# Paulsboro Schools

# Curriculum

## Honors Biology

**Grade 9**

**2011 - 2012**

*** For adoption by all regular education programs**
**Board Approved: June 2011**
**as specified and for adoption or adaptation by all Special Education Programs in accordance with Board of Education Policy.**

# PAULSBORO SCHOOL DISTRICT

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# Paulsboro Schools Mission Statement

The mission of the Paulsboro School District is to provide each student educational opportunities to assist in attaining their full potential in a democratic society.

Our instructional programs will take place in a responsive, community based school system that fosters respect among all people.

Our expectation is that all students will achieve the New Jersey Core Curriculum Content Standards (NJCCCS) at every grade level.

# INTRODUCTION, PHILOSOPHY OF EDUCATION, AND EDUCATIONAL GOALS

**Introduction/Philosophy: "Today more than ever before, science holds the key to our survival as a planet and our security and prosperity as a nation"(Obama, 2008)**
**Scientific literacy assumes an increasingly important role in the context of globalization. The rapid pace of technological advance, access to an unprecedented wealth of information, and the pervasive impact of science and technology on day-to-day living require a depth of understanding that can be enhanced through quality science education. In the 21st century, science education focuses on the practices of science that lead to a greater understand of the growing body of scientific knowledge that is required of citizens in an ever-changing world.**

## Educational Goals (taken from NJCCCS)

**The main goal of Honors Biology is to help students gain an appreciation of science as a process. Due to the many advances in technology, Biology is an every changing subject matter. The primary emphasis in this course is to give students an overall understanding of larger Biological concepts rather than a narrow view of terms and processes that need to be memorized. Essential to this conceptual understanding of Biology is a grasp of science as a process rather than as an accumulation of facts. This conceptual understanding can be achieved through scientific inquiry and critical thinking assessments rather than rote memory skills. The goal of this course is to provide students with the knowledge of Biology by giving them the skills they need to conceptualize Biology rather than memorize Biology**.

# Honors Biology
# Scope and Sequence Map

## Quarter 1

This unit will cover the concepts of water's characteristics and importance to living things, main types of organic molecules in organisms, free energy changes and the actions and limitations to enzymes ( Themes: Regulation, Energy transfer)

I. Chemistry of Life
   a. Review Basic Chemistry
   b. Water
   c. Organic Chemistry
   d. Biological Macromolecules

This unit will cover the concepts of early evolution of life, evidence for evolution, and the mechanisms of evolution (Themes: Evolution, Continuity and change)

III. Evolutionary Biology
   a. Darwin's theory of Natural Selection
   b. Population Genetics
   c. Speciation

This unit will cover the concepts of population dynamics, communities and ecosystems, and global issues. Also included in this unit will be discussions on environmental concerns and possible solutions to these problems (Themes: Energy Transfer, Interdependence in Nature)

II. Ecology
   a. Interactions in the biosphere
   b. Community Ecology
   c. Population Ecology
   d. Ecosystems

## Quarter 2

This unit will cover the concepts of early evolution of life, evidence for evolution, and the mechanisms of evolution (Themes: Evolution, Continuity and change)

IV. Evolutionary Biology
   a. Darwin's theory of Natural Selection
   b. Population Genetics
   c. Speciation

This unit will cover the concepts of the similarities, difference and evolutionary significance of prokaryotic and eukaryotic cells, sub-cellular organization, the cell cycle, its regulation and cell division (mitosis) (Theme: Relationship of structure to function)

V. Cells
   a. Cell Organelles
   b. Cellular Energetics and Metabolism

# Scope and Sequence Map Page 2

## Quarter 3

This unit will cover the concepts of meiosis, gametogenesis, eukaryotic chromosomes, and inheritance patterns (Themes: Evolution, Continuity and change)

VI. Heredity

a. Mitosis
b. Meiosis
c. Mendelian Genetics
d. Structure and Function of DNA/RNA
e. Transcription and Translation

## Quarter 4

This unit will cover the concepts of fermentation, cellular respiration, photosynthesis and coupled reactions (Themes: Energy transfer, Regulation)

**VI.** Cells

a. Cellular Respiration
b. Photosynthesis

This unit will cover the concepts of reproduction, growth and development of animals, evolutionary adaptations of animals, and animal response to the environment (Themes: Evolution, Relationship of Structure and Function).

