

Pennsylvania Tutorials are designed specifically for the Pennsylvania Core Standards and the Pennsylvania Academic Standards to prepare students for the Keystone Exams and the Pennsylvania System of School Assessment (PSSA).

Biology Tutorials offer targeted instruction, practice, and review designed to help students develop fluency, deepen conceptual understanding, and apply scientific thinking skills. Students engage with the content in an interactive, feedback-rich environment as they progress through standards-aligned modules. By constantly honing their ability to explain and analyze biological scenarios, students build the depth of knowledge and higher-order skills required to demonstrate their mastery when put to the test.

In each module, the Learn It and Try It make complex ideas accessible through focused content, guided analysis, multi-modal representations, and personalized feedback as students reason through increasingly challenging problems. The Review It offers a high-impact summary of key concepts and relates those concepts to students' lives. The Test It assesses students' mastery of the module's concepts, providing granular performance data to students and teachers after each attempt. To help students focus on the content most relevant to them, unit-level pretests and posttests can quickly identify where students are strong and where they're still learning.

Unit 1: Nature of Life

• FROM ATOMS TO BIOSPHERE

- BIO.A.1.2.2: Cells and Cell Processes Basic Biological Principles Describe relationships between structure and function at biological levels of organization. Describe and interpret relationships between structure and function at various levels of biological organization (i.e., organelles, cells, tissues, organs, organ systems, and multicellular organisms).
- BIO.A.2.2.1: Cells and Cell Processes The Chemical Basis for Life Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules). Explain how carbon is uniquely suited to form biological macromolecules.
- BIO.A.2.2.2: Cells and Cell Processes The Chemical Basis for Life Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules). Describe how biological macromolecules form from monomers.
- BIO.B.4.1.1: Continuity and Unity of Life Ecology Describe ecological levels of organization in the biosphere. Describe the levels of ecological organization (i.e., organism, population, community, ecosystem, biome, and biosphere).
- BIO.B.4.1.2: Continuity and Unity of Life Ecology Describe ecological levels of organization in the biosphere. Describe characteristic biotic and abiotic components of aquatic and terrestrial ecosystems.

- **CHARACTERISTICS OF LIFE**

- BIO.A.1.1.1: Cells and Cell Processes Basic Biological Principles Explain the characteristics common to all organisms. Describe the characteristics of life shared by all prokaryotic and eukaryotic organisms.
- BIO.A.3.2.1: Cells and Cell Processes Bioenergetics Identify and describe how organisms obtain and transform energy for their life processes. Compare the basic transformation of energy during photosynthesis and cellular respiration.
- BIO.A.4.2.1: Cells and Cell Processes Homeostasis and Transport Explain mechanisms that permit organisms to maintain biological balance between their internal and external environments. Explain how organisms maintain homeostasis (e.g., thermoregulation, water regulation, oxygen regulation).
- BIO.B.2.4.1: Continuity and Unity of Life Genetics Apply scientific thinking, processes, tools, and technologies in the study of genetics. Explain how genetic engineering has impacted the fields of medicine, forensics, and agriculture (e.g., selective breeding, gene splicing, cloning, genetically modified organisms, gene therapy).
- BIO.B.3.2.1: Continuity and Unity of Life Theory of Evolution Analyze the sources of evidence for biological evolution. Interpret evidence supporting the theory of evolution (i.e., fossil, anatomical, physiological, embryological, biochemical, and universal genetic code).
- BIO.B.1.1.1: Continuity and Unity of Life Cell Growth and Reproduction Describe the three stages of the cell cycle: interphase, nuclear division, cytokinesis. Describe the events that occur during the cell cycle: interphase, nuclear division (i.e., mitosis or meiosis), cytokinesis.

Unit 2: Chemistry of Life

- **BIOMOLECULES**

- BIO.A.2.2.1: Cells and Cell Processes The Chemical Basis for Life Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules). Explain how carbon is uniquely suited to form biological macromolecules.
- BIO.A.2.2.3: Cells and Cell Processes The Chemical Basis for Life Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules). Compare the structure and function of carbohydrates, lipids, proteins, and nucleic acids in organisms.
- BIO.A.2.2.2: Cells and Cell Processes The Chemical Basis for Life Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules). Describe how biological macromolecules form from monomers.

- **ENZYMES**

- BIO.A.2.3.1: Cells and Cell Processes The Chemical Basis for Life Explain how enzymes regulate biochemical reactions within a cell. Describe the role of an enzyme as a catalyst in regulating a

specific biochemical reaction.

