Life Sciences (General Goal 10)

General Goal (10): Students will understand basic concepts of living things, the nature of scientific knowledge, and relevance of biological knowledge to human affairs.

Reviewers are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark level of performance.

	Capstone	Milestone	Benchmark
General Goal 10	Apply fundamental concepts of life science and scientific methods to demonstrate the relevance of biological knowledge to human affairs.	Demonstrate knowledge of fundamental concepts in life science and methods of developing scientific knowledge to summarize the relevance to human affairs.*	Identify basic concepts of life science and methods of developing scientific knowledge.
SLO 10.1 **Knowledge of Life Science**	Demonstrate knowledge of the interconnection of concepts in life science to describe the function and responses in living systems.	Recognize how fundamental concepts in life sciences (structure, organization, and evolution) describe living systems.*	Recall fundamental concepts in life sciences (Concepts: organization, systems, structure, function, stimulus production/response, energy transformation, and evolution).
SLO 10.2 **Understanding of Scientific Method**	Apply the scientific method to generate knowledge in the life sciences.	Recognize how the scientific method is used to generate knowledge in the life sciences.*	Identify the basic principles of the scientific method.
SLO 10.3 **Testing Hypotheses**	Use results of biological experiment to evaluate the validity of a hypothesis and develop alternative hypothesis as appropriate.	Test hypothesis and draw defensible conclusions to develop knowledge regarding living things.	Test hypothesis to develop knowledge regarding living things.
SLO 10.4 **Connection between humans and nature**	Describe the interaction between humans and other living things through key concepts and multiple facets in the life sciences (molecular, organismal, ecological, etc.).	Recognize the interaction between humans and other living things through key concepts in the life sciences.*	Give examples of interaction between humans and other living things.

SLO 10.5 **Humans as biological organism**	Apply experimental process to show how fundamental concepts in life sciences relate to humans as a biological organism.	Demonstrate how fundamental concepts in life sciences relate to humans as a biological organism.*	Recognize some basic concepts in life sciences that demonstrate humans as a biological organism.
SLO 10.6 **Connection between Life and Environment**	Describe the interconnected relationship between human action and the physical environment in multiple facets of life sciences (molecular, organismal, ecological, etc.).	Recognize the interconnected relationship between human action and the environment.*	Identify how the environment impacts humanity or how human actions affect the environment.

*indicates the Faculty Senate approved SLO

General Goal 10: Life Sciences (GG10)
Students will understand basic concepts of living things, the nature of scientific knowledge, and relevance of biological knowledge to human affairs.

SLO 10.1. Understand living systems by describing their nature, organization, and evolution.

SLO 10.2. Understand and use the processes by which scientific knowledge of living things is generated.

SLO 10.3. Develop knowledge of living things through hypothesis testing and gain the ability to draw defensible conclusions regarding living things.

SLO 10.4. Make logical connections between key concepts in the life sciences and describe the interaction between human lives and other living things.

SLO 10.5. Understanding the human species as a biological organism

SLO 10.6. Understand the ways the environment impacts humanity and how human actions affect the environment.

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V&C Core Concepts: Structure/function, Systems, Pathways and transformation of energy and matter, information flow/exchange/storage, and evolution

V&C Core Competencies: Process of Science, Quantitative reasoning, Modeling and simulation, interdisciplinary nature of science, communication and collaboration, understanding the relationship between science and society

Structure/Function: Biological structures exist at all levels of organization, from molecules to ecosystems. A structure's physical and chemical characteristics influence its interactions with other structures, and therefore its function. Molecular Example: The structure of a cell--its shape, membrane, organelles, cytoskeleton, and polarity--impacts its function. Physiological Example: The size, shape, and physical properties of organs and organisms all affect function. The ratio of surface area to volume is particularly critical for structures that function in transport or exchange of materials and heat. Ecological: Natural selection has favored structures whose shape and composition contribute to their ecological function.