VII. Animals

a. Vertebrates vs. Invertebrates
b. Animal Nutrition
c. Circulation and Gas Exchange
d. Immune System

**5.3 Life Science**: Life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

**A. Organization and Development**: Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

| Essential Questions | Enduring Understandings |
|---|---|
| How does structure relate to function in living systems from the organismal to the cellular level? | Living systems, from the organismal to the cellular level, demonstrate the complementary nature of structure and function. |
| **Content Statements** | **Cumulative Progress Indicators** |
| Cells are made of complex molecules that consist mostly of a few elements. Each class of molecules has its own building blocks and specific functions. | Represent and explain the relationship between the structure and function of each class of complex molecules using a variety of models. **(5.3.12.A.1)** |

**Instructional Focus:**

- Modeling (using physical or digital tools) the four major categories of organic molecules (carbohydrates, fats, proteins, and nucleic acids) using unique characteristics and primary functions
- Determining how and why each major category of organic molecule is essential to life
- Identifying the six elements most common to biological organisms: carbon, hydrogen, oxygen, nitrogen, phosphorous and sulfur

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Describe the characteristics that distinguish nucleic acid from the other major groups of macromolecules<br><br>Explain how organic polymers contribute to biological diversity<br><br>Describe the unique properties, building block molecules and biological importance of the four major categories of organic molecules<br><br>Describe how Carbon skeletons may vary and explain how this variation contributes to the diversity and complexity of organic molecules<br><br>Explain how Carbon's electron configuration determines the kinds and number of bonds carbon will form<br><br>Recognize the major functional groups and describe the chemical properties of organic molecules in which they occur | - Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Answer essential questions<br>- Webquest: The chemistry of life and Biochemistry |

**A. Organization and Development:** Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

| Essential Questions | Enduring Understandings |
|---|---|
| How does structure relate to function in living systems from the organismal to the cellular level? | Living systems, from the organismal to the cellular level, demonstrate the complementary nature of structure and function. |

| Content Statements | Cumulative Progress Indicators |
|---|---|
| Cellular processes are carried out by many different types of molecules, mostly by the group of proteins known as enzymes. | Demonstrate the properties and functions of enzymes by designing and carrying out an experiment. **(5.3.12.A.2)** |

**Instructional Focus:**

- Analyzing and explaining how cells carry out a variety of chemical transformations that allow conversion of energy from one form to another, the breakdown of molecules into smaller units, and the building of larger molecules from smaller ones
    - *Assessments will not include the molecular basis of enzyme function*
- Recognizing that most chemical transformations are made possible by protein catalysts called enzymes
- Identifying enzymes as proteins, and determining how they catalyze biochemical reactions
    - *Assessments will not include the molecular basis of enzyme catalysis*
- Conducting experiments to demonstrate that the activities of enzymes are affected by the temperature, ionic conditions, and the pH of the surroundings

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Collect data on the rates of reactions (synthesis and breakdown) via different enzymes and the rates of reactions that occur without each enzyme. Construct tables and graphs to represent the data for each enzyme. Compare the rates of reactions for the different enzymes.<br><br>Give examples of several enzyme-catalyzed reactions that occur in living systems, and describe the importance of each reaction for the organism. Explain why an organism that has a deficiency of one of the enzymes is unable to perform a particular life function.<br><br>Distinguish between entropy and enthalpy and exergonic and endergonic<br><br>Describe the function of enzymes in biological systems and explain the relationship between enzyme structure and enzyme specificity<br><br>Describe several mechanisms by which enzymes lower activation energy. | **AP Lab 2: Enzyme Catalysis***<br>*- Lab Objectives:*<br>*-measure the effects of changes in temperature, pH, ion concentration and enzyme concentration on the reaction rates of an enzyme catalyze reaction in a controlled experiment (energy transfer)*<br><br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Answer essential questions |

**A. Organization and Development:** Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

| Essential Questions | Enduring Understandings |
|---|---|
| How does structure relate to function in living systems from the organismal to the cellular level? | Living systems, from the organismal to the cellular level, demonstrate the complementary nature of structure and function. |
| **Content Statements** | **Cumulative Progress Indicators** |
| Cellular function is maintained through the regulation of cellular processes in response to internal and external environmental conditions. | Predict a cell's response in a given set of environmental conditions. **(5.3.12.A.3)** |

**Instructional Focus:**

- Modeling how processes are regulated both internally and externally by environments in which cells exist
- Explaining how the fundamental life processes of organisms depend on a variety of chemical reactions that occur in specialized areas of the organism's cells
    - *Assessments will not include the identification of cellular organelles*
- Modeling how cells are enclosed within semi-permeable membranes that regulate their interaction with their surroundings, including the transport of materials into and out of the cell
    - *Assessments will not include the molecular basis of membrane transport*

