Tennessee Science Curriculum Framework

Biology II

Course Description

Biology II is a laboratory course that engages students in an in-depth study of biological principles. This course emphasizes internal and external structures and their functions, the environmental interactions of organisms, processes of living things, mechanisms that maintain homeostasis, biodiversity, and changes in life forms over time. Students explore all of the major biological concepts through an inquiry approach.

Biology II students investigate:

- Inquiry
- Technology and Engineering
- Cells
- Interdependence
- Flow of Matter and Energy
- Heredity
- Biodiversity and Change
- Comparative Anatomy and Physiology
- Botany

Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?

Course Level Expectations

CLE 3216.Inq.1 Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted.

CLE 3216.Inq.2 Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.

CLE 3216.Inq.3 Use appropriate tools and technology to collect precise and accurate data.

CLE 3216.Inq.4 Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.

CLE 3216.Inq.5 Compare experimental evidence and conclusions with those drawn by others about the same testable question.
CLE 3216.Inq.6 Communicate and defend scientific findings.

Checks for Understanding (Formative/Summative Assessment)

- ✓3216.Inq.1 Trace the historical development of a scientific principle or theory, such as cell theory, evolution, or DNA structure.
- ✓3216.Inq.2 Conduct scientific investigations that include testable questions, verifiable hypotheses, and appropriate variables to explore new phenomena or verify the experimental results of others.
- ✓3216.Inq.3 Analyze the components of a properly designed scientific investigation.
- ✓3216.Inq.4 Select appropriate tools and technology to collect precise and accurate quantitative and qualitative data.
- ✓3216.Inq.5 Determine if data supports or contradicts a hypothesis or conclusion.
- ✓3216.Inq.6 Recognize, analyze, and evaluate alternative explanations for the same set of observations.
- ✓3216.Inq.7 Evaluate the accuracy and precision of data.
- ✓3216.Inq.8 Defend a conclusion based on scientific evidence.
- ✓3216.Inq.9 Determine why a conclusion is free of bias.
- ✓3216.Inq.10 Analyze experimental results and identify possible sources of experimental error.
- ✓3216.Inq.11 Formulate and revise scientific explanations and models using logic and evidence.
- ✓3216.Inq.12 Compare conclusions that offer different, but acceptable explanations for the same set of experimental data.

Embedded Technology and Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Course Level Expectations

CLE 3216.T/E.1 Explore the impact of technology on social, political, and economic systems.
CLE 3216.T/E.2 Differentiate among elements of the engineering design cycle: design constraints, model building, testing, evaluating, modifying, and retesting.
CLE 3216.T/E.3 Explain the relationship between the properties of a material and the use of the material in the application of a technology.
CLE 3216.T/E.4 Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.

Checks for Understanding (Formative/Summative Assessment)

- ✓3216.T/E.1 Distinguish among tools and procedures best suited to conduct a specified scientific inquiry.
- ✓3216.T/E.2 Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.
- ✓3216.T/E.3 Evaluate a protocol to determine the degree to which an engineering design process was successfully applied.
- ✓3216.T/E.4 Explore how the unintended consequences of new technologies can impact human and non-human communities.
- ✓3216.T/E.5 Evaluate the overall benefit to cost ratio of a new technology.
- ✓3216.T/E.6 Present research on current bioengineering technologies that advance health and contribute to improvements in our daily lives.
- ✓3216.T/E.7 Design a series of multi-view drawings that can be used by other students to construct an adaptive design and test its effectiveness.

Embedded Mathematics

Conceptual Strand

Science applies mathematics to investigate questions, solve problems, and communicate findings.

Guiding Question

What mathematical skills and understandings are needed to successfully investigate biological topics?

Course Level Expectations

CLE 3216.Math.1 Understand the mathematical principles associated with the science of biology.

CLE 3216.Math.2 Utilize appropriate mathematical equations and processes to understand biological concepts.

Checks for Understanding (Formative/Summative Assessment)

- ✓3216.Math.1 Choose, construct, and analyze appropriate graphical representations for a data set.
- ✓3216.Math.2 Analyze graphs to interpret biological events.
- ✓3216.Math.3 Make decisions about units, scales, and measurement tools that are appropriate for problem situations involving measurement.
- ✓3216.Math.4 Select and apply an appropriate method to evaluate the reasonableness of results.
- ✓3216.Math.5 Apply and interpret rates of change from graphical and numerical data.
- ✓3216.Math.6 Apply geometric properties, formulas, and relationships to interpret biological phenomena.
- ✓3216.Math.7 Use length, area, and volume to estimate and explain real-world problems.
- ✓3216.Math.8 Make predictions from a linear data set using a line of best fit.
- ✓3216.Math.9 Interpret a set of data using the appropriate measure of central tendency.

Standard 1 – Cells

Conceptual Strand 1

All living things are made of cells that perform functions necessary for life.