- BIO.A.2.3.2: Cells and Cell Processes The Chemical Basis for Life Explain how enzymes regulate biochemical reactions within a cell. Explain how factors such as pH, temperature, and concentration levels can affect enzyme function.

Unit 3: Cell Structure and Function

• PROKARYOTIC AND EUKARYOTIC CELLS

- BIO.A.1.2.1: Cells and Cell Processes Basic Biological Principles Describe relationships between structure and function at biological levels of organization. Compare cellular structures and their functions in prokaryotic and eukaryotic cells.
- BIO.A.4.1.1: Cells and Cell Processes Homeostasis and Transport Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell. Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for a cell.
- BIO.A.4.1.2: Cells and Cell Processes Homeostasis and Transport Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell. Compare the mechanisms that transport materials across the plasma membrane (i.e., passive transport-diffusion, osmosis, facilitated diffusion; and active transport-pumps, endocytosis, exocytosis).
- BIO.A.3.1.1: Cells and Cell Processes Bioenergetics Identify and describe the cell structures involved in processing energy. Describe the fundamental roles of plastids (e.g., chloroplasts) and mitochondria in energy transformations.
- BIO.A.4.1.3: Cells and Cell Processes Homeostasis and Transport Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell. Describe how membrane-bound cellular organelles (e.g., endoplasmic reticulum, Golgi apparatus) facilitate the transport of materials within a cell.
- BIO.B.2.2.2: Continuity and Unity of Life Genetics Explain the process of protein synthesis (i.e., transcription, translation, and protein modification). Describe the role of ribosomes, endoplasmic reticulum, Golgi apparatus, and the nucleus in the production of specific types of proteins.
- BIO.A.1.1.1: Cells and Cell Processes Basic Biological Principles Explain the characteristics common to all organisms. Describe the characteristics of life shared by all prokaryotic and eukaryotic organisms.

• PLANT AND ANIMAL CELLS

- BIO.A.4.1.3: Cells and Cell Processes Homeostasis and Transport Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell. Describe how membrane-bound cellular organelles (e.g., endoplasmic reticulum, Golgi apparatus) facilitate the transport of materials within a cell.
- BIO.B.2.2.2: Continuity and Unity of Life Genetics Explain the process of protein synthesis (i.e., transcription, translation, and protein modification). Describe the role of ribosomes,

endoplasmic reticulum, Golgi apparatus, and the nucleus in the production of specific types of proteins.

- BIO.A.1.2.1: Cells and Cell Processes Basic Biological Principles Describe relationships between structure and function at biological levels of organization. Compare cellular structures and their functions in prokaryotic and eukaryotic cells.
- BIO.A.3.1.1: Cells and Cell Processes Bioenergetics Identify and describe the cell structures involved in processing energy. Describe the fundamental roles of plastids (e.g., chloroplasts) and mitochondria in energy transformations.

• PASSIVE TRANSPORT

- BIO.A.1.2.1: Cells and Cell Processes Basic Biological Principles Describe relationships between structure and function at biological levels of organization. Compare cellular structures and their functions in prokaryotic and eukaryotic cells.
- BIO.A.4.1.1: Cells and Cell Processes Homeostasis and Transport Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell. Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for a cell.
- BIO.A.4.1.3: Cells and Cell Processes Homeostasis and Transport Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell. Describe how membrane-bound cellular organelles (e.g., endoplasmic reticulum, Golgi apparatus) facilitate the transport of materials within a cell.
- BIO.A.4.2.1: Cells and Cell Processes Homeostasis and Transport Explain mechanisms that permit organisms to maintain biological balance between their internal and external environments. Explain how organisms maintain homeostasis (e.g., thermoregulation, water regulation, oxygen regulation).
- BIO.A.4.1.2: Cells and Cell Processes Homeostasis and Transport Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell. Compare the mechanisms that transport materials across the plasma membrane (i.e., passive transport-diffusion, osmosis, facilitated diffusion; and active transport-pumps, endocytosis, exocytosis).

• ACTIVE TRANSPORT

- BIO.A.1.2.1: Cells and Cell Processes Basic Biological Principles Describe relationships between structure and function at biological levels of organization. Compare cellular structures and their functions in prokaryotic and eukaryotic cells.
- BIO.A.4.1.1: Cells and Cell Processes Homeostasis and Transport Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell. Describe how the structure of the plasma membrane allows it to function as a regulatory structure and/or protective barrier for a cell.
- BIO.A.4.1.2: Cells and Cell Processes Homeostasis and Transport Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell. Compare the

mechanisms that transport materials across the plasma membrane (i.e., passive transport-diffusion, osmosis, facilitated diffusion; and active transport-pumps, endocytosis, exocytosis).

