Teaching & Learning Standards

BIOLOGY

Cherokee County School District

Science

Biology
Science

Course Description

The Biology Cherokee Teaching & Learning Standards are designed to continue the student investigations of the life sciences that began in grades K-8 and provide students the necessary skills to be proficient in biology by focusing on the identification of patterns, processes, and relationships of living organisms. These standards include more abstract concepts such as the interdependence of organisms, the relationship of matter, energy, and organization in living systems, the behavior of organisms, and biological evolution. Students investigate biological concepts through experiences in laboratories and field work using the process of inquiry. Biology students start by developing an understanding of the cellular structure and the role these structures play in living cells. The students develop a fundamental understanding of the role of bio-macromolecules, their structure and function as related to life processes. The students then analyze how genetic information is passed to their offspring and how these mechanisms lead to variability and hence diversity of species. They use cladograms and phylogenetic trees to determine relationships among major groups of organisms. Biology students are able to recognize the central role the theory of evolution plays in explaining how the diversity observed within species has led to the diversity of life across species through a process of descent with adaptive modification.

Science standards integrate the three dimensions of **Science and Engineering Practices (SEPs)**, **Crosscutting Concepts (CCCs)**, and **Disciplinary Core Ideas (DCIs)** to provide a comprehensive framework that emphasizes active engagement, interdisciplinary connections, and core scientific principles. Together, they show how science standards engage *students* in obtaining, evaluating, and communicating information.

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Science and Engineering Practices are fundamental approaches that scientists and engineers use to investigate the natural world and solve practical problems. **Crosscutting Concepts** in science are overarching themes that bridge various disciplines, helping students and researchers see connections and deepen their understanding of the natural world. **Disciplinary Core Ideas** are fundamental concepts that students need to understand to develop a deep knowledge of science across various disciplines.

Thinking Like a Scientist

Thinking Like a Scientist standards represent scientific thinking skills that should be incorporated throughout the entire course.

Overarching Standard

TLS9-12: Refine scientific inquiry skills by designing and conducting investigations, applying scientific theories, critically evaluating scientific literature, and contributing to scientific discussions.

Supporting Standards for Student Mastery

TLS9-12.a: Use specialized scientific terms and concepts to analyze and explain scientific phenomena.

TLS9-12.b: Design and conduct independent experiments with multiple variables.

TLS9-12.c: Utilize advanced tools and statistical methods for data analysis.

TLS9-12.d: Communicate complex findings through reports and presentations.

Semester 1 (August – December)

Unit 1: Characteristics of Life (1 week)

In this introductory unit, students will explore the fundamental characteristics that define life. They will focus on understanding the organization and interaction of systems within both single-celled and multi-celled organisms, and construct arguments supported by evidence to compare and contrast viruses with living organisms.

Overarching Standard for Unit 1

B4: Obtain, evaluate, and communicate information to illustrate the organization of interacting systems within single-celled and multi-celled organisms.

B4.c: Construct an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms.

Milestones Achievement Level Descriptors for Unit 1

Beginning	Developing	Proficient	Distinguished
Can identify characteristics of viruses.	Can describe the characteristics of viruses and organisms.	Can construct an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms.	Can refine an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms.

Unit 2: Homeostasis (7 weeks)

In this unit, students will explore the relationships between structures and functions in living cells. Students will learn how various cell structures and organelles work together as a system to maintain homeostasis. They will relate the structure of macromolecules to their roles in cellular processes and investigate cellular transport mechanisms that help maintain homeostasis. This unit will also introduce the roles of photosynthesis and respiration in the cycling of matter and flow of energy within cells.

Overarching Standard for Unit 2

B1: Obtain, evaluate, and communicate information to analyze the nature of the relationships between structures and functions in living cells.

B1.a: Construct an explanation of how cell structures and organelles (including nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, Golgi, endoplasmic reticulum, vacuoles, ribosomes, and mitochondria) interact as a system to maintain homeostasis.

Supporting Standards for Student Mastery in Unit 2

B1.c: Construct arguments supported by evidence to relate the structure of macromolecules (carbohydrates, proteins, lipids, and nucleic acids) to their interactions in carrying out cellular processes.

