South Carolina Tutorials are designed specifically for the South Carolina College and Career Readiness Standards and the South Carolina Academic Standards to prepare students for the South Carolina End-of-Course Examination Program (EOCEP), ACT Aspire, and the South Carolina Palmetto Assessment of State Standards (SCPASS).

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.

This Tutorial is aligned to state standards and the Next Generation Science Standards for Biology.

Unit 1: Nature of Life

- **FROM ATOMS TO BIOSPHERE**
  - H.B.3A.3: Energy Transfer The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem. Cells transform energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another. Construct scientific arguments to support claims that chemical elements in the sugar molecules produced by photosynthesis may interact with other elements to form amino acids, lipids, nucleic acids or other large organic molecules.
- **CHARACTERISTICS OF LIFE**
  - H.B.4B.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of

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an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Obtain, evaluate and communicate information on how biotechnology (including gel electrophoresis, plasmid-based transformation and DNA fingerprinting) may be used in the fields of medicine, agriculture, and forensic science.

- H.B.2C.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Develop and use models to exemplify how the cell membrane serves to maintain homeostasis of the cell through both active and passive transport processes.
- H.B.2C.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Ask scientific questions to define the problems that organisms face in maintaining homeostasis within different environments (including water of varying solute concentrations).
- H.B.2D.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The cells of multicellular organisms repeatedly divide to make more cells for growth and repair. During embryonic development, a single cell gives rise to a complex, multicellular organism through the processes of both cell division and differentiation. Construct models to explain how the processes of cell division and cell differentiation produce and maintain complex multicellular organisms.
- H.B.2B.3: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Obtain information to contrast the structure of viruses with that of cells and to explain, in general, why viruses must use living cells to reproduce.

- **HOMEOSTASIS AND DYNAMIC EQUILIBRIUM**
  - H.B.2C.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Ask scientific questions to define the problems that organisms face in maintaining homeostasis within different environments (including water of varying solute concentrations).
  - H.B.2C.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Develop and use models to exemplify how the cell membrane serves to maintain homeostasis of the cell through both active and passive transport processes.

Unit 2: Chemistry of Life

- **BIOMOLECULES**

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- H.B.2A.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The essential functions of a cell involve chemical reactions that take place between many different types of molecules (including carbohydrates, lipids, proteins and nucleic acids) and are catalyzed by enzymes. Construct explanations of how the structures of carbohydrates, lipids, proteins, and nucleic acids (including DNA and RNA) are related to their functions in organisms.
- H.B.2A.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The essential functions of a cell involve chemical reactions that take place between many different types of molecules (including carbohydrates, lipids, proteins and nucleic acids) and are catalyzed by enzymes. Plan and conduct investigations to determine how various environmental factors (including temperature and pH) affect enzyme activity and the rate of biochemical reactions.
- H.B.3A.3: Energy Transfer The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem. Cells transform energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another. Construct scientific arguments to support claims that chemical elements in the sugar molecules produced by photosynthesis may interact with other elements to form amino acids, lipids, nucleic acids or other large organic molecules.

- **ENZYMES**
  - H.B.2A.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The essential functions of a cell involve chemical reactions that take place between many different types of molecules (including carbohydrates, lipids, proteins and nucleic acids) and are catalyzed by enzymes. Plan and conduct investigations to determine how various environmental factors (including temperature and pH) affect enzyme activity and the rate of biochemical reactions.

Unit 3: Cell Structure and Function

- **PROKARYOTIC AND EUKARYOTIC CELLS**
  - H.B.2B.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Collect and interpret descriptive data on cell structure to compare and contrast different types of cells (including prokaryotic versus eukaryotic, and animal versus plant versus fungal).
  - H.B.2C.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Develop and

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use models to exemplify how the cell membrane serves to maintain homeostasis of the cell through both active and passive transport processes.

- H.B.2C.3: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Analyze and interpret data to explain the movement of molecules (including water) across a membrane.
- H.B.2B.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Develop and use models to explain how specialized structures within cells (including the nucleus, chromosomes, cytoskeleton, endoplasmic reticulum, ribosomes and Golgi complex) interact to produce, modify, and transport proteins. Models should compare and contrast how prokaryotic cells meet the same life needs as eukaryotic cells without similar structures.

