformations of energy and matter (PTEM)	PTEM1: Energy is neither created nor destroyed, but can be transformed from one form to another to generate biological activity.
Pathways and transformations of energy and matter (PTEM)	PTEM2: Input of energy, which can be from different sources, is needed to build and maintain biological entities, thereby lowering entropy in the system.
Pathways and transformations of energy and matter (PTEM)	PTEM3: Biological entities harness potential energy stored in electrochemical gradients and released from chemical reactions.
Pathways and transformations of energy and matter (PTEM)	PTEM4: Matter is recycled through the rearrangement of chemical bonds in biological entities.
Pathways and transformations of energy and matter (PTEM)	PTEM5: Biological entities regulate the synthesis, storage, and mobilization of biological compounds to meet energy demands.
Pathways and transformations of energy and matter (PTEM)	PTEM6: Many chemical elements can serve as electron donors and acceptors to drive biological processes.
Pathways and transformations of energy and matter (PTEM)	PTEM7: Matter can transfer between the abiotic and biotic components of biological systems.
Information flow, exchange, and storage (IFES)	IFES1: Information exists in many forms and is relayed within and across biological molecules, cells, tissues, organisms, populations, and ecosystems.
Information flow, exchange, and storage (IFES)	IFES2: Genetic information is stored in nucleic acids (DNA and RNA); epigenetic information is stored in proteins that associate with DNA and in reversible DNA modifications.
Information flow, exchange, and storage (IFES)	IFES3: The process of protein synthesis results from the flow of genetic information through various pathways.
Information flow, exchange, and storage (IFES)	IFES4: Information from the environment regulates protein synthesis and activity, which control cellular processes and thereby organismal and population-level activity.
Information flow, exchange, and storage (IFES)	IFES5: Organisms transmit genes and epigenetic information to their offspring
Structure and function (SF)	SF1: Biological structures from the molecular to the ecosystem scale, and their interactions are determined by chemical and physical properties that both enable and constrain function.
Structure and function (SF)	SF2: Individual structures can be arranged into organized units that enable more complex functions.
Structure and function (SF)	SF3: Structural features of biological entities undergo changes during development that are determined by the regulation of gene expression.

Structure and function (SF)	SF4: Structural features are dynamic and modifications can be made in response to environmental changes that are compensatory to restore lost function or noncompensatory to eliminate functions that are no longer needed.
Structure and function (SF)	SF5: Comparable changes in structure can have small or large effects on function, depending on the spatial location.
Evolution (E)	E1: All living organisms share common ancestors at some time in the past.
Evolution (E)	E2: The phenotypes of living organisms result from the gain and loss of traits along their lineage.
Evolution (E)	E3: Genetic variation within a population can be generated by mutation, which results in the generation of novel traits, and by sexual recombination, endosymbiosis, and horizontal gene transfer.
Evolution (E)	E4: Phenotypes, based upon underlying genotypes and environmental factors, can be subject to selective pressure.
Evolution (E)	E5: Organisms have greater fitness if they have a phenotype that increases their ability to survive and reproduce in a particular environment.
Evolution (E)	E6: Populations are composed of individual organisms that vary in their fitness, leading to differential rates of survival and reproduction and therefore changes in allele frequency over time.
Evolution (E)	E7: Evolution in a population may be due to events not related to fitness, including genetic drift and gene flow.
Evolution (E)	E8: The rate of evolutionary change varies and is influenced by many factors, including mutation rate, generation time, and environmental variation.
Evolution (E)	E9: Speciation occurs when subpopulations can no longer exchange genetic material, allowing them to diverge over time in their physiological and ecological traits.
Systems (S)	S1: Biological entities interact through chemical and physical signals that can be transient, depend on spatial organization, and are influenced by environmental factors.
Systems (S)	S2: Changes in one component of a biological system can affect or be regulated by other components of the same system.
Systems (S)	S3. Biological systems can be defined at different scales, interact within and across scales, and together form complex networks.
Systems (S)	S4: Biological systems include and are affected by biotic and abiotic factors in the environment.
Systems (S)	S5: Interactions between and among biological entities can generate new system properties.