Guiding Question 1

How are cells organized to carry on the processes of life?

Course Level Expectations

CLE 3216.1.1 Compare the characteristics of prokaryotic and eukaryotic cells.
CLE 3216.1.2 Describe how fundamental life processes depend on chemical reactions that occur in specialized parts of the cell.
CLE 3216.1.3 Explain how materials move into and out of cells.
CLE 3216.1.4 Describe the enzyme-substrate relationship.
CLE 3216.1.5 Investigate how proteins regulate the internal environment of a cell through communication and transport.
CLE 3216.1.6 Describe the relationship between viruses and their host cells.

Checks for Understanding (Formative/Summative Assessment)

✓3216.1.1 Compare the organization and function of prokaryotic and eukaryotic cells.
✓3216.1.2 Conduct an experiment or simulation to demonstrate the movement of molecules through diffusion, facilitated diffusion, and active transport.
✓3216.1.3 Describe the composition and function of enzymes.
✓3216.1.4 Analyze the rate of reactions in which variables such as temperature, pH, and substrate and enzyme concentration are manipulated.
✓3216.1.5 Develop a flow chart that tracks a protein molecule from transcription through export from the cell.
✓3216.1.6 Describe the role of the ribosomes, endoplasmic reticulum, and Golgi apparatus in the production and packaging of proteins.
✓3216.1.7 Describe how carbohydrates, proteins, lipids, and nucleic acids function in the cell.
✓3216.1.8 Illustrate the interactions between a virus and a host cell.

Standard 2 – Interdependence

Conceptual Strand 2

All life is interdependent and interacts with the environment.

Guiding Question 2

How do living things interact with one another and with the non-living elements of their environment?

Course Level Expectations

CLE 3216.2.1 Describe how the stability of an ecosystem is maintained.
CLE 3216.2.2 Investigate the major factors that influence population size and age distribution.

CLE 3216.2.3 Describe the varying degrees to which individual organisms are able to accommodate changes in the environment.

CLE 3216.2.4 Distinguish between the accommodation of individual organisms and the adaptation of a population to environmental change.

Checks for Understanding (Formative/Summative Assessment)

✓3216.2.1 Analyze the ecological impact of a change in climate, human activity, introduction of non-native species, and changes in population size over time.

✓3216.2.2 Investigate how fluctuations in population size in an ecosystem are determined by the relative rates of birth, death, immigration, and emigration.

✓3216.2.3 Investigate how human changes to the environment have led populations to adapt, migrate, or become extinct.

✓3216.2.4 Contrast accommodations of individual organisms with the adaptation of a species.

Standard 3 – Flow of Matter and Energy

Conceptual Strand 3

Matter cycles and energy flows through the biosphere.

Guiding Question 3

What are the scientific explanations for how matter cycles and energy flows through the biosphere?

Course Level Expectations

CLE 3216.3.1 Describe the role of biotic and abiotic factors in the cycling of matter in the ecosystem.

CLE 3216.3.2 Explain how sunlight is captured by plant cells and converted into usable energy.

CLE 3216.3.3 Describe how mitochondria make stored chemical energy available to cells.

CLE 3216.3.4 Examine how macromolecules are synthesized from simple precursor molecules.

CLE 3216.3.5 Analyze the role of ATP in the storage and release of cellular energy.

Checks for Understanding (Formative/Summative Assessment)

✓3216.3.1 Describe how water, carbon, oxygen, and nitrogen cycle between the biotic and abiotic elements of the environment.

✓3216.3.2 Calculate the amount of energy transfer through an ecosystem.

✓3216.3.3 Design an experiment to separate plant leaf pigments.

✓3216.3.4 Develop a concept map or flow chart to compare the sequence of molecular events during photosynthesis and cellular respiration.

✓3216.3.5 Sequence the steps involved in sugar production during photosynthesis.

✓3216.3.6 Trace the breakdown of sugar molecules during cellular respiration.

✓3216.3.7 Compare the amount of ATP produced during aerobic and anaerobic respiration.

✓3216.3.8 Build models of macromolecules from simple precursors.

Standard 4 – Heredity

Conceptual Strand 4

Organisms reproduce and transmit hereditary information.

Guiding Question 4

What are the principal mechanisms by which living things reproduce and transmit hereditary information from parents to offspring?

Course Level Expectations

CLE 3216.4.1 Describe how mutation and sexual reproduction contribute to the amount of genetic variation in a population.

CLE 3216.4.2 Describe the relationship between phenotype and genotype.

CLE 3216.4.3 Predict the probable outcome of genetic crosses based on Mendel's laws of segregation and independent assortment.

CLE 3216.4.4 Describe the relationship among genes, the DNA code, production of protein molecules, and the characteristics of an organism.