- **PLANT AND ANIMAL CELLS**
  - H.B.2B.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Develop and use models to explain how specialized structures within cells (including the nucleus, chromosomes, cytoskeleton, endoplasmic reticulum, ribosomes and Golgi complex) interact to produce, modify, and transport proteins. Models should compare and contrast how prokaryotic cells meet the same life needs as eukaryotic cells without similar structures.
  - H.B.2B.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Collect and interpret descriptive data on cell structure to compare and contrast different types of cells (including prokaryotic versus eukaryotic, and animal versus plant versus fungal).
  - H.B.2C.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Develop and use models to exemplify how the cell membrane serves to maintain homeostasis of the cell through both active and passive transport processes.
- **PASSIVE TRANSPORT**
  - H.B.2B.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made

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of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Collect and interpret descriptive data on cell structure to compare and contrast different types of cells (including prokaryotic versus eukaryotic, and animal versus plant versus fungal).

- H.B.2C.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Develop and use models to exemplify how the cell membrane serves to maintain homeostasis of the cell through both active and passive transport processes.
- H.B.2C.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Ask scientific questions to define the problems that organisms face in maintaining homeostasis within different environments (including water of varying solute concentrations).
- H.B.2C.3: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Analyze and interpret data to explain the movement of molecules (including water) across a membrane.

- **ACTIVE TRANSPORT**
  - H.B.2B.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Collect and interpret descriptive data on cell structure to compare and contrast different types of cells (including prokaryotic versus eukaryotic, and animal versus plant versus fungal).
  - H.B.2C.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Develop and use models to exemplify how the cell membrane serves to maintain homeostasis of the cell through both active and passive transport processes.
  - H.B.2C.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell. Ask scientific questions to define the problems that organisms face in maintaining homeostasis within different environments (including water of varying solute concentrations).
  - H.B.2C.3: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Transport processes which move

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materials into and out of the cell serve to maintain the homeostasis of the cell. Analyze and interpret data to explain the movement of molecules (including water) across a membrane.

Unit 4: Cellular Energetics

- **PHOTOSYNTHESIS**
  - H.B.3A.1: Energy Transfer The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem. Cells transform energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another. Develop and use models to explain how chemical reactions among ATP, ADP, and inorganic phosphate act to transfer chemical energy within cells.
  - H.B.3A.2: Energy Transfer The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem. Cells transform energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another. Develop and revise models to describe how photosynthesis transforms light energy into stored chemical energy.
  - H.B.3A.3: Energy Transfer The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem. Cells transform energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another. Construct scientific arguments to support claims that chemical elements in the sugar molecules produced by photosynthesis may interact with other elements to form amino acids, lipids, nucleic acids or other large organic molecules.
- **CELLULAR RESPIRATION**
  - H.B.3A.1: Energy Transfer The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem. Cells transform energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another. Develop and use models to explain how chemical reactions among ATP, ADP, and inorganic phosphate act to transfer chemical energy within cells.
  - H.B.3A.4: Energy Transfer The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem. Cells transform energy that organisms need to perform essential life functions

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through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another. Develop models of the major inputs and outputs of cellular respiration (aerobic and anaerobic) to exemplify the chemical process in which the bonds of molecules are broken, the bonds of new compounds are formed and a net transfer of energy results.

- H.B.3A.5: Energy Transfer The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem. Cells transform energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another. Plan and conduct scientific investigations or computer simulations to determine the relationship between variables that affect the processes of fermentation and/or cellular respiration in living organisms and interpret the data in terms of real-world phenomena.
- H.B.2B.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Collect and interpret descriptive data on cell structure to compare and contrast different types of cells (including prokaryotic versus eukaryotic, and animal versus plant versus fungal).