Systems: Biological molecules, genes, cells, tissues, organs, individuals, and ecosystems interact to form complex networks. A change in one component of the network can affect many other components. Organisms have complex systems that integrate internal and external information, incorporate feedback control, and allow them to respond to changes in the environment.

Pathways and transformation of energy and matter: Energy and matter cannot be created or destroyed, but can be changed from one form to another. Energy captured by primary producers is necessary to support the maintenance, growth and reproduction of all organisms. Natural selection leads to the evolution of efficient use of resources within constraints. Molecular Examples: In cells, the synthesis and breakdown of molecules is highly regulated. Biochemical pathways usually involve multiple reactions catalyzed by enzymes that lower activation energies. Energetically unfavorable reactions are driven by coupling to energetically favorable reactions such as ATP hydrolysis. Ecological examples: Chemical elements are transferred among the abiotic and biotic components of an ecosystem; changes in the amount and distribution of chemical elements can impact the ecosystem.

Information flow/exchange/storage: Organisms inherit genetic and epigenetic information that influences the location, timing, and intensity of gene expression. Cells/organs/organisms have multiple mechanisms to perceive and respond to changing environmental conditions. Molecular Examples: Gene expression and protein activity are regulated by intracellular and extracellular signaling molecules. Signal transduction pathways are crucial in relaying these signals. Organismal/Ecological Examples: Organisms have sophisticated mechanisms for sensing changes in the internal or external environment. They use chemical, electrical, or other forms of signaling to coordinate responses at the cellular, tissue, organ, and/or system level.

Evolution: All living organisms share a common ancestor. Species evolve over time, and new species can arise, when allele frequencies change due to mutation, natural selection, gene flow, and genetic drift. Molecular Example: Multiple molecular mechanisms, including DNA damage and errors in replication, lead to the generation of random mutations. These mutations create new alleles that can be inherited via mitosis, meiosis, or cell division. Physiological Example: Physiological systems are constrained by ancestral structures, physical limits, and the requirements of other physiological systems, leading to trade-offs that affect fitness. Ecological Example: Fitness is an individual's ability to survive and reproduce. It is environment-specific and depends on both abiotic and biotic factors. Evolution of optimal fitness is constrained by existing variation, trade-offs and other factors.

Table 2.1: Core Competencies and Disciplinary Practices. A competency-based approach to undergraduate biology education focuses on demonstrating analytical, experimental, and technical skills as measurable outcomes of student learning. Biology literacy is defined primarily in terms of acquired competencies, demonstrated within the context of fundamental biology concepts.

Core Competency	Ability to apply the process of science	Ability to use quantitative reasoning	Ability to use modeling and simulation	Ability to tap into the interdisciplinary nature of science	Ability to communicate and collaborate with other disciplines	Ability to understand the relationship between science and society
Instantiation of Ability in Disciplinary Practice	Biology is an evidence-based discipline	Biology relies on applications of quantitative analysis and mathematical reasoning	Biology focuses on the study of complex systems	Biology is an interdisciplinary science	Biology is a collaborative scientific discipline	Biology is conducted in a societal context
Demonstration of Competency in Practice	Design scientific process to understand living systems	Apply quantitative analysis to interpret biological data	Use mathematical modeling and simulation tools to describe living systems	Apply concepts from other sciences to interpret biological phenomena	Communicate biological concepts and interpretations to scientists in other disciplines	Identify social and historical dimensions of biology practice
Examples of Core Competencies Applied to Biology Practice	Observational strategies Hypothesis testing Experimental design Evaluation of experimental evidence Developing problem-solving strategies	Developing and interpreting graphs Applying statistical methods to diverse data Mathematical modeling Managing and analyzing large data sets	Computational modeling of dynamic systems Applying informatics tools Managing and analyzing large data sets Incorporating stochasticity into biological models	Applying physical laws to biological dynamics Chemistry of molecules and biological systems Applying imaging technologies	Scientific writing Explaining scientific concepts to different audiences Team participation Collaborating across disciplines Cross-cultural awareness	Evaluating the relevance of social contexts to biological problems Developing biological applications to solve societal problems Evaluating ethical implications of biological research