CLE 3216.4.5 Explain how the different shapes and properties of proteins are determined by the type, number, and sequence of amino acids.

CLE 3216.4.6 Explain how the genetic makeup of cells can be engineered.

Checks for Understanding (Formative/Summative Assessment)

✓3216.4.1 Illustrate the movement of chromosomes and other cellular organelles involved in meiosis.

✓3216.4.2 Provide a detailed explanation of how meiosis and fertilization result in new genetic combinations.

✓3216.4.3 Compare the expected outcome with the actual results of a cross in an organism such as a fruit fly or fast plant.

✓3216.4.4 Develop a model to illustrate the stages of protein synthesis.

✓3216.4.5 Apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.

✓3216.4.6 Recognize how various types of mutations affect gene expression and the sequence of amino acids in the encoded protein.

✓3216.4.7 Distinguish among the characteristics of various structural levels found in protein molecules.

✓3216.4.8 Describe the formation of recombinant DNA molecules.

✓3216.4.9 Recognize that genetic engineering can be applied to develop novel biomedical and agricultural products.

Standard 5 – Biodiversity and Change

Conceptual Strand 5

A rich variety and complexity of organisms have developed in response to changes in the environment.

Guiding Question 5

How does natural selection explain how organisms have changed over time?

Course Level Expectations

CLE 3216.5.1 Identify factors that determine the frequency of an allele in the gene pool of a population.

CLE 3216.5.2 Determine how mutation, gene flow, and migration influence population structure.

Checks for Understanding (Formative/Summative Assessment)

✓3216.5.1 Predict how variation within a population affects the survival of a species.

✓3216.5.2 Recognize that natural selection acts on an organism's phenotype rather than its genotype.

✓3216.5.3 Describe how reproductive and geographic isolation affect speciation.

✓3216.5.4 Analyze population changes in terms of the Hardy-Weinberg principle.

✓3216.5.5 Explain how amount of biodiversity is affected by habitat alteration.

✓3216.5.6 Use fossil evidence, DNA structure, amino acid sequences, and other data sources to construct a cladogram that illustrates evolutionary relationships.

Standard 6 – Comparative Anatomy and Physiology

Conceptual Strand 6

All living organisms are both alike and different.

Guiding Question 6

In what ways are all living organisms similar and what makes a species unique?

Course Level Expectations

CLE 3216.6.1 Investigate the unity and the diversity among living things.

CLE 3216.6.2 Describe the events associated with reproduction from gamete production through birth.

CLE 3216.6.3 Compare organ systems of representative animal phyla that: regulate gas exchange, process and distribute nutrients, remove wastes, transmit chemical and electrical information, and respond to environmental stimuli.

Checks for Understanding (Formative/Summative Assessment)

✓3216.6.1 Describe how the activities of major body systems help to maintain homeostasis.

✓3216.6.2 Distinguish between various methods of sexual and asexual reproduction.

✓3216.6.3 Create a model that illustrates stages of embryological development.

- ✓3216.6.4 Develop a representation of the different germ layers and the tissue type into which they develop.
- ✓3216.6.5 Describe how the nervous and endocrine systems coordinate various body functions.
- ✓3216.6.6 Develop a multimedia product for an immune disorder or infectious disease to demonstrate the impact on the individual organism.
- ✓3216.6.7 Observe, model, manipulate, and/or dissect representative specimens of major animal groups.
- ✓3216.6.8 Compare and contrast the function of the major organ systems found in representative animal species.

Standard 7 – Botany

Conceptual Strand 7

Plants are essential for life to exist.

Guiding Question 7

What conditions are needed for plants to grow and reproduce?

Course Level Expectations

- CLE 3216.7.1 Describe different plant types plants based on their anatomy and physiology.
- CLE 3216.7.2 Investigate the relationship between form and function for the major plant structures.
- CLE 3216.7.3 Examine the anatomical and physiological differences between plants and their growth, reproduction, survival, and co-evolution.
- CLE 3216.7.4 Describe the difference between plants and fungi.
- CLE 3216.7.5 Investigate the impact of plants on humans.

Checks for Understanding (Formative/Summative Assessment)

- ✓3216.7.1 Describe the function of plant cellular organelles.
- ✓3216.7.2 Employ a dichotomous key to identify plants based on their structural characteristics.
- ✓3216.7.3 Distinguish between the following: vascular and nonvascular plants, spore and seed, gymnosperms and angiosperms, and monocots and dicots.
- ✓3216.7.4 Investigate the significance of structural and physiological adaptations of plants.
- ✓3216.7.5 Compare and contrast spore and seed production.
- ✓3216.7.6 Design an experiment to investigate the function of plant hormones.
- ✓3216.7.7 Prepare a presentation about plants that are harmful or beneficial to humans.
- ✓3216.7.8 Describe co-evolution among various plant and animal species.