Unit 5: Cell Growth and Reproduction

- **THE CELL CYCLE**
  - H.B.2D.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The cells of multicellular organisms repeatedly divide to make more cells for growth and repair. During embryonic development, a single cell gives rise to a complex, multicellular organism through the processes of both cell division and differentiation. Develop and use models to exemplify the changes that occur in a cell during the cell cycle (including changes in cell size, chromosomes, cell membrane/cell wall, and the number of cells produced) and predict, based on the models, what might happen to a cell that does not progress through the cycle correctly.
  - H.B.2D.3: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The cells of multicellular organisms repeatedly divide to make more cells for growth and repair. During embryonic development, a single cell gives rise to a complex, multicellular organism through the processes of both cell division and differentiation. Construct explanations for how the cell cycle is monitored by check point systems and communicate possible consequences of the continued cycling of abnormal cells.
  - H.B.4A.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA

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molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).

- H.B.4A.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).
- H.B.4A.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).
- H.B.2D.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The cells of multicellular organisms repeatedly divide to make more cells for growth and repair. During embryonic development, a single cell gives rise to a complex, multicellular organism through the processes of both cell division and differentiation. Construct models to explain how the processes of cell division and cell differentiation produce and maintain complex multicellular organisms.
- H.B.4A.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).

- **MITOSIS**
  - H.B.1A.2.1: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Develop, use, and refine models to understand or represent phenomena, processes, and relationships,
  - H.B.1A.6.4: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop

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understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Construct explanations of phenomena using data communicated in graphs, tables, or diagrams.

- H.B.2D.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The cells of multicellular organisms repeatedly divide to make more cells for growth and repair. During embryonic development, a single cell gives rise to a complex, multicellular organism through the processes of both cell division and differentiation. Construct models to explain how the processes of cell division and cell differentiation produce and maintain complex multicellular organisms.
- H.B.2D.2: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The cells of multicellular organisms repeatedly divide to make more cells for growth and repair. During embryonic development, a single cell gives rise to a complex, multicellular organism through the processes of both cell division and differentiation. Develop and use models to exemplify the changes that occur in a cell during the cell cycle (including changes in cell size, chromosomes, cell membrane/cell wall, and the number of cells produced) and predict, based on the models, what might happen to a cell that does not progress through the cycle correctly.
- H.B.4A.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).
- H.B.2D.3: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The cells of multicellular organisms repeatedly divide to make more cells for growth and repair. During embryonic development, a single cell gives rise to a complex, multicellular organism through the processes of both cell division and differentiation. Construct explanations for how the cell cycle is monitored by check point systems and communicate possible consequences of the continued cycling of abnormal cells.
- H.B.4A.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).

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- H.B.4A.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).
- H.B.4A.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).

- **MEIOSIS**
  - H.B.1A.2.1: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Develop, use, and refine models to understand or represent phenomena, processes, and relationships,
  - H.B.1A.6.4: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Construct explanations of phenomena using data communicated in graphs, tables, or diagrams.
  - H.B.4C.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Develop and use models of sex cell formation (meiosis) to explain why the DNA of the daughter cells is different from the DNA of the parent cell.

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- H.B.4C.3: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Construct explanations for how meiosis followed by fertilization ensures genetic variation among offspring within the same family and genetic diversity within populations of sexually reproducing organisms.
- H.B.4C.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Develop and use models of sex cell formation (meiosis) to explain why the DNA of the daughter cells is different from the DNA of the parent cell.
- H.B.4C.3: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Construct explanations for how meiosis followed by fertilization ensures genetic variation among offspring within the same family and genetic diversity within populations of sexually reproducing organisms.
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sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Develop and use models of sex cell formation (meiosis) to explain why the DNA of the daughter cells is different from the DNA of the parent cell.

- H.B.4C.3: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Construct explanations for how meiosis followed by fertilization ensures genetic variation among offspring within the same family and genetic diversity within populations of sexually reproducing organisms.
- H.B.4C.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Develop and use models of sex cell formation (meiosis) to explain why the DNA of the daughter cells is different from the DNA of the parent cell.
- H.B.4C.3: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations.

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The cell produced during fertilization has one set of chromosomes from each parent. Construct explanations for how meiosis followed by fertilization ensures genetic variation among offspring within the same family and genetic diversity within populations of sexually reproducing organisms.

