Tennessee Science Curriculum Framework

Biology I

Course Description

Biology I is a laboratory course that investigates the relationship between structure and function from molecules to organisms and systems, the interdependence and interactions of biotic and abiotic components of the environment, and mechanisms that maintain continuity and lead to changes over time. Students explore biological concepts through an inquiry approach.

Biology I students investigate:

- Inquiry
- Technology and Engineering
- Cells
- Interdependence
- Flow of Matter and Energy
- Heredity
- Biodiversity and Change

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 3210.Inq.1 Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted.

CLE 3210.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 3210.Inq.3 Use appropriate tools and technology to collect precise and accurate data.

CLE 3210.Inq.4 Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.

CLE 3210.Inq.5 Compare experimental evidence and conclusions with those drawn by others about the same testable question.

CLE 3210.Inq.6 Communicate and defend scientific findings.

Checks for Understanding (Formative/Summative Assessment)

- ✓**3210.Inq.1** Trace the historical development of a scientific principle or theory, such as cell theory, evolution, or DNA structure.
- ✓**3210.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.
- ✓**3210.Inq.3** Select appropriate tools and technology to collect precise and accurate quantitative and qualitative data.
- ✓**3210.Inq.4** Determine if data supports or contradicts a hypothesis or conclusion.
- ✓**3210.Inq.5** Compare or combine experimental evidence from two or more investigations.
- ✓**3210.Inq.6** Recognize, analyze, and evaluate alternative explanations for the same set of observations.
- ✓**3210.Inq.7** Analyze experimental results and identify possible sources of experimental error.
- ✓**3210.Inq.8** Formulate and revise scientific explanations and models using logic and evidence.

State Performance Indicators

SPI 3210 Inq.1 Select a description or scenario that reevaluates and/or extends a scientific finding.
SPI 3210 Inq.2 Analyze the components of a properly designed scientific investigation.
SPI 3210 Inq.3 Determine appropriate tools to gather precise and accurate data.
SPI 3210 Inq.4 Evaluate the accuracy and precision of data.
SPI 3210 Inq.5 Defend a conclusion based on scientific evidence.
SPI 3210 Inq.6 Determine why a conclusion is free of bias.
SPI 3210 Inq.7 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 3210.T/E.1 Explore the impact of technology on social, political, and economic systems.
CLE 3210.T/E.2 Differentiate among elements of the engineering design cycle: design constraints, model building, testing, evaluating, modifying, and retesting.
CLE 3210.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 3210.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)

- ✓**3210.T/E.1** Select appropriate tools to conduct a scientific inquiry.
- ✓**3210.T/E.2** Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.
- ✓**3210.T/E.3** Explore how the unintended consequences of new technologies can impact human and non-human communities.
- ✓**3210.T/E.4** Present research on current bioengineering technologies that advance health and contribute to improvements in our daily lives.
- ✓**3210.T/E.5** Design a series of multi-view drawings that can be used by other students to construct an adaptive design and test its effectiveness.

State Performance Indicators

SPI 3210.T/E.1 Distinguish among tools and procedures best suited to conduct a specified scientific inquiry.

SPI 3210.T/E.2 Evaluate a protocol to determine the degree to which an engineering design process was successfully applied.

SPI 3210.T/E.3 Evaluate the overall benefit to cost ratio of a new technology.

SPI 3210.T/E.4 Use design principles to determine if a new technology will improve the quality of life for an intended audience.

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 3210.Math.1 Understand the mathematical principles associated with the science of biology.

CLE 3210.Math.2 Utilize appropriate mathematical equations and processes to understand biological concepts.

Checks for Understanding (Formative/Summative Assessment)

- ✓**3210.Math.1** Choose and construct appropriate graphical representations for a data set.
- ✓**3210.Math.2** Analyze graphs to interpret biological events.
- ✓**3210.Math.3** Make decisions about units, scales, and measurement tools that are appropriate for investigations involving measurement.
- ✓**3210.Math.4** Select and apply an appropriate method to evaluate the reasonableness of results.

✓**3210.Math.5** Apply and interpret rates of change from graphical and numerical data.
✓**3210.Math.6** Apply probabilistic reasoning to solve genetic problems.

State Performance Indicators

SPI 3210.Math.1 Interpret a graph that depicts a biological phenomenon.
SPI 3210.Math.2 Predict the outcome of a cross between parents of known genotype.