(*Clarification statement*: The function of proteins as enzymes is limited to a conceptual understanding.)

B1.d: Plan and carry out investigations to determine the role of cellular transport (e.g., active, passive, and osmosis) in maintaining homeostasis.

B1.e: Ask questions to investigate and provide explanations about the roles of photosynthesis and respiration in the cycling of matter and flow of energy within the cell (e.g., single-celled alga).

(*Clarification statement*: Instruction should focus on understanding the inputs, outputs, and functions of photosynthesis and respiration and the functions of the major sub-processes of each including glycolysis, Krebs cycle, electron transport chain, light reactions, and Calvin cycle.)

B5.b: Develop and use models to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.

- Arranging components of a food web according to energy flow.
- Comparing the quantity of energy in the steps of an energy pyramid.
- Explaining the need for cycling of major biochemical elements (C, O, N, P, and H).

Milestones Achievement Level Descriptors for Unit 2

Beginning	Developing	Proficient	Distinguished
Can identify the structures and functions of cell parts.	Can explain that cell structures and organelles interact as a system to maintain homeostasis.	Can construct an explanation of how cell structures and organelles (i.e., nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, Golgi, endoplasmic reticulum, vacuoles, ribosomes, mitochondria) interact as a system to maintain homeostasis.	Can refine explanations of how cell structures and organelles interact as a system to maintain homeostasis.
Can relate the structure of macromolecules to their interactions in carrying out cellular processes.	Can select arguments that are supported by evidence to relate the structure of macromolecules to their interactions in carrying out cellular processes.	Can construct arguments supported by evidence to relate the structure of macromolecules (carbohydrates, proteins, lipids, and nucleic acids) to their interactions in carrying out cellular processes.	Can refine arguments supported by evidence to relate the structure of macromolecules to their interactions in carrying out cellular processes.
Can recognize that cellular transport is involved in maintaining homeostasis.	Can identify investigations used to determine the role of cellular transport in maintaining homeostasis.	Can plan and carry out investigations to determine the role of cellular transport (e.g., active, passive, and osmosis) in maintaining homeostasis.	Can refine investigations to determine the role of cellular transport in maintaining homeostasis.
Can recognize the roles of photosynthesis and respiration in the cycling of matter and flow of energy within the cell.	Can identify questions used to investigate and provide explanations about the roles of photosynthesis and respiration in the cycling of matter and flow of energy within the cell.	Can ask questions to investigate and provide explanations about the roles of photosynthesis and respiration in the cycling of matter and flow of energy within the cell (e.g., single celled alga).	Can analyze complex questions used to investigate and provide explanations about the roles of photosynthesis and respiration in the cycling of matter and flow of energy within the cell.
Can describe the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis & respiration.	Can identify models that can be used to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.	Can develop and use models to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.	Can refine models used to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.

Unit 3 – Gene to Protein (5-6 weeks)

In this unit, students will investigate how genetic information is expressed in cells and how genetic variations arise. Students will learn how DNA and RNA facilitate protein synthesis within a cell and they will construct arguments to support the claim that genetic variation can result from meiosis, replication errors, and environmental factors. Additionally, students will examine the ethical considerations of biotechnology, compare sexual and asexual reproduction, and analyze the characteristics of viruses and organisms.

Overarching Standards for Unit 3

B2: Obtain, evaluate, and communicate information to analyze how genetic information is expressed in cells.

B2.a: Construct an explanation of how the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation.

B2.b: Construct an argument based on evidence to support the claim that inheritable genetic variations may result from:

- new genetic combinations through meiosis (crossing over, nondisjunction);
- non-lethal errors occurring during replication (insertions, deletions, substitutions); and/or
- heritable mutations caused by environmental factors (radiation, chemicals and viruses).

Supporting Standards for Student Mastery in Unit 3

B1.a: Construct an explanation of how cell structures and organelles (including nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, Golgi, endoplasmic reticulum, vacuoles, ribosomes, and mitochondria) interact as a system to maintain homeostasis.

