Biology Major
Iowa State University
Objectives and Outcomes

All students majoring in Biology take a uniform set of basic courses followed by an individualized set of advanced courses. This sequence should ensure that all students, at a minimum, have knowledge of core concepts pertinent to all areas of biology, as described below, along with more specialized concepts from their advanced coursework, and can integrate these concepts to provide a robust understanding of biology as a science. Graduates of the Biology major will have core competencies relevant to practices in biology and specific sub-disciplines and to being educated, responsible members of society.

Core concepts for biological literacy

1. Evolution: ***the diversity of life evolved over time by processes of genetic change, diversification, and extinction.***

Principles: The product of evolution is the amazing diversity of organisms present, both currently and in the past, on Earth. Species evolve over time, and new species can arise when allele frequencies change due to mutation, natural selection, gene flow, or genetic drift.

Students will be able to explain/apply:

- --the types of evidence that support the conclusion that evolution explains the diversity of life on Earth and reveal evolutionary relationships amongst groups of organisms.
- --how genetic variation amongst individuals arises in populations and how genetic variation affects survival and reproduction.
- -- how changes in genes, and in aggregate genomes, can be applied to agriculture, industry, and medicine.
- --the phylogenetic relationships among groups of organisms at the large taxonomic scale, i.e., domains and kingdoms.
- -- the vast range of biological diversity on Earth, both currently and in the past, as well as appreciate current threats to biological diversity.

2. Structure and function: ***basic units of structure define the function of all living things.***
Principles: Biological structures exist at all levels of organization, from molecules to ecosystems. The physical and chemical characteristics of each biological structure influence its interactions with other structures as well as its function.

Students will be able to explain/apply:

- **--**the major types of molecules that make up living organisms and how these molecules enable life functions.
- --the structures found in cells and the functions of those sub-cellular structures.
- --the processes by which cells replicate to produce genetically identical, or genetically variable, daughter cells.
- --how groups of cells produce structurally distinct organs to carry out specific functions in multicellular organisms.
- --how the structure of organisms affects their ability to survive and reproduce, including interactions with their biotic and abiotic environments.
- --how the structures of populations, communities, and ecosystems affect species dynamics, survival, and ecosystem functions.

3. Information flow, exchange, and storage: ***context-specific expression of genetic information regulates growth and behavior of organisms. The phenotype of an organism is controlled by its genotype and the environment.***

Principles: Organisms inherit genetic and epigenetic information that influences the location, timing, and intensity of gene expression. Organisms also acquire, use, and transfer nongenetic information.

Students will be able to explain/apply:

- --how organisms store genetic information and pass genetic and epi-genetic information from one generation to the next.
- --how non-genetic information is passed from one generation to the next.
- --how organisms control the expression of genetic information during development and ontogeny.
- --how organisms, tissues, and cells detect, process, and interpret information from the environment to modulate gene expression and to regulate physiological processes and behavior.

4. Pathways and transformations of energy and matter: ***biological systems grow and change by processes based upon chemical transformation pathways and are governed by the laws of thermodynamics.***

Principles: Energy cannot be created or destroyed, but can be changed from one form to another. 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.

Students will be able to explain/apply:

- --how organisms obtain and use matter and energy to live and grow.
- --how organisms interact with the environment.
- --how matter and energy move through an ecosystem.

5. Systems: ***living systems are interconnected and interacting.***

Principles: Biological molecules, genes, cells, tissues, organs, organisms, communities, 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.

Students will be able to explain/apply:

- --how organisms are composed of interacting systems with varying degrees of homeostasis.
- --how living systems, at levels of organization from the organism to the biosphere, are interconnected and interacting.
- --how systems change over time.
- --how living systems interact with non-living components of the earth.
- --the direct effects that biological diversity has on ecosystem services and humans.
- --how humans depend on ecosystems for their health and well-being.
- --what effects humans have on ecosystems and what humans can do to mitigate negative impacts they have on ecosystems.

Core competencies and disciplinary practice:

1. Ability to apply the process of science: ***biology is evidence-based and grounded in the formal practices of observation, experimentation, and hypothesis testing.***

Students will be able to:

--exhibit critical thinking and problem-solving skills.

--distinguish among belief, opinion, fact, hypothesis, and theory and explain the process of inference, within the context of science.

--describe and practice the scientific methods of observation, experimentation, hypothesis formulation, and hypothesis testing.

--design experiments and interpret data.

--obtain and evaluate information and information resources.

2. Ability to use quantitative reasoning: ***biology relies on applications of quantitative analysis and mathematical reasoning.***

Students will be able to:

--apply quantitative skills such as estimation, graphing data, statistical analyses, and analysis of large datasets.

--evaluate and summarize experimental evidence, using quantitative or computational skills.

3. Ability to use modeling and simulation: ***biology focuses on the study of complex systems.***

Students will be able to:

--explain the basic components of models and explain the advantages and disadvantages of using models to address biological questions.

--distinguish conceptual models, simulation models, model organisms, and model systems and describe their uses.

4. Ability to utilize, communicate with, and collaborate with other disciplines: ***biology is an interdisciplinary, collaborative science.***

Students will be able to:

--apply principles of the physical sciences and other disciplines to biological questions.

--communicate science in multiple forms, including written, oral, and electronic, to diverse audiences.

5. Ability to understand the relationship between science and society: ***biology is conducted in a societal context.***

Students will be able to:

--communicate and apply biological principles and global perspectives in an ethical manner to issues in human society.

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2 May 2016
adopted 11 May 2016