| Desired Results | |
|---|---|
| Observe the internal structures of at least three different types of cells (e.g., amoeba, fungi, plant root, plant leaf, animal muscle, animal skin). Describe, using information gathered from print and electronic resources, the functions of these structures. Construct a representation of each cell type, and compare — using gathered information and knowledge of cell structures and functions — the structures and functions across cell types. Explain why the representation is limited and simplified.<br><br>Formulate a scientific question about the movement of molecules across a membrane under differing conditions of temperature, starting concentration, pH, etc.<br><br>Plan an investigation to address the variables that might affect the movement of molecules across a membrane.<br><br>Gather and record data on the movement of molecules across a membrane via passive transport under varying conditions of temperature, starting concentration, pH, etc., by completing multiple trials or by using class data.<br><br>Calculate measures of central tendency (i.e., mean), spread of data (i.e., range) and error (i.e., number of outliers) of the concentration of the different molecules on either side of the membrane at different times.<br><br>Make claims about the movement of the different molecules across the membrane and the factors that affect that movement.<br><br>Explain why cells of organisms swell when placed in water and why they shrink when placed in a solution of salt water. Evaluate other student explanations of the same phenomenon. Construct a representation that generalizes the phenomenon to all organisms.<br><br>Construct a representation of a cell membrane undergoing passive and active transport, in terms of difference in concentration required energy and direction of molecule movement. Explain how the movement of molecules impacts the cell, and, as a result, impacts the organism as well. | **AP Lab 1: Diffusion and Osmosis***<br>*Lab Objectives:*<br>*-measure the water potential of a solution in a controlled experiment*<br>*-determine the osmotic concentration of living tissue*<br>*-describe the effects of water gain or loss in animal and plant cells*<br><br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Answer essential questions |

**A. Organization and Development:** Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

| Essential Questions | Enduring Understandings |
|---|---|
| How does structure relate to function in living systems from the organismal to the cellular level? | Living systems, from the organismal to the cellular level, demonstrate the complementary nature of structure and function. |
| **Content Statements** | **Cumulative Progress Indicators** |
| Cells divide through the process of mitosis, resulting in daughter cells that have the same genetic composition as the original cell. | Distinguish between the processes of cellular growth (cell division) and development (differentiation). **(5.3.12.A.4)** |

**Instructional Focus:**

- Explaining how the many cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions
- Tracing the general process where the progeny from a single cell form an embryo in which the cells multiply and differentiate to form the many specialized cells, tissues and organs that comprise the final organism
    - *Assessments will not include the details or graphic demonstration of each stage in mitosis*
- Present evidence that supports the concept that complex multicellular organisms are formed as a highly organized arrangement of differentiated cells
- Providing examples of how different parts of the genetic instructions are influenced by the cell's environment

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Make a claim about and justify, using ideas about conservation of matter, why new atoms and molecules must be added to cells in order for them to grow.<br><br>Construct a representation of the changes that occur in a cell in terms of its size and internal components, and of the number of cells produced as a cell goes through a single cycle of cell growth and division. Predict, based on the representation, what might happen to a cell (e.g., increase in size, change in internal structure) that does not go through the entire cell cycle but still goes through division.<br><br>Describe, using information gathered from print and electronic resources, examples of the following cell types from any multicellular organism: a cell type that divides, a cell type that does not divide at all, or a cell type that divides only under very unusual circumstances. Description includes information about the consequences and significance to an organism of having some cells that divide and some that do not.<br><br>Identify, using information gathered from print and electronic resources, several specific parts of the cell cycle that are monitored by check point systems, and describe some of the problems that might occur if abnormal cells were allowed to continue cycling. | **AP Lab 3A: Mitosis**<br>*Lab Objectives:*<br>*-Recognize the stages of mitosis in a plant or animal cell*<br>*-Calculate the relative duration of the cell cycle stages*<br><br>- Detailed chapter outlines for each unit<br>- Answer essential questions<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Construct a model of meitosis |

**A. Organization and Development:** Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

| Essential Questions | Enduring Understandings |
|---|---|
| How does structure relate to function in living systems from the organismal to the cellular level? | Living systems, from the organismal to the cellular level, demonstrate the complementary nature of structure and function. |

| Content Statements | Cumulative Progress Indicators |
|---|---|
| Cell differentiation is regulated through the expression of different genes during the development of complex multicellular organisms. | Describe modern applications of the regulation of cell differentiation and analyze the benefits and risks (e.g. stem cells, sex determination). **(5.3.12.A.5)** |

**Instructional Focus:**

- Identifying genes as a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism
    - *Assessments will not include the names and structures of nucleotides or the individual detailed steps of the processes of transcription and translation*
- Relating the specialization of cells in multicellular organisms to the different patterns of gene expression rather than to differences of the genes themselves
- Applying these understandings to analyze, support and/or critique current and emerging biotechnologies
    - *Assessments will not include the mechanisms of biotechnologies such as PCR, electrophoresis*