- BIO.A.4.2.1: Cells and Cell Processes Homeostasis and Transport Explain mechanisms that permit organisms to maintain biological balance between their internal and external environments. Explain how organisms maintain homeostasis (e.g., thermoregulation, water regulation, oxygen regulation).
- BIO.A.3.2.2: Cells and Cell Processes Bioenergetics Identify and describe how organisms obtain and transform energy for their life processes. Describe the role of ATP in biochemical reactions.

Unit 4: Cellular Energetics

- **PHOTOSYNTHESIS**

- BIO.A.3.1.1: Cells and Cell Processes Bioenergetics Identify and describe the cell structures involved in processing energy. Describe the fundamental roles of plastids (e.g., chloroplasts) and mitochondria in energy transformations.
- BIO.A.3.2.1: Cells and Cell Processes Bioenergetics Identify and describe how organisms obtain and transform energy for their life processes. Compare the basic transformation of energy during photosynthesis and cellular respiration.
- BIO.A.3.2.2: Cells and Cell Processes Bioenergetics Identify and describe how organisms obtain and transform energy for their life processes. Describe the role of ATP in biochemical reactions.

- **CELLULAR RESPIRATION**

- BIO.A.3.2.1: Cells and Cell Processes Bioenergetics Identify and describe how organisms obtain and transform energy for their life processes. Compare the basic transformation of energy during photosynthesis and cellular respiration.
- BIO.A.3.2.2: Cells and Cell Processes Bioenergetics Identify and describe how organisms obtain and transform energy for their life processes. Describe the role of ATP in biochemical reactions.
- BIO.A.1.2.1: Cells and Cell Processes Basic Biological Principles Describe relationships between structure and function at biological levels of organization. Compare cellular structures and their functions in prokaryotic and eukaryotic cells.
- BIO.A.3.1.1: Cells and Cell Processes Bioenergetics Identify and describe the cell structures involved in processing energy. Describe the fundamental roles of plastids (e.g., chloroplasts) and mitochondria in energy transformations.
- BIO.A.4.1.3: Cells and Cell Processes Homeostasis and Transport Identify and describe the cell structures involved in transport of materials into, out of, and throughout a cell. Describe how membrane-bound cellular organelles (e.g., endoplasmic reticulum, Golgi apparatus) facilitate the transport of materials within a cell.

Unit 5: Cell Growth and Reproduction

- **THE CELL CYCLE**

- BIO.B.1.1.1: Continuity and Unity of Life Cell Growth and Reproduction Describe the three stages of the cell cycle: interphase, nuclear division, cytokinesis. Describe the events that occur during the cell cycle: interphase, nuclear division (i.e., mitosis or meiosis), cytokinesis.
- BIO.B.1.2.1: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Describe how the process of DNA replication results in the transmission and/or conservation of genetic information.

- **MITOSIS**

- BIO.B.1.1.1: Continuity and Unity of Life Cell Growth and Reproduction Describe the three stages of the cell cycle: interphase, nuclear division, cytokinesis. Describe the events that occur during the cell cycle: interphase, nuclear division (i.e., mitosis or meiosis), cytokinesis.
- BIO.B.1.1.2: Continuity and Unity of Life Cell Growth and Reproduction Describe the three stages of the cell cycle: interphase, nuclear division, cytokinesis. Compare the processes and outcomes of mitotic and meiotic nuclear divisions.

- **MEIOSIS**

- BIO.B.1.1.1: Continuity and Unity of Life Cell Growth and Reproduction Describe the three stages of the cell cycle: interphase, nuclear division, cytokinesis. Describe the events that occur during the cell cycle: interphase, nuclear division (i.e., mitosis or meiosis), cytokinesis.
- BIO.B.1.1.2: Continuity and Unity of Life Cell Growth and Reproduction Describe the three stages of the cell cycle: interphase, nuclear division, cytokinesis. Compare the processes and outcomes of mitotic and meiotic nuclear divisions.
- BIO.B.2.1.2: Continuity and Unity of Life Genetics Compare Mendelian and non-Mendelian patterns of inheritance. Describe processes that can alter composition or number of chromosomes (i.e., crossing-over, nondisjunction, duplication, translocation, deletion, insertion, and inversion).
- BIO.B.3.1.1: Continuity and Unity of Life Theory of Evolution Explain the mechanisms of evolution. Explain how natural selection can impact allele frequencies of a population.