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 3210.1.1 Compare the structure and function of cellular organelles in both prokaryotic and eukaryotic cells.
CLE 3210.1.2 Distinguish among the structure and function of the four major organic macromolecules found in living things.
CLE 3210.1.3 Describe how enzymes regulate chemical reactions in the body.
CLE 3210.1.4 Describe the processes of cell growth and reproduction**.**
CLE 3210.1.5 Compare different models to explain the movement of materials into and out of cells.

Checks for Understanding (Formative/Summative Assessment)

✓**3210.1.1** Investigate cells using a compound microscope.
✓**3210.1.2** Construct a model of a prokaryotic or eukaryotic cell.
✓**3210.1.3** Design a graphic organizer that compares proteins, carbohydrates, lipids, and nucleic acids.
✓**3210.1.4** Conduct tests to detect the presence of proteins, carbohydrates, and lipids.
✓**3210.1.5** Design a model that illustrates enzyme function.
✓**3210.1.6** Demonstrate the movement of chromosomes during mitosis in plant and animal cells.
✓**3210.1.7** Design and conduct an experiment to investigate the effect of various solute concentrations on water movement in cells.
✓**3210.1.8** Analyze experimental data to distinguish between active and passive transport.

State Performance Indicators

SPI 3210.1.1 Identify the cellular organelles associated with major cell processes**.**
SPI 3210.1.2 Distinguish between prokaryotic and eukaryotic cells.
SPI 3210.1.3 Distinguish among proteins, carbohydrates, lipids, and nucleic acids.
SPI 3210.1.4 Identify positive tests for carbohydrates, lipids, and proteins.
SPI 3210.1.5 Identify how enzymes control chemical reactions in the body.
SPI 3210.1.6 Determine the relationship between cell growth and cell reproduction.

SPI 3210.1.7 Predict the movement of water and other molecules across selectively permeable membranes.
SPI 3210.1.8 Compare and contrast active and passive transport.

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 3210.2.1 Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms.
CLE 3210.2.2 Analyze and interpret population data, graphs, or diagrams.
CLE 3210.2.3 Predict how global climate change, human activity, geologic events, and the introduction of non-native species impact an ecosystem.
CLE 3210.2.4 Describe the sequence of events associated with biological succession.

Checks for Understanding (Formative/Summative Assessment)

✓**3210.2.1** Analyze human population distribution graphs to predict the impact on global resources, society, and the economy.
✓**3210.2.2** Construct and maintain a model of an ecosystem.
✓**3210.2.3** Monitor and evaluate changes in a yeast population.
✓**3210.2.4** Investigate an outdoor habitat to identify the abiotic and biotic factors, plant and animal populations, producers, consumers, and decomposers.
✓**3210.2.5** Conduct research on how human influences have changed an ecosystem and communicate findings through written or oral presentations.
✓**3210.2.6** Describe a sequence of events that illustrates biological succession.

State Performance Indicators

SPI 3210.2.1 Predict how population changes of organisms at different trophic levels affect an ecosystem.
SPI 3210.2.2 Interpret the relationship between environmental factors and fluctuations in population size.
SPI 3210.2.3 Determine how the carrying capacity of an ecosystem is affected by interactions among organisms.
SPI 3210.2.4 Predict how various types of human activities affect the environment.
SPI 3210.2.5 Make inferences about how a specific environmental change can affect the amount of biodiversity.
SPI 3210.2.6 Predict how a specific environmental change may lead to the extinction of a particular species.
SPI 3210.2.7 Analyze factors responsible for the changes associated with biological succession.

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 3210.3.1 Analyze energy flow through an ecosystem.
CLE 3210.3.2 Distinguish between aerobic and anaerobic respiration.
CLE 3210.3.3 Investigate the relationship between the processes of photosynthesis and cellular respiration.
CLE 3210.3.4 Describe the events which occur during the major biogeochemical cycles.

Check for Understanding (Formative/Summative Assessment)

✓**3210.3.1** Track energy flow through an ecosystem.
✓**3210.3.2** Construct a concept map to differentiate between aerobic and anaerobic respiration.
✓**3210.3.3** Conduct experiments to investigate photosynthesis and cellular respiration.
✓**3210.3.4** Investigate the process of fermentation.
✓**3210.3.5** Construct models of the carbon, oxygen, nitrogen, phosphorous, and water cycles.

