BIOLOGY II: COURSE OVERVIEW

The academic standards for high school Biology II are built on the foundation provided by Biology I (a prerequisite course) and are research-based, supported by the National Research Council's *Framework for K-12 Science Education*. Biology II provides students with the opportunity to focus on a particular aspect of life science in more detail while continuing to provide knowledge that is rooted in the same crosscutting concepts and practices utilized throughout all of the sciences. The academic standards for Biology II focus on organism classification and evolution with in depth analysis of plants and animals.

The major disciplinary core ideas utilized for Biology II include:

<table>
<tr><th colspan="2">Biology II (BIO2)</th></tr>
<tr><td>Life Sciences (LS)</td><td>Engineering, Technology, and Applications of Science (ETS)</td></tr>
<tr><td>From Molecules to Organisms: Structure and Process</td><td>Engineering Design</td></tr>
<tr><td>Ecosystems: Interactions, Energy, and Dynamics</td><td>Links Among Engineering, Technology, Science, and Society (ETS)
• Microscope
• Biotechnology support of the theory of evolution
Engineering and technology applications using living organisms</td></tr>
<tr><td>Heredity: Inheritance and Variation of Traits</td><td rowspan="2">Applications of Science</td></tr>
<tr><td>Biological Change: Unity and Diversity
• History and classification of life
• Plant structure, function, classification, and evolution
• Animal structure, function, classification, and evolution
• Animal social interactions and group behaviors</td></tr>
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Although science is a body of knowledge consisting of theories that explain data, science is also a set of practices that use analysis and argumentation to establish, extend, and refine knowledge. The science and engineering practices are used as a means to learn science by doing science. These practices are not intended to be a sequence of steps nor are they intended to be taught as a separate, introductory unit for the course. By combining content knowledge with skill, students discover how scientific knowledge is acquired and applied to solve problems or advance scientific knowledge further. In addition, there are seven crosscutting concepts that are fundamental to the nature of science and thus stretch across all science disciplines. The Biology II standards have been constructed by explicitly integrating practices and crosscutting concepts, iteratively and in combination, within each core idea to provide students with a well-rounded education in science.

Special attention has been given to mathematics and literacy through the use of the science and engineering practices described above. Students are required to use mathematics in the collection, presentation, and analysis of data, and computational thinking is employed for complex data sets and simulation models. Students are also required to obtain information from reliable sources, evaluate information, and construct evidenced-based arguments. The importance of STEM integration has been stressed by including a set of stand-alone disciplinary core ideas under Engineering, Technology, and Applications of Science, as well as being integrated throughout other major disciplinary core ideas.

Tennessee's state mathematics standards are integrated within the Biology II standards, specifically in the collection and analysis of quantitative data in designed investigations and less specifically in standards throughout that incorporate data measurements and/or analysis. Literacy standards are integrated into the Biology II standards in the development of arguments, collection and evaluation of information, and through the use of graphs as informational texts. STEM applications are incorporated throughout the life science core ideas presented in Biology II, when data collected with technology is used to support and explain observations.

The skills and content knowledge emphasized in the following Biology II standards are intended to provide a deep appreciation of the variety of life forms that have previously existed and currently exist on Earth. Consequently, a more integrated approach to the LS4 disciplinary core idea outlined throughout this document has been implemented, with standards LS4.1-11 focusing on bacteria, archaea, fungi, and protists, standards LS4.12-19 on plants, and LS4.20-28 on animals. In addition, the standards should provide opportunities to practice science, promoting the development of critical consumers of scientific information.

BIOLOGY II: ACADEMIC STANDARDS

BIO2.LS2: Ecosystems: Interactions, Energy, and Dynamics

1) Plan and carry out an ethology investigation of a simple organism. Gather, analyze, and present data in tabular and graphical formats. Draw conclusions based on data and communicate findings.

2) Compare innate versus learned behavior. Construct an argument from evidence that shows the value of both types of behavior and their importance to species survival.

3) Obtain information and construct an explanation to support or oppose an adaptive advantage of social behaviors.

BIO2.LS4: Biological Change: Unity and Diversity

1) Use models of viruses, prokaryotes, and eukaryotes to ask questions about characteristics of living things and analyze theories regarding the origin of life on Earth. Construct an argument from evidence supporting the idea that eukaryotes could not exist on the planet if not for prokaryotes.