B1.b: Develop and use models to explain the role of cellular reproduction (including binary fission, mitosis, and meiosis) in maintaining genetic continuity.

B1.c: Construct arguments supported by evidence to relate the structure of macromolecules (carbohydrates, proteins, lipids, and nucleic acids) to their interactions in carrying out cellular processes.

(*Clarification statement*: The function of proteins as enzymes is limited to a conceptual understanding.)

B2.c: Ask questions to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture.

(*Clarification statement*: The element is intended to include advancements in technology relating to economics and society such as advancements may include Genetically Modified Organisms.)

B3.c: Construct an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.

B4.c: Construct an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms.

B6.a: Construct an explanation of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.

B6.c: Construct an argument using valid and reliable sources to support the claim that evidence from comparative morphology (analogous vs. homologous structures), embryology, biochemistry (protein sequence) and genetics support the theory that all living organisms are related by way of common descent.

Milestones Achievement Level Descriptors for Unit 3

Beginning	Developing	Proficient	Distinguished
Can identify features in the structures of DNA.	Can recognize that the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation.	Can construct an explanation of how the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation.	Can refine an explanation of how the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation.
Can recognize that genetic variations may result from new genetic combinations through meiosis.	Can provide examples of inheritable genetic variations that may result from new genetic combinations through meiosis.	Can construct an argument based on evidence to support the claim that inheritable genetic variations may result from new genetic combinations through meiosis (crossing over, nondisjunction); nonlethal errors occurring during replication (insertions, deletions, substitutions); and/or heritable mutations caused by environmental factors (radiation, chemicals, viruses).	Can analyze an argument based on evidence to support the claim that inheritable genetic variations may result from new genetic combinations through meiosis; non-lethal errors occurring during replication; and/or heritable mutations caused by environmental factors.

Can identify the structures and functions of cell parts.	Can explain that cell structures and organelles interact as a system to maintain homeostasis.	Can construct an explanation of how cell structures and organelles (i.e., nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, Golgi, endoplasmic reticulum, vacuoles, ribosomes, mitochondria) interact as a system to maintain homeostasis.	Can refine explanations of how cell structures and organelles interact as a system to maintain homeostasis.
Can recognize the role of cellular reproduction in maintaining genetic continuity.	Can recognize models used to explain the role of cellular reproduction in maintaining genetic continuity.	Can develop and use models to explain the role of cellular reproduction (i.e., binary fission, mitosis, and meiosis) in maintaining genetic continuity.	Can refine models to explain the role of cellular reproduction in maintaining genetic continuity.
Beginning	**Developing**	**Proficient**	**Distinguished**
Can relate the structure of macromolecules to their interactions in carrying out cellular processes.	Can select arguments that are supported by evidence to relate the structure of macromolecules to their interactions in carrying out cellular processes.	Can construct arguments supported by evidence to relate the structure of macromolecules (carbohydrates, proteins, lipids, and nucleic acids) to their interactions in carrying out cellular processes.	Can refine arguments supported by evidence to relate the structure of macromolecules to their interactions in carrying out cellular processes.
Can identify considerations related to the use of biotechnology in forensics, medicine, and agriculture.	Can gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture.	Can ask questions to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture.	Can refine questions used to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture.
Can communicate that there are advantages and disadvantages of sexual and asexual reproduction.	Can describe the advantages and disadvantages of sexual and asexual reproduction.	Can construct an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.	Can refine an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.

Can identify characteristics of viruses.	Can describe the characteristics of viruses and organisms.	Can construct an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms.	Can refine an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms.
Can recognize that new understandings of Earth's history have influenced our understanding of biology.	Can identify an explanation of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.	Can construct an explanation of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.	Can compare explanations of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.
Beginning	**Developing**	**Proficient**	**Distinguished**
Can recognize that evidence from comparative morphology, embryology, biochemistry, and genetics support the theory that all living organisms are related by way of common descent.	Can identify an argument used to support the claim that evidence from comparative morphology, embryology, biochemistry, and genetics support the theory that all living organisms are related by way of common descent.	Can construct an argument using valid and reliable sources to support the claim that evidence from comparative morphology (analogous vs. homologous structures), embryology, biochemistry (protein sequence) and genetics support the theory that all living organisms are related by way of common descent.	Can evaluate an argument using valid and reliable sources to support the claim that evidence from comparative morphology, embryology, biochemistry, and genetics support the theory that all living organisms are related by way of common descent.