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Construct a representation to demonstrate how gene activation and gene inactivation lead to cell differentiation. Representation includes the transmission of genetic information from DNA to protein to cell traits.<br><br>Give examples, using information gathered from print and electronic resources, of situations in which errors that occur during gene activation or gene inactivation lead to errors in cell differentiation.<br><br>Gather, from print and electronic resources, data that can be used as evidence to support or refute the claim that some kinds of stem cells have a greater potential than other kinds of stem cells to develop into a variety of different tissue types. Include comparisons between embryonic stem cells and adult or body stem cells, and comparisons among different types of adult stem cells.<br><br>Identify current applications of plant and animal stem cells, and describe problems surrounding the use of these cells.<br><br>Give examples, using information gathered from print and electronic resources, of traits that depend on the quantity of protein produced, which, in turn, is dependent on the number of copies of a particular version of a gene. Predict and justify how zero, one or two copies of a particular version of a gene might affect the expression of a particular trait.<br><br>Identify functions performed by DNA segments that do not code for proteins. | - DNA webquest<br>- Biotechnology Ethical Discussion (science, technology, and society)<br>- Lab techniques research paper<br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses |

**A. Organization and Development:** Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

| Essential Questions | Enduring Understandings |
|---|---|
| How does structure relate to function in living systems from the organismal to the cellular level? | Living systems, from the organismal to the cellular level, demonstrate the complementary nature of structure and function. |

| Content Statements | Cumulative Progress Indicators |
|---|---|
| There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism. | Describe how a disease is the result of a malfunctioning system, organ, and cell, and relate this to possible treatment interventions (e.g. diabetes, cystic fibrosis, lactose intolerance). **(5.3.12.A.6)** |

**Instructional Focus:**

- Describing the relationships within multi-cellular organisms, where cells perform specialized functions as parts of sub-systems (e.g., tissues, organs, and organ systems), which work together to maintain optimum conditions for the benefit of the whole organism
  - *Assessments will not include the identification of specific tissues, organs or body systems*
- Recognizing that certain chemicals, pathogens, and high-energy radiation can seriously impair normal cell functions and the health of the organism
  - *Assessments will not include the specific mechanisms of action of mutagens*
- Identifying emerging biotechnology that shows promise in preventing and treating disease
  - *Assessments will not include the mechanisms of biotechnologies such as PCR, electrophoresis or the molecular actions of specific treatments*

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Describe the structure and function of at least one organ located in a plant and the analogous organ located in an animal (e.g., organs used for food storage, movement, reproduction, etc.). Description includes the types of cells, the structure of these cells, and the processes they perform to support the function of both the organ and the organism as a whole.<br><br>Describe the function of at least one type of organ located in two different plants or in two different animals. Description includes the similarities and differences in the cells that make up the organ, and the similarities and differences in the processes that the cells perform to support the function of the organ in the two organisms.<br><br>Describe, using information gathered from print and electronic resources, the structure and function of at least two organs that are part of a human body system (e.g., circulatory, digestive, gas exchange). Description includes how the two organs differ regarding the types of cells that make up each organ. Explain, using knowledge of systems of cells, how the cells and organs coordinate and contribute to the overall essential functions of the organism. | **AP Lab 10: Physiology of Circulatory System***<br>*Lab Objectives:*<br>*-describe the effect of changing body position on heart rate and blood pressure*<br>*-explain how exercise changes hear rate*<br>*-discuss and explain the relationship between heart rate and temperature*<br><br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Cell webquest<br>- Cell project |

**5.3 Life Science:** Life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

**B. Matter and Energy Transformations:** Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

| Essential Questions | Enduring Understandings |
|---|---|
| How is matter transferred and energy transferred/ transformed in living systems? | All organisms transfer matter and convert energy from one form to another. Both matter and energy are necessary to build and maintain structures within the organism. |
| **Content Statements** | **Cumulative Progress Indicators** |
| As matter cycles and energy flows through different levels of organization within living systems (cells, organs, organisms, communities), and between living systems and the physical environment, chemical elements are recombined into different products. | Cite evidence that the transfer and transformation of matter and energy links organisms to one another and to their physical setting. **(5.3.12.B.1)** |

**Instructional Focus:**

- Tracing the cycling of atoms and molecules on Earth among the living and nonliving components of the biosphere
- Explaining how molecules are used to assemble larger molecules with biological activity (including proteins, DNA, sugars and fats)
    - *Assessments will not include the representations of specific detailed steps of synthesis and decomposition (intermediate steps and molecules, details of dehydration synthesis)*
- Following the transfer of matter (molecules) from one organism to another repeatedly and between organisms and their