Department of Biology
Georgetown University

Department-wide Learning Goals in Biology

A. Insight into the Process and Product of Science

We begin our learning goals with a focus on process to emphasize our belief that the goal of a biology education is to enable students to make creative and careful use of their knowledge. Only then will they be scientists.

1. **Integration of new knowledge into existing scientific frameworks**
    a. Ability to interpret scientific text, primary literature and presentations
    b. Ability to critique scientific text, primary literature and presentations
    c. Ability to structure and contextualize understanding with proper references to literature
    d. Ability to speculate on meanings of scientific data and on possible future directions
    e. Ability to place (relate) biology into other scientific disciplines
2. **Engagement with scientific inquiry**
    a. Ability to evaluate the significance and context of the area of investigation
    b. Ability to use texts, primary literature, presentations and mathematical models to stimulate questioning and develop scientific hypotheses
    c. Ability to appropriately design and perform experiments and to construct mathematical models in order to text scientific hypotheses
    d. Ability to interpret data to evaluate hypotheses and place findings into an intellectual framework to plan further experiments
3. **Representing and interpreting data in quantitative and statistically meaningful forms**
    a. Ability to distinguish between and work rigorously with qualitative and quantitative data
    b. Ability to construct and interpret visual representations of quantitative data
    c. Ability to use probability and statistical analyses to evaluate and interpret data
4. **Communicating scientific understanding in oral and written forms**
    a. Ability to communicate scientific understanding to both scientific and general audiences
    b. Ability to present scientific ideas arguing from evidence
    c. Ability to write and speak precisely
    d. Ability to stimulate interest of the audience
5. **Appreciating the epistemology of science**
    a. Ability to understand how the history of scientific thought has shaped the development of scientific principles
    b. Ability to understand how scientific principles are applied to interpret new data
    c. Ability to understand the limitations of methodologies as they affect the interpretation of data
    d. Ability to understand the biological basis of scientific debate and the role of probability (certainty and uncertainty) in science
    e. Ability to appreciate and participate in a scientific community as a forum for scientific thinking, research, debate and progress

B. FUNDAMENTAL BIOLOGICAL CONCEPTS

Two themes rise above the five categories of fundamental biological concepts that we describe below and we highlight them here:

- *All of biology operates under constraints defined by our understanding of math, physics, and chemistry. It is therefore essential that Biology students have a strong foundational understanding of these fields – of both their concepts and their "ways of knowing".*
- *All of biology operates under the constraints of the mechanisms of evolution. It is therefore essential that Biology students have a strong foundational understanding of the theories, evidence, and mechanism of evolution.*

6. Organization of molecular, cellular, organismal and ecological systems

a. Understand what are the building blocks of biological systems
b. Understand the relationship between structure and function
c. Understand the hierarchy of biological organizations (e.g., individual, population; community ecosystem; atoms, molecules, cell, tissue, organ, systems)
d. Understand behavior of molecules, cells, organisms

7. The origins and evolution of biological systems

a. Understand evidence for evolution and natural selection
b. Understand how phylogenetic concepts are used to formulate and test hypotheses
c. Understand the mechanisms of evolution and their actions at the molecular, developmental and phenotypic levels
d. Understand variation and evolution

8. The flow of biological information

a. Understand the central dogma of information flow
b. Understand how genetic information is exchanged between cells
c. Understand the epigenetic modulation of information systems
d. Understand how signals are used as biological information

9. The flow of energy and matter in biological systems

a. Understand metabolic pathways
b. Understand the mechanisms of harvesting energy from organic and inorganic sources
c. Understand food webs, biogeochemical cycles (e.g., nitrogen and carbon cycles)

10. Interdependence and interactions within biological systems and their emergent properties

a. Understand the interactions between genetic and environmental factors leading to emergent properties of phenotypes
b. Understand the plasticity of biological systems (e.g., learning, behavior)
c. Understand the intercellular and inter-organismal communications and interactions
d. Understand how population and species interactions lead to the organization of ecological communities