Unit 6: DNA Structure and Function

- **COMPONENTS OF DNA**
  - H.B.2A.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The essential functions of a cell involve chemical reactions that take place between many different types of molecules (including carbohydrates, lipids, proteins and nucleic acids) and are catalyzed by enzymes. Construct explanations of how the structures of carbohydrates, lipids, proteins, and nucleic acids (including DNA and RNA) are related to their functions in organisms.
  - H.B.4A.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models at different scales to explain the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring.
  - H.B.4B.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Develop and use models to describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.
  - H.B.4A.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models at different scales to explain the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring.
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- H.B.4B.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Develop and use models to describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.

- **THE GENETIC CODE**
  - H.B.2A.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The essential functions of a cell involve chemical reactions that take place between many different types of molecules (including carbohydrates, lipids, proteins and nucleic acids) and are catalyzed by enzymes. Construct explanations of how the structures of carbohydrates, lipids, proteins, and nucleic acids (including DNA and RNA) are related to their functions in organisms.
  - H.B.4A.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models at different scales to explain the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring.
  - H.B.4B.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Develop and use models to describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.
  - H.B.4B.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be

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translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Obtain, evaluate and communicate information on how biotechnology (including gel electrophoresis, plasmid-based transformation and DNA fingerprinting) may be used in the fields of medicine, agriculture, and forensic science.

- H.B.4A.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models at different scales to explain the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring.
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- H.B.4B.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Develop and use models to describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.

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- **DNA REPLICATION**
  - H.B.4A.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models at different scales to explain the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring.
  - H.B.4A.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).

Unit 7: Gene Expression

- **TRANSCRIPTION**
  - H.B.2A.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The essential functions of a cell involve chemical reactions that take place between many different types of molecules (including carbohydrates, lipids, proteins and nucleic acids) and are catalyzed by enzymes. Construct explanations of how the structures of carbohydrates, lipids, proteins, and nucleic acids (including DNA and RNA) are related to their functions in organisms.

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- H.B.4B.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Develop and use models to describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.
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- H.B.2B.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Develop and use models to explain how specialized structures within cells (including the nucleus, chromosomes, cytoskeleton, endoplasmic reticulum, ribosomes and Golgi complex) interact to produce, modify, and transport proteins. Models should compare and contrast how prokaryotic cells meet the same life needs as eukaryotic cells without similar structures.
- H.B.4B.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Develop and use models to describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.

- **TRANSLATION**
  - H.B.2A.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. The essential functions of a cell involve chemical reactions that take place between many different types of molecules (including carbohydrates, lipids, proteins and nucleic acids) and are catalyzed by enzymes.

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Construct explanations of how the structures of carbohydrates, lipids, proteins, and nucleic acids (including DNA and RNA) are related to their functions in organisms.

- H.B.4B.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Develop and use models to describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.
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- H.B.2B.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Develop and use models to explain how specialized structures within cells (including the nucleus, chromosomes, cytoskeleton, endoplasmic reticulum, ribosomes and Golgi complex) interact to produce, modify, and transport proteins. Models should compare and contrast how prokaryotic cells meet the same life needs as eukaryotic cells without similar structures.
- H.B.4B.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Develop and use models to describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.

Unit 8: Mutations

- **GENETIC CHANGES IN DNA**

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- H.B.4D.1.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Imperfect transmission of genetic information may have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation. Develop and use models to explain how mutations in DNA that occur during replication can affect the proteins that are produced or the traits that result and
- H.B.4D.1.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Imperfect transmission of genetic information may have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation. Develop and use models to explain how mutations in DNA that occur during replication may or may not be inherited.
- H.B.4D.1.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Imperfect transmission of genetic information may have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation. Develop and use models to explain how mutations in DNA that occur during replication can affect the proteins that are produced or the traits that result and
- H.B.4D.1.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Imperfect transmission of genetic information may have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation. Develop and use models to explain how mutations in DNA that occur during replication may or may not be inherited.
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have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation. Develop and use models to explain how mutations in DNA that occur during replication may or may not be inherited.

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- H.B.4D.1.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Imperfect transmission of genetic information may have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation. Develop and use models to explain how mutations in DNA that occur during replication may or may not be inherited.