2) Using information based on the geologic time scale and history of life on Earth, look for patterns in changes in organisms over time and explain how these patterns support the theory of evolution.

3) Use molecular data to construct cladograms depicting phylogenetic relationships between major groups of organisms.

4) Trace changes in classification schemes over time, explaining these changes considering new findings and new interpretations of existing data.

5) Construct an argument from evidence supporting the three domain classification system or opposing the system with a suggested alternative system.

6) Obtain information and compare features of Bacteria and Archaea. Ask questions about the evolution of each group.

7) Using models, compare how the following processes occur in major groups of bacteria: gas exchange; nutrient distribution; energy acquisition and use; response to internal and external stimuli; and, reproduction.

8) Construct an explanation for the evolution of eukaryotes and multicellularity based on evidence supporting the theory of endosymbiosis. Consider examples of extant organisms (viruses, bacteria, and protists) that invade host cells.

9) Using models, compare how the following processes occur in major groups of protists: gas exchange; nutrient distribution; energy acquisition and use; response to internal and external stimuli; and, reproduction.

10) Evaluate information regarding the diversity of protists. Use this information to analyze evolutionary relationships among protists, fungi, plants, and animals.

11) Using models, compare how the following processes occur in major groups of fungi: gas exchange; nutrient distribution; energy acquisition and use; response to internal and external stimuli; and, reproduction.

12) Analyze evolutionary relationships among algae and major groups of plants. In this analysis, consider adaptations necessary for survival in terrestrial habitats.

13) Interpret data supporting current plant classification schemes. Use a dichotomous key to identify plants based on variations in characteristics.

14) Obtain information and ask questions about the advantages and disadvantages of the basic plant life cycle (alternation of generations). Compare variations in this life cycle among major groups of plants.

15) Use a model angiosperm to differentiate plant organs and the tissues from which they are made. Use the model to explain how the plant structures: provide support; regulate gas exchange; obtain and use energy; and, process and distribute nutrients.

16) Design and carry out an investigation examining the function of plant hormones.

17) Develop a model explaining plant tropisms at different scales (cell, tissue, organ, system). Use the model to predict how plants will respond in various environmental conditions.

18) Create an argument from evidence regarding the importance of plant relationships including symbiosis and co-evolutionary relationships (examples: mycorrhizae, Rhizobium, pollination, etc.).

19) Investigate the role of different plant types in ecosystem building and maintenance (examples: soil formation, inhibition of erosion, oxygen production, carbon sequestration, habitats).

20) Create a model to distinguish animal germ layers (endoderm, mesoderm, and ectoderm) and resulting tissue types. Use the model to make predictions regarding phylogenetic relationships among groups of organisms with varying body plans.

21) Construct an argument for the importance of embryological development in understanding relatedness (evolutionary relationships). As part of the argument, compare models of embryological development of protostomes and deuterostomes.

22) Observe examples of organisms from major animal phyla in order to describe the diverse structures associated with the following functions: gas exchange; energy acquisition; nutrient processing and distribution; environmental responses; and reproduction.

23) Design and carry out an investigation examining how major body systems interact to maintain homeostasis of nutrient, energy, water, waste, and/or temperature balance.

24) Obtain and communicate information on how the nervous and endocrine systems in a model vertebrate organism coordinate body functions such as: growth and development; stimuli response and information transmission; and, the maintenance of homeostasis.

25) Create a model demonstrating how the immune system functions in monitoring of and responding to bacterial and viral infectious diseases.

26) Gather and analyze data on ectothermic and endothermic organisms and argue the advantages and disadvantages these organisms possess, considering various environments in which they live and various strategies for survival.

27) Model several reproductive strategies used by example organisms and compare them to explain how each differentially accomplishes reproductive success. Collect information in support of the argument that rapidly reproducing species that produce more young are more resilient.

28) Evaluate scientific data collected from multiple sources to trace animal evolution.

BIO2.ETS2: Links Among Engineering, Technology, Science, and Society

1) Research the development of the microscope and advances in microscopy technology for the discovery and ongoing understanding of microorganisms.

2) Construct an explanation for how classification schemes have changed based on new evidence gained due to advances in biotechnology.

3) Create a timeline depicting how humans have employed engineering and technology to maximize use of microorganisms, plants, and animals for various purposes. Choose one specific example and construct an argument supporting or opposing the use of engineering or technology in this instance.