Unit 4A – Patterns of Inheritance (3.5-4 weeks)

In this unit, students will explore how biological traits are passed on to successive generations by analyzing patterns of inheritance. They will use Punnett squares and probability rules to predict and explain inheritance patterns that follow Mendel's laws, as related to reproductive variability and biodiversity in populations. Students will learn about cellular reproduction, including mitosis and meiosis, in maintaining genetic continuity and explain changes in populations due to natural selection and genetic drift.

Overarching Standard for Unit 4A

B3: Obtain, evaluate, and communicate information to analyze how biological traits are passed on to successive generations.

B3.b: Use mathematical models to predict and explain patterns of inheritance.
(*Clarification statement*: Students should be able to use Punnett squares (monohybrid and dihybrid crosses) and/or rules of probability, to analyze the following inheritance patterns: dominance, codominance, incomplete dominance.)

B3.c: Construct an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.

Supporting Standards for Student Mastery in Unit 4A

B1.b: Develop and use models to explain the role of cellular reproduction (including binary fission, mitosis, and meiosis) in maintaining genetic continuity.

B2.b: Construct an argument based on evidence to support the claim that inheritable genetic variations may result from:

- new genetic combinations through meiosis (crossing over, nondisjunction);
- non-lethal errors occurring during replication (insertions, deletions, substitutions); and/or
- heritable mutations caused by environmental factors (radiation, chemicals, and viruses).

B3.a: Use Mendel's laws (segregation and independent assortment) to ask questions and define problems that explain the role of meiosis in reproductive variability.

B5.a: Plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.

(*Clarification statement*: Factors include population size, carrying capacity, response to limiting factors, and keystone species.)

B5.e: Construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).

B6.b: Analyze and interpret data to explain patterns in biodiversity that result from speciation.

B6.d: Develop and use mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.

(*Clarification statement*: Element is intended to focus on basic statistical and graphic analysis. Hardy Weinberg would be an optional application to address this element.)

Milestones Achievement Level Descriptors for Unit 4A

Beginning	Developing	Proficient	Distinguished
Can recognize examples of Mendel's laws.	Can describe Mendel's laws and recognize how they can be used to explain the role of meiosis in reproductive variability.	Can use Mendel's laws (segregation and independent assortment) to ask questions and define problems that explain the role of meiosis in reproductive variability.	Can use Mendel's laws to answer questions and solve problems related to the role of meiosis in reproductive variability.
Can identify general patterns of inheritance.	Can determine how models can be used to explain patterns of inheritance.	Can use mathematical models to predict and explain patterns of inheritance.	Can analyze mathematical models used to predict and explain patterns of inheritance.
Can communicate that there are advantages and disadvantages of sexual and asexual reproduction.	Can describe the advantages and disadvantages of sexual and asexual reproduction.	Can construct an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.	Can refine an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.
Can recognize the role of cellular reproduction in maintaining genetic continuity.	Can recognize models used to explain the role of cellular reproduction in maintaining genetic continuity.	Can develop and use models to explain the role of cellular reproduction (i.e., binary fission, mitosis, and meiosis) in maintaining genetic continuity.	Can refine models to explain the role of cellular reproduction in maintaining genetic continuity.
Can recognize that genetic variations may result from new genetic combinations through meiosis.	Can provide examples of inheritable genetic variations that may result from new genetic combinations through meiosis.	Can construct an argument based on evidence to support the claim that inheritable genetic variations may result from new genetic combinations through meiosis (crossing over, nondisjunction);	Can analyze an argument based on evidence to support the claim that inheritable genetic variations may result from new genetic combinations through meiosis;