- **GENETIC CHANGES IN CHROMOSOMES**
  - H.B.2B.1: Cells as a System The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells. Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life. Develop and use models to explain how specialized structures within cells (including the nucleus, chromosomes, cytoskeleton, endoplasmic reticulum, ribosomes and Golgi complex) interact to produce, modify, and transport proteins. Models should compare and contrast how prokaryotic cells meet the same life needs as eukaryotic cells without similar structures.
  - H.B.4A.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models at different scales to explain the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring.
  - H.B.4B.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be

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translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems. Obtain, evaluate and communicate information on how biotechnology (including gel electrophoresis, plasmid-based transformation and DNA fingerprinting) may be used in the fields of medicine, agriculture, and forensic science.

- H.B.4C.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Develop and use models of sex cell formation (meiosis) to explain why the DNA of the daughter cells is different from the DNA of the parent cell.
- H.B.4C.3: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Construct explanations for how meiosis followed by fertilization ensures genetic variation among offspring within the same family and genetic diversity within populations of sexually reproducing organisms.
- H.B.4D.1.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Imperfect transmission of genetic information may have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation. Develop and use models to explain how mutations in DNA that occur during replication can affect the proteins that are produced or the traits that result and
- H.B.4D.1.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Imperfect transmission of genetic information may

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have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation. Develop and use models to explain how mutations in DNA that occur during replication may or may not be inherited.

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Unit 9: Heredity

- **MENDELIAN LAWS OF HEREDITY**
  - H.B.4A.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and

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transferred to subsequent generations. Develop and use models at different scales to explain the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring.

- H.B.4C.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Analyze data on the variation of traits among individual organisms within a population to explain patterns in the data in the context of transmission of genetic information.
- H.B.4C.3: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Construct explanations for how meiosis followed by fertilization ensures genetic variation among offspring within the same family and genetic diversity within populations of sexually reproducing organisms.
- H.B.1A.2.1: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Develop, use, and refine models to understand or represent phenomena, processes, and relationships,
- H.B.4A.1: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations. Develop and use models at different scales to explain

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the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring.

- H.B.4C.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Analyze data on the variation of traits among individual organisms within a population to explain patterns in the data in the context of transmission of genetic information.
- H.B.1A.5.3: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Use mathematical and computational thinking to use grade-level appropriate statistics to analyze data.
- H.B.1A.6.4: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Construct explanations of phenomena using data communicated in graphs, tables, or diagrams.
- H.B.4C.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Analyze data on the variation of traits among individual organisms within a population to explain patterns in the data in the context of transmission of genetic information.

- **MULTIPLE ALLELES AND ALLELES WITHOUT DOMINANCE**

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- H.B.1A.2.1: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Develop, use, and refine models to understand or represent phenomena, processes, and relationships,
- H.B.1A.5.3: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Use mathematical and computational thinking to use grade-level appropriate statistics to analyze data.
- H.B.1A.6.4: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Construct explanations of phenomena using data communicated in graphs, tables, or diagrams.
- H.B.4C.2: Heredity Inheritance and Variation of Traits The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes. Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent. Analyze data on the variation of traits among individual organisms within a population to explain patterns in the data in the context of transmission of genetic information.

Unit 10: Cycles in Nature

- **THE CARBON CYCLE**

- H.B.1A.2.1: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by

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scientists and engineers. Develop, use, and refine models to understand or represent phenomena, processes, and relationships,

- H.B.1A.6.4: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Construct explanations of phenomena using data communicated in graphs, tables, or diagrams.
- H.B.6B.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged between the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. Develop and use models of the carbon cycle, which include the interactions between photosynthesis, cellular respiration and other processes that release carbon dioxide, to evaluate the effects of increasing atmospheric carbon dioxide on natural and agricultural ecosystems.
- H.B.6C.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively stable over long periods of time. Fluctuations in conditions can challenge the functioning of ecosystems in terms of resource and habitat availability. Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.
- H.B.6B.2: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged between the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. Analyze and interpret quantitative data to construct an explanation for the effects of greenhouse gases (such as carbon dioxide and methane) on the carbon cycle and global climate.