Unit 6: DNA Structure and Function

- **COMPONENTS OF DNA**

- BIO.A.2.2.3: Cells and Cell Processes The Chemical Basis for Life Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules). Compare the structure and function of carbohydrates, lipids, proteins, and nucleic acids in organisms.
- BIO.B.1.2.2: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.
- BIO.B.1.2.1: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Describe how the process of DNA replication results in the transmission and/or conservation of genetic information.

- **THE GENETIC CODE**

- BIO.A.2.2.3: Cells and Cell Processes The Chemical Basis for Life Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules). Compare the structure and function of carbohydrates, lipids, proteins, and nucleic acids in organisms.
- BIO.B.1.2.2: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.
- BIO.B.2.2.1: Continuity and Unity of Life Genetics Explain the process of protein synthesis (i.e., transcription, translation, and protein modification). Describe how the processes of transcription and translation are similar in all organisms.
- BIO.B.3.2.1: Continuity and Unity of Life Theory of Evolution Analyze the sources of evidence for biological evolution. Interpret evidence supporting the theory of evolution (i.e., fossil, anatomical, physiological, embryological, biochemical, and universal genetic code).

- **DNA REPLICATION**

- BIO.B.1.2.1: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Describe how the process of DNA replication results in the transmission and/or conservation of genetic information.
- BIO.B.1.2.2: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.

Unit 7: Gene Expression

- **TRANSCRIPTION**

- BIO.A.2.2.3: Cells and Cell Processes The Chemical Basis for Life Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules). Compare the structure and function of carbohydrates, lipids, proteins, and nucleic acids in organisms.
- BIO.B.1.2.1: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Describe how the process of DNA replication results in the transmission and/or conservation of genetic information.
- BIO.B.1.2.2: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.
- BIO.B.2.2.2: Continuity and Unity of Life Genetics Explain the process of protein synthesis (i.e., transcription, translation, and protein modification). Describe the role of ribosomes, endoplasmic reticulum, Golgi apparatus, and the nucleus in the production of specific types of proteins.

- BIO.B.2.2.1: Continuity and Unity of Life Genetics Explain the process of protein synthesis (i.e., transcription, translation, and protein modification). Describe how the processes of transcription and translation are similar in all organisms.

- **TRANSLATION**

- BIO.A.2.2.3: Cells and Cell Processes The Chemical Basis for Life Describe and interpret relationships between structure and function at various levels of biochemical organization (i.e., atoms, molecules, and macromolecules). Compare the structure and function of carbohydrates, lipids, proteins, and nucleic acids in organisms.
- BIO.B.2.2.1: Continuity and Unity of Life Genetics Explain the process of protein synthesis (i.e., transcription, translation, and protein modification). Describe how the processes of transcription and translation are similar in all organisms.
- BIO.B.2.2.2: Continuity and Unity of Life Genetics Explain the process of protein synthesis (i.e., transcription, translation, and protein modification). Describe the role of ribosomes, endoplasmic reticulum, Golgi apparatus, and the nucleus in the production of specific types of proteins.
- BIO.A.2.3.1: Cells and Cell Processes The Chemical Basis for Life Explain how enzymes regulate biochemical reactions within a cell. Describe the role of an enzyme as a catalyst in regulating a specific biochemical reaction.

Unit 8: Mutations

- **GENETIC CHANGES IN DNA**

- BIO.B.2.1.2: Continuity and Unity of Life Genetics Compare Mendelian and non-Mendelian patterns of inheritance. Describe processes that can alter composition or number of chromosomes (i.e., crossing-over, nondisjunction, duplication, translocation, deletion, insertion, and inversion).
- BIO.B.2.3.1: Continuity and Unity of Life Genetics Explain how genetic information is expressed. Describe how genetic mutations alter the DNA sequence and may or may not affect phenotype (e.g., silent, nonsense, frame-shift).
- BIO.B.3.1.3: Continuity and Unity of Life Theory of Evolution Explain the mechanisms of evolution. Explain how genetic mutations may result in genotypic and phenotypic variations within a population.
- BIO.B.1.2.2: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.

- **GENETIC CHANGES IN CHROMOSOMES**

- BIO.B.1.2.2: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.