		nonlethal errors occurring during replication (insertions, deletions, substitutions); and/or heritable mutations caused by environmental factors (radiation, chemicals, viruses).	non-lethal errors occurring during replication; and/or heritable mutations caused by environmental factors.
Beginning	**Developing**	**Proficient**	**Distinguished**
Can identify factors affecting biodiversity and populations in ecosystems.	Can analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.	Can plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.	Can refine investigations to support explanations about factors affecting biodiversity and populations in ecosystems.
Can recognize that an organism's ability to survive is affected by changing environmental limits.	Can identify explanations that predict an organism's ability to survive within changing environmental limits.	Can construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).	Can analyze explanations used to predict an organism's ability to survive within changing environmental limits.
Can recognize that undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.	Can identify mathematical models that can be used to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.	Can develop and use mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.	Can refine mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.

Semester 2 (January - May)

Unit 4B – Patterns of Inheritance: Non-Mendelian Inheritance (2.5-3 weeks)

In this unit, students will explore how biological traits are passed on to successive generations with a focus on non-Mendelian inheritance patterns. Students will use Punnett squares and probability rules to predict and explain inheritance patterns, such as codominance and incomplete dominance, alongside traditional Mendelian dominance. Emphasis will be placed on understanding how new genetic combinations and non-lethal mutations contribute to genetic variability and analyzing patterns in biodiversity resulting from speciation.

Overarching Standard for Unit 4B

B3: Obtain, evaluate, and communicate information to analyze how biological traits are passed on to successive generations.

B3.b: Use mathematical models to predict and explain patterns of inheritance.
(*Clarification statement*: Students should be able to use Punnett squares (monohybrid and dihybrid crosses) and/or rules of probability, to analyze the following inheritance patterns: dominance, codominance, incomplete dominance.)

B3.c: Construct an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.

Supporting Standards for Student Mastery in Unit 4B

B1.b: Develop and use models to explain the role of cellular reproduction (including binary fission, mitosis, and meiosis) in maintaining genetic continuity.

B2.b: Construct an argument based on evidence to support the claim that inheritable genetic variations may result from:

- new genetic combinations through meiosis (crossing over, nondisjunction);
- non-lethal errors occurring during replication (insertions, deletions, substitutions); and/or
- heritable mutations caused by environmental factors (radiation, chemicals, and viruses).

B3.a: Use Mendel's laws (segregation and independent assortment) to ask questions and define problems that explain the role of meiosis in reproductive variability.

B5.a: Plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.

(*Clarification statement*: Factors include population size, carrying capacity, response to limiting factors, and keystone species.)

B5.e: Construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).

B6.b: Analyze and interpret data to explain patterns in biodiversity that result from speciation.

B6.d: Develop and use mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.

(*Clarification statement*: Element is intended to focus on basic statistical and graphic analysis. Hardy Weinberg would be an optional application to address this element.)

Milestones Achievement Level Descriptors for Unit 4B

Beginning	Developing	Proficient	Distinguished
Can identify general patterns of inheritance.	Can determine how models can be used to explain patterns of inheritance.	Can use mathematical models to predict and explain patterns of inheritance.	Can analyze mathematical models used to predict and explain patterns of inheritance.
Can communicate that there are advantages and disadvantages of sexual and asexual reproduction.	Can describe the advantages and disadvantages of sexual and asexual reproduction.	Can construct an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.	Can refine an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.
Can recognize the role of cellular reproduction in maintaining genetic continuity.	Can recognize models used to explain the role of cellular reproduction in maintaining genetic continuity.	Can develop and use models to explain the role of cellular reproduction (i.e., binary fission, mitosis, and meiosis) in maintaining genetic continuity.	Can refine models to explain the role of cellular reproduction in maintaining genetic continuity.
Can recognize that genetic variations may result from new genetic combinations through meiosis.	Can provide examples of inheritable genetic variations that may result from new genetic combinations through meiosis.	Can construct an argument based on evidence to support the claim that inheritable genetic variations may result from new genetic combinations through meiosis (crossing over, nondisjunction); nonlethal errors occurring during replication	Can analyze an argument based on evidence to support the claim that inheritable genetic variations may result from new genetic combinations through meiosis; non-lethal errors occurring during replication; and/or heritable