- **THE NITROGEN AND PHOSPHORUS CYCLES**
  - H.B.1A.2.1: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by

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scientists and engineers. Develop, use, and refine models to understand or represent phenomena, processes, and relationships,

- H.B.1A.6.4: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Construct explanations of phenomena using data communicated in graphs, tables, or diagrams.
- H.B.6C.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively stable over long periods of time. Fluctuations in conditions can challenge the functioning of ecosystems in terms of resource and habitat availability. Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.
- H.B.6D.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. Sustaining biodiversity maintains ecosystem functioning and productivity which are essential to supporting and enhancing life on Earth. Humans depend on the living world for the resources and other benefits provided by biodiversity. Human activity can impact biodiversity. Design solutions to reduce the impact of human activity on the biodiversity of an ecosystem.

Unit 11: Matter and Energy

- **FOOD CHAINS AND WEBS**
  - H.B.1A.2.1: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Develop, use, and refine models to understand or represent phenomena, processes, and relationships,
  - H.B.1A.6.4: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Construct explanations of phenomena using data communicated in graphs, tables, or diagrams.

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- H.B.6C.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively stable over long periods of time. Fluctuations in conditions can challenge the functioning of ecosystems in terms of resource and habitat availability. Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.
- H.B.6D.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. Sustaining biodiversity maintains ecosystem functioning and productivity which are essential to supporting and enhancing life on Earth. Humans depend on the living world for the resources and other benefits provided by biodiversity. Human activity can impact biodiversity. Design solutions to reduce the impact of human activity on the biodiversity of an ecosystem.

- **PYRAMIDS OF ENERGY, NUMBERS, AND BIOMASS**
  - H.B.1A.2.1: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Develop, use, and refine models to understand or represent phenomena, processes, and relationships,
  - H.B.1A.6.4: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Construct explanations of phenomena using data communicated in graphs, tables, or diagrams.
  - H.B.6A.2: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. Limiting factors include the availability of biotic and abiotic resources and challenges such as predation, competition, and disease. Use mathematical and computational thinking to support claims that limiting factors affect the number of individuals that an ecosystem can support.
  - H.B.6A.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. Limiting factors include

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the availability of biotic and abiotic resources and challenges such as predation, competition, and disease. Analyze and interpret data that depict changes in the abiotic and biotic components of an ecosystem over time or space (such as percent change, average change, correlation and proportionality) and propose hypotheses about possible relationships between the changes in the abiotic components and the biotic components of the environment.

- H.B.6C.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively stable over long periods of time. Fluctuations in conditions can challenge the functioning of ecosystems in terms of resource and habitat availability. Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.
- H.B.6D.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. Sustaining biodiversity maintains ecosystem functioning and productivity which are essential to supporting and enhancing life on Earth. Humans depend on the living world for the resources and other benefits provided by biodiversity. Human activity can impact biodiversity. Design solutions to reduce the impact of human activity on the biodiversity of an ecosystem.

Unit 12: Ecology of Succession

- **SUCCESSION IN COMMUNITIES**
  - H.B.6C.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively stable over long periods of time. Fluctuations in conditions can challenge the functioning of ecosystems in terms of resource and habitat availability. Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.
  - H.B.6A.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. Limiting factors include the availability of biotic and abiotic resources and challenges such as predation, competition, and disease. Analyze and interpret data that depict changes in the abiotic and biotic components of an ecosystem over time or space (such as percent change, average change, correlation and proportionality) and propose hypotheses about possible relationships between the changes in the abiotic components and the biotic components of the environment.
- **NATURAL IMPACTS ON ECOSYSTEMS**

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- H.B.1A.8.2: Science and Engineering Practices The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content. The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers. Obtain and evaluate scientific information to explain or describe phenomena,
- H.B.6A.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. Limiting factors include the availability of biotic and abiotic resources and challenges such as predation, competition, and disease. Analyze and interpret data that depict changes in the abiotic and biotic components of an ecosystem over time or space (such as percent change, average change, correlation and proportionality) and propose hypotheses about possible relationships between the changes in the abiotic components and the biotic components of the environment.
- H.B.6C.1: Ecosystem Dynamics The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment. A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively stable over long periods of time. Fluctuations in conditions can challenge the functioning of ecosystems in terms of resource and habitat availability. Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.

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