- BIO.B.1.1.1: Continuity and Unity of Life Cell Growth and Reproduction Describe the three stages of the cell cycle: interphase, nuclear division, cytokinesis. Describe the events that occur during the cell cycle: interphase, nuclear division (i.e., mitosis or meiosis), cytokinesis.
- BIO.B.1.1.2: Continuity and Unity of Life Cell Growth and Reproduction Describe the three stages of the cell cycle: interphase, nuclear division, cytokinesis. Compare the processes and outcomes of mitotic and meiotic nuclear divisions.
- BIO.B.2.1.2: Continuity and Unity of Life Genetics Compare Mendelian and non-Mendelian patterns of inheritance. Describe processes that can alter composition or number of chromosomes (i.e., crossing-over, nondisjunction, duplication, translocation, deletion, insertion, and inversion).
- BIO.B.3.1.3: Continuity and Unity of Life Theory of Evolution Explain the mechanisms of evolution. Explain how genetic mutations may result in genotypic and phenotypic variations within a population.
- BIO.B.2.3.1: Continuity and Unity of Life Genetics Explain how genetic information is expressed. Describe how genetic mutations alter the DNA sequence and may or may not affect phenotype (e.g., silent, nonsense, frame-shift).
- BIO.B.2.4.1: Continuity and Unity of Life Genetics Apply scientific thinking, processes, tools, and technologies in the study of genetics. Explain how genetic engineering has impacted the fields of medicine, forensics, and agriculture (e.g., selective breeding, gene splicing, cloning, genetically modified organisms, gene therapy).

Unit 9: Heredity

- **MENDELIAN LAWS OF HEREDITY**

- BIO.B.1.2.2: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.
- BIO.B.2.1.1: Continuity and Unity of Life Genetics Compare Mendelian and non-Mendelian patterns of inheritance. Describe and/or predict observed patterns of inheritance (i.e., dominant, recessive, co-dominance, incomplete dominance, sex-linked, polygenic, and multiple alleles).

- **MULTIPLE ALLELES AND ALLELES WITHOUT DOMINANCE**

- BIO.B.1.2.2: Continuity and Unity of Life Cell Growth and Reproduction Explain how genetic information is inherited. Explain the functional relationships between DNA, genes, alleles, and chromosomes and their roles in inheritance.
- BIO.B.2.1.1: Continuity and Unity of Life Genetics Compare Mendelian and non-Mendelian patterns of inheritance. Describe and/or predict observed patterns of inheritance (i.e., dominant, recessive, co-dominance, incomplete dominance, sex-linked, polygenic, and multiple alleles).

Unit 10: Evolution

- **MULTIPLE LINES OF EVIDENCE**

- BIO.B.3.2.1: Continuity and Unity of Life Theory of Evolution Analyze the sources of evidence for biological evolution. Interpret evidence supporting the theory of evolution (i.e., fossil, anatomical, physiological, embryological, biochemical, and universal genetic code).

- **THE FOSSIL RECORD**

- BIO.B.3.2.1: Continuity and Unity of Life Theory of Evolution Analyze the sources of evidence for biological evolution. Interpret evidence supporting the theory of evolution (i.e., fossil, anatomical, physiological, embryological, biochemical, and universal genetic code).

Unit 11: Mechanisms of Evolution

- **NATURAL SELECTION**

- BIO.B.3.1.1: Continuity and Unity of Life Theory of Evolution Explain the mechanisms of evolution. Explain how natural selection can impact allele frequencies of a population.
- BIO.B.3.1.2: Continuity and Unity of Life Theory of Evolution Explain the mechanisms of evolution. Describe the factors that can contribute to the development of new species (e.g., isolating mechanisms, genetic drift, founder effect, migration).
- BIO.B.2.4.1: Continuity and Unity of Life Genetics Apply scientific thinking, processes, tools, and technologies in the study of genetics. Explain how genetic engineering has impacted the fields of medicine, forensics, and agriculture (e.g., selective breeding, gene splicing, cloning, genetically modified organisms, gene therapy).

- **EVOLUTION OF SPECIES**

- BIO.B.3.1.2: Continuity and Unity of Life Theory of Evolution Explain the mechanisms of evolution. Describe the factors that can contribute to the development of new species (e.g., isolating mechanisms, genetic drift, founder effect, migration).
- BIO.B.4.2.4: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe how ecosystems change in response to natural and human disturbances (e.g., climate changes, introduction of nonnative species, pollution, fires).
- BIO.B.3.2.1: Continuity and Unity of Life Theory of Evolution Analyze the sources of evidence for biological evolution. Interpret evidence supporting the theory of evolution (i.e., fossil, anatomical, physiological, embryological, biochemical, and universal genetic code).