		(insertions, deletions, substitutions); and/or heritable mutations caused by environmental factors (radiation, chemicals, viruses).	mutations caused by environmental factors.
Can identify factors affecting biodiversity and populations in ecosystems.	Can analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.	Can plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.	Can refine investigations to support explanations about factors affecting biodiversity and populations in ecosystems.
Beginning	**Developing**	**Proficient**	**Distinguished**
Can recognize that an organism's ability to survive is affected by changing environmental limits.	Can identify explanations that predict an organism's ability to survive within changing environmental limits.	Can construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).	Can analyze explanations used to predict an organism's ability to survive within changing environmental limits.
Can recognize that undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.	Can identify mathematical models that can be used to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.	Can develop and use mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.	Can refine mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.

Unit 5 – Change Over Time: Evolution and Classification (6-7 weeks)

In this unit, students will examine the theory of evolution, analyzing how new insights into Earth's history, the emergence of new species, and advances in genetics have shaped our understanding of biology. Students will investigate patterns in biodiversity resulting from speciation, construct arguments to explain the origin of eukaryotes through endosymbiosis, and compare patterns of structure and function among major clades of organisms. They will analyze data to develop cladograms and phylogenetic trees to determine relationships among organisms. Students will explain changes in populations due to natural selection and develop models to explain biological resistance.

Overarching Standard for Unit 5

B6: Obtain, evaluate, and communicate information to assess the theory of evolution.

B6.a: Construct an explanation of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.

B6.b: Analyze and interpret data to explain patterns in biodiversity that result from speciation

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Supporting Standards for Student Mastery in Unit 5

B1.a: Construct an explanation of how cell structures and organelles (including nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, Golgi, endoplasmic reticulum, vacuoles, ribosomes, and mitochondria) interact as a system to maintain homeostasis.

B3.c: Construct an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction.

B4.a: Construct an argument supported by scientific information to explain patterns in structures and function among clades of organisms, including the origin of eukaryotes by endosymbiosis. Clades should include:

- archaea
- bacteria
- eukaryotes (fungi, plants, and animals)

(*Clarification statement*: This is reflective of 21st century classification schemes and nested hierarchy of clades and is intended to develop a foundation for comparing major groups of organisms. The term 'protist' is useful in describing those eukaryotes that are not within the animal, fungal or plant clades but the term does not describe a well-defined clade or a natural taxonomic group.)

B4.b: Analyze and interpret data to develop models (i.e., cladograms and phylogenetic trees) based on patterns of common ancestry and the theory of evolution to determine relationships among major groups of organisms.

B4.c: Construct an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms.

B5.e: Construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).

B6.c: Construct an argument using valid and reliable sources to support the claim that evidence from comparative morphology (analogous vs. homologous structures), embryology, biochemistry (protein sequence) and genetics support the theory that all living organisms are related by way of common descent.

B6.d: Develop and use mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.

(*Clarification statement*: Element is intended to focus on basic statistical and graphic analysis. Hardy Weinberg would be an optional application to address this element.)

B6.e: Develop a model to explain the role natural selection plays in causing biological resistance (e.g., pesticides, antibiotic resistance, and influenza vaccines).

Milestones Achievement Level Descriptors for Unit 5

Beginning	Developing	Proficient	Distinguished
Can recognize that new understandings of Earth's history have influenced our understanding of biology.	Can identify an explanation of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.	Can construct an explanation of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.	Can compare explanations of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.
Can define the terms biodiversity and speciation.	Can identify patterns in biodiversity that result from speciation.	Can analyze and interpret data to explain patterns in biodiversity that result from speciation.	Can make predictions or inferences based on analyzed data related to biodiversity that results from speciation.

