

# Guidelines for Introductory Life Sciences/Biology CALS Distribution

*Approved and voted into effect by CALS Curriculum Committee on 12/16/2022*

## Minimum requirements for all Introductory Life Sciences/Biology distribution courses in CALS:

1. No prerequisites or requirements of science comprehension beyond NYSED High School Performance Expectations (listed below)
2. Focuses at least 60% of the course on one or more V&C Core Concept (listed below)
3. Includes an evolutionary component
4. Includes the ability to apply the process of science (V&C Core Competency 1) and at least one additional V&C Core Competency (listed below) in learning outcomes
5. Includes a significant student-centered teaching component (e.g. laboratory sections, problem-solving or case study activities, research projects, collaborative activities. Click [here](#) for more information)

\*Additionally, course proposals submitted for this distribution will require instructor to indicate if course is suitable for non-life science students. Determination of how these courses will count toward major requirements will remain at the discretion of the department.

## **Background**

National Science Foundation (NSF), in partnership with the Howard Hughes Medical Institute (HHMI), the National Institutes of Health (NIH) and the American Association for the Advancement of Science (AAAS), launched a national initiative in 2007 called '[Vision and Change in Undergraduate Biology](#)'. This initiative was designed to distill a set of state-of-the-art approaches to undergraduate biology education from decades of conversations, reports and calls for change.

The [final report](#) identifies **core concepts and competencies** and emphasizes the importance of developing **student-centered teaching approaches** that actively engage students in interactive, inquiry-driven, cooperative and collaborative activities. The report emphasizes that these approaches should:

- Develop lifelong science learning competencies.
- Relate abstract concepts in biology to real-world examples on a regular basis, and make biology content relevant by presenting problems in a real-life context.
- Stimulate the curiosity students have for learning about the natural world.
- Demonstrate both the passion scientists have for their discipline and their delight in sharing their understanding of the world with students.

## V&C Core Concepts

1. **Evolution:** The diversity of life evolved over time by processes of mutation, selection and genetic change
2. **Structure and Function:** Basic units of structure define the function of all living things
3. **Information Flow, Exchange and Storage:** The growth and behavior of organisms are activated through the expression of genetic information in context
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 thermodynamic
5. **Systems:** Living systems are interconnected and interacting

## V&C Core Competencies

1. **Ability to Apply the Process of Science:** Biology is evidence based and grounded in the formal practices of observation, experimentation, and hypothesis testing.
2. **Ability to Use Quantitative Reasoning:** Biology relies on applications of quantitative analysis and mathematical reasoning.
3. **Ability to Use Modeling and Simulation:** Biology focuses on the study of complex systems
4. **Ability to Tap into the Interdisciplinary Nature of Science:** Biology is an interdisciplinary science
5. **Ability to Communicate and Collaborate with Other Disciplines:** Biology is a collaborative scientific discipline.
6. **Ability to Understand the Relationship Between Science and Society:** Biology is conducted in a societal context.

## **NYSED High School Student Performance Expectations**

From [High School Course Maps for Life Science: Biology](#) and [High School Science Learning Standards](#)

Students who demonstrate understanding can:

### Structure and Function

- HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
- HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis

### Inheritance and Variation of Traits

- HS-LS1-4. Use a model to illustrate cellular division (mitosis) and differentiation.
- HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, (3) mutations caused by environmental factors and/or (4) genetic engineering.
- HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- HS-LS1-8. Use models to illustrate how human reproduction and development maintains continuity of life.

### Matter and Energy in Organisms and Ecosystems

- HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements such as nitrogen, sulfur, and phosphorus to form amino acids and other carbon-based molecules.
- HS-LS1-7. Use a model to illustrate that aerobic cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
- HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in ecosystems.
- HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- HS-LS2-5. Develop a model to illustrate the role of various processes in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

### Interdependent Relationships in Ecosystems

- HS-LS2-1. Use mathematical and/or computational representations to support explanations of biotic and abiotic factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

#### Natural Selection and Evolution

- HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
- HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
- HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

#### Chemical Reactions

- HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
- HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
- HS-PS1-5. Apply scientific principles and evidence to explain how the rate of a physical or chemical change is affected when conditions are varied.
- HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.