Unit 12: Homeostasis

- **HOMEOSTASIS AND DYNAMIC EQUILIBRIUM**

- BIO.A.4.2.1: Cells and Cell Processes Homeostasis and Transport Explain mechanisms that permit organisms to maintain biological balance between their internal and external environments. Explain how organisms maintain homeostasis (e.g., thermoregulation, water regulation, oxygen regulation).
- BIO.A.1.2.2: Cells and Cell Processes Basic Biological Principles Describe relationships between structure and function at biological levels of organization. Describe and interpret relationships

between structure and function at various levels of biological organization (i.e., organelles, cells, tissues, organs, organ systems, and multicellular organisms).

- BIO.B.4.1.1: Continuity and Unity of Life Ecology Describe ecological levels of organization in the biosphere. Describe the levels of ecological organization (i.e., organism, population, community, ecosystem, biome, and biosphere).

- **FEEDBACK MECHANISMS IN ANIMALS**

- BIO.A.4.2.1: Cells and Cell Processes Homeostasis and Transport Explain mechanisms that permit organisms to maintain biological balance between their internal and external environments. Explain how organisms maintain homeostasis (e.g., thermoregulation, water regulation, oxygen regulation).
- BIO.A.1.2.2: Cells and Cell Processes Basic Biological Principles Describe relationships between structure and function at biological levels of organization. Describe and interpret relationships between structure and function at various levels of biological organization (i.e., organelles, cells, tissues, organs, organ systems, and multicellular organisms).
- BIO.B.4.1.1: Continuity and Unity of Life Ecology Describe ecological levels of organization in the biosphere. Describe the levels of ecological organization (i.e., organism, population, community, ecosystem, biome, and biosphere).

Unit 13: Cycles in Nature

- **THE CARBON CYCLE**

- BIO.A.3.2.1: Cells and Cell Processes Bioenergetics Identify and describe how organisms obtain and transform energy for their life processes. Compare the basic transformation of energy during photosynthesis and cellular respiration.
- BIO.B.4.2.3: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe how matter recycles through an ecosystem (i.e., water cycle, carbon cycle, oxygen cycle, and nitrogen cycle).
- BIO.B.4.2.4: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe how ecosystems change in response to natural and human disturbances (e.g., climate changes, introduction of nonnative species, pollution, fires).

- **THE NITROGEN AND PHOSPHORUS CYCLES**

- BIO.B.4.2.3: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe how matter recycles through an ecosystem (i.e., water cycle, carbon cycle, oxygen cycle, and nitrogen cycle).
- BIO.B.4.2.4: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe how ecosystems change in response to natural and human disturbances (e.g., climate changes, introduction of nonnative species, pollution, fires).

Unit 14: Matter and Energy

- **FOOD CHAINS AND WEBS**

- BIO.B.4.2.1: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe how energy flows through an ecosystem (e.g., food chains, food webs, energy pyramids).
- BIO.B.4.2.2: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe biotic interactions in an ecosystem (e.g., competition, predation, symbiosis).
- BIO.B.4.2.4: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe how ecosystems change in response to natural and human disturbances (e.g., climate changes, introduction of nonnative species, pollution, fires).
- **PYRAMIDS OF ENERGY, NUMBERS, AND BIOMASS**
 - BIO.B.4.2.1: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe how energy flows through an ecosystem (e.g., food chains, food webs, energy pyramids).
 - BIO.B.4.2.2: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe biotic interactions in an ecosystem (e.g., competition, predation, symbiosis).
 - BIO.B.4.2.5: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe the effects of limiting factors on population dynamics and potential species extinction.

Unit 15: Ecology of Succession

- **SUCCESSION IN COMMUNITIES**
 - BIO.B.4.2.4: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe how ecosystems change in response to natural and human disturbances (e.g., climate changes, introduction of nonnative species, pollution, fires).
- **NATURAL IMPACTS ON ECOSYSTEMS**
 - BIO.B.4.2.4: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe how ecosystems change in response to natural and human disturbances (e.g., climate changes, introduction of nonnative species, pollution, fires).
 - BIO.B.4.2.5: Continuity and Unity of Life Ecology Describe interactions and relationships in an ecosystem. Describe the effects of limiting factors on population dynamics and potential species extinction.