Can recognize that evidence from comparative morphology, embryology, biochemistry, and genetics support the theory that all living organisms are related by way of common descent.	Can identify an argument used to support the claim that evidence from comparative morphology, embryology, biochemistry, and genetics support the theory that all living organisms are related by way of common descent.	Can construct an argument using valid and reliable sources to support the claim that evidence from comparative morphology (analogous vs. homologous structures), embryology, biochemistry (protein sequence) and genetics support the theory that all living organisms are related by way of common descent.	Can evaluate an argument using valid and reliable sources to support the claim that evidence from comparative morphology, embryology, biochemistry, and genetics support the theory that all living organisms are related by way of common descent.
Can recognize that undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.	Can identify mathematical models that can be used to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.	Can develop and use mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.	Can refine mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms.
Beginning	**Developing**	**Proficient**	**Distinguished**
Can determine the role of natural selection in causing biological resistance.	Can identify a model that can be used to explain the role of natural selection in causing biological resistance.	Can develop a model to explain the role of natural selection in causing biological resistance (e.g., pesticides, antibiotic resistance, influenza vaccines).	Can refine a model to explain the role of natural selection in causing biological resistance.
Can identify the structures and functions of cell parts.	Can explain that cell structures and organelles interact as a system to maintain homeostasis.	Can construct an explanation of how cell structures and organelles (i.e., nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, Golgi, endoplasmic reticulum, vacuoles, ribosomes, mitochondria) interact as a system to maintain homeostasis.	Can refine explanations of how cell structures and organelles interact as a system to maintain homeostasis.
Can communicate that there are advantages and	Can describe the advantages and disadvantages of sexual and	Can construct an argument to support a claim about the relative advantages	Can refine an argument to support a claim about the relative

disadvantages of sexual and asexual reproduction.	asexual reproduction.	and disadvantages of sexual and asexual reproduction.	advantages and disadvantages of sexual and asexual reproduction.
Can identify patterns in structures and function among clades of organisms.	Can explain patterns in structures and function among clades of organisms, including the origin of eukaryotes by endosymbiosis.	Can construct an argument supported by scientific information to explain patterns in structures and function among clades of organisms, including the origin of eukaryotes by endosymbiosis.	Can refine an argument supported by scientific information to explain patterns in structures and function among clades of organisms, including the origin of eukaryotes by endosymbiosis.
Can recognize that patterns of common ancestry and the theory of evolution can be used to determine relationships among major groups of organisms.	Can analyze and interpret simple data related to patterns of common ancestry and the theory of evolution to determine relationships among major groups of organisms.	Can analyze and interpret data to develop models (i.e., cladograms, phylogenetic trees) based on patterns of common ancestry and the theory of evolution to determine relationships among major groups of organisms.	Can use data to evaluate models based on patterns of common ancestry and the theory of evolution to determine relationships among major groups of organisms.
Beginning	**Developing**	**Proficient**	**Distinguished**
Can identify characteristics of viruses.	Can describe the characteristics of viruses and organisms.	Can construct an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms.	Can refine an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms.
Can recognize that an organism's ability to survive is affected by changing environmental limits.	Can identify explanations that predict an organism's ability to survive within changing environmental limits.	Can construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).	Can analyze explanations used to predict an organism's ability to survive within changing environmental limits.

Unit 6 – Human Impact: Ecology (6 weeks)

In this unit, students will investigate the interdependence of all organisms and their environment, focusing on assessing the impact of environmental change on ecosystem stability. Students will construct arguments to predict these impacts and design solutions to mitigate human activities that affect the environment. They will investigate the roles of photosynthesis and respiration in matter cycling and energy flow within cells and use models to analyze energy flow in food webs and energy pyramids.

Overarching Standard for Unit 6

B5: Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment.

B5.c: Construct an argument to predict the impact of environmental change on the stability of an ecosystem.

B5.d: Design a solution to reduce the impact of a human activity on the environment.
(*Clarification statement*: Human activities may include chemical use, natural resources consumption, introduction of non-native species, greenhouse gas production.)

Supporting Standards for Student Mastery in Unit 6

B1.e: Ask questions to investigate and provide explanations about the roles of photosynthesis and respiration in the cycling of matter and flow of energy within the cell (e.g., single-celled alga).
(*Clarification statement*: Instruction should focus on understanding the inputs, outputs, and functions of photosynthesis and respiration and the functions of the major sub-processes of each including glycolysis, Krebs cycle, electron transport chain, light reactions, and Calvin cycle.)