State Performance Indicators

SPI 3210.3.1 Interpret a diagram that illustrates energy flow in an ecosystem.
SPI 3210.3.2 Distinguish between aerobic and anaerobic respiration.
SPI 3210.3.3 Compare and contrast photosynthesis and cellular respiration in terms of energy transformation.
SPI 3210.3.4 Predict how changes in a biogeochemical cycle can affect an ecosystem.

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 3210.4.1 Investigate how genetic information is encoded in nucleic acids.
CLE 3210.4.2 Describe the relationships among genes, chromosomes, proteins, and hereditary traits.
CLE 3210.4.3 Predict the outcome of monohybrid and dihybrid crosses.

CLE 3210.4.4 Compare different modes of inheritance: sex linkage, co-dominance, incomplete dominance, multiple alleles, and polygenic traits.
CLE 3210.4.5 Recognize how meiosis and sexual reproduction contribute to genetic variation in a population.
CLE 3210.4.6 Describe the connection between mutations and human genetic disorders.
CLE 3210.4.7 Assess the scientific and ethical ramifications of emerging genetic technologies.

Checks for Understanding (Formative/Summative Assessment)

✓**3210.4.1** Use models of DNA, RNA, and amino acids to explain replication and protein synthesis.
✓**3210.4.2** Complete and interpret genetic problems that illustrate sex linkage, co-dominance, incomplete dominance, multiple alleles, and polygenic inheritance.
✓**3210.4.3** Apply data to complete and interpret a genetic pedigree.
✓**3210.4.4** Describe how the process of meiosis controls the number of chromosomes in a gamete.
✓**3210.4.5** Associate gene mutation with changes in a DNA molecule.
✓**3210.4.6** Design an informational brochure to describe a human genetic disorder.
✓**3210.4.7** Conduct research to explore the scientific and ethical issues associated with emerging gene technologies.

State Performance Indicators

SPI 3210.4.1 Identify the structure and function of DNA.
SPI 3210.4.2 Associate the process of DNA replication with its biological significance.
SPI 3210.4.3 Recognize the interactions between DNA and RNA during protein synthesis.
SPI 3210.4.4 Determine the probability of a particular trait in an offspring based on the genotype of the parents and the particular mode of inheritance.
SPI 3210.4.5 Apply pedigree data to interpret various modes of genetic inheritance.
SPI 3210.4.6 Describe how meiosis is involved in the production of egg and sperm cells.
SPI 3210.4.7 Describe how meiosis and sexual reproduction contribute to genetic variation in a population.
SPI 3210.4.8 Determine the relationship between mutations and human genetic disorders.
SPI 3210.4.9 Evaluate the scientific and ethical issues associated with gene technologies: genetic engineering, cloning, transgenic organism production, stem cell research, and DNA fingerprinting.

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 3210.5.1 Associate structural, functional, and behavioral adaptations with the ability of organisms to survive under various environmental conditions.
CLE 3210.5.2 Analyze the relationship between form and function in living things.
CLE 3210.5.3 Explain how genetic variation in a population and changing environmental conditions are associated with adaptation and the emergence of new species.
CLE 3210.5.4 Summarize the supporting evidence for the theory of evolution.
CLE 3210.5.5 Explain how evolution contributes to the amount of biodiversity.
CLE 3210.5.6 Explore the evolutionary basis of modern classification systems.

Checks for Understanding (Formative/Summative Assessment)

✓**3210.5.1** Create graphic organizers to demonstrate the relationship between form and function in representative organisms.
✓**3210.5.2** Explain how natural selection operates in the development of a new species.
✓**3210.5.3** Associate fossil data with biological and geological changes in the environment.
✓**3210.5.4** Analyze a variety of models, samples, or diagrams to demonstrate the genetic relatedness of organisms.
✓**3210.5.5** Use a dichotomous key to identify an unknown organism.

State Performance Indicators

SPI 3210.5.1 Compare and contrast the structural, functional, and behavioral adaptations of animals or plants found in different environments.
SPI 3210.5.2 Recognize the relationship between form and function in living things.
SPI 3210.5.3 Recognize the relationships among environmental change, genetic variation, natural selection, and the emergence of a new species.
SPI 3210.5.4 Describe the relationship between the amount of biodiversity and the ability of a population to adapt to a changing environment.
SPI 3210.5.5 Apply evidence from the fossil record, comparative anatomy, amino acid sequences, and DNA structure that support modern classification systems.
SPI 3210.5.6 Infer relatedness among different organisms using modern classification systems.