B2.c: Ask questions to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture.
(*Clarification statement*: The element is intended to include advancements in technology relating to economics and society such as advancements may include Genetically Modified Organisms.)

B5.a: Plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.
(*Clarification statement*: Factors include population size, carrying capacity, response to limiting factors, and keystone species.)

B5.b: Develop and use models to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.

- Arranging components of a food web according to energy flow.
- Comparing the quantity of energy in the steps of an energy pyramid.
- Explaining the need for cycling of major biochemical elements (C, O, N, P, and H).

B5.e: Construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).

B6.a: Construct an explanation of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.

B6.b: Analyze and interpret data to explain patterns in biodiversity that result from speciation.

Milestones Achievement Level Descriptors for Unit 6

Beginning	Developing	Proficient	Distinguished
Can identify factors affecting biodiversity and populations in ecosystems.	Can analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.	Can plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems.	Can refine investigations to support explanations about factors affecting biodiversity and populations in ecosystems.
Can describe the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.	Can identify models that can be used to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.	Can develop and use models to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.	Can refine models used to analyze the cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration.
Can identify a possible impact of an environmental change on the stability of an ecosystem.	Can predict the impact of different types of environmental changes on the stability of an ecosystem.	Can construct an argument to predict the impact of environmental change on the stability of an ecosystem.	Can explain why a specific argument can be used to predict the impact of environmental change on the stability of an ecosystem.

Can identify ways that human activity impacts the environment.	Can identify a solution that could be used to reduce the impact of a human activity on the environment.	Can design a solution to reduce the impact of a human activity on the environment.	Can refine a solution to reduce the impact of a human activity on the environment.
Can recognize that an organism's ability to survive is affected by changing environmental limits.	Can identify explanations that predict an organism's ability to survive within changing environmental limits.	Can construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).	Can analyze explanations used to predict an organism's ability to survive within changing environmental limits.
Beginning	**Developing**	**Proficient**	**Distinguished**
Can recognize the roles of photosynthesis and respiration in the cycling of matter and flow of energy within the cell.	Can identify questions used to investigate and provide explanations about the roles of photosynthesis and respiration in the cycling of matter and flow of energy within the cell.	Can ask questions to investigate and provide explanations about the roles of photosynthesis and respiration in the cycling of matter and flow of energy within the cell (e.g., single celled alga).	Can analyze complex questions used to investigate and provide explanations about the roles of photosynthesis and respiration in the cycling of matter and flow of energy within the cell.
Can identify considerations related to the use of biotechnology in forensics, medicine, and agriculture.	Can gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture.	Can ask questions to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture.	Can refine questions used to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture.
Can recognize that new understandings of Earth's history have influenced our understanding of biology.	Can identify an explanation of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.	Can construct an explanation of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.	Can compare explanations of how new understandings of Earth's history, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology.

Can define the terms biodiversity and speciation.	Can identify patterns in biodiversity that result from speciation.	Can analyze and interpret data to explain patterns in biodiversity that result from speciation.	Can make predictions or inferences based on analyzed data related to biodiversity that results from speciation.

Unit 7 –Capstone Project (2 weeks)

This unit is designed to consolidate and reinforce the key scientific concepts and skills that biology students have learned throughout the year. The capstone project will provide an opportunity for students to apply their knowledge in a real-world context, demonstrating their understanding of scientific principles and their ability to communicate information effectively.

Overarching Standards

B1: Obtain, evaluate, and communicate information to analyze the nature of the relationships between structures and functions in living cells.

B2: Obtain, evaluate, and communicate information to analyze how genetic information is expressed in cells.

B3: Obtain, evaluate, and communicate information to analyze how biological traits are passed on to successive generations.

B4: Obtain, evaluate, and communicate information to illustrate the organization of interacting systems within single-celled and multi-celled organisms**.**

B5: Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment.

B6: Obtain, evaluate, and communicate information to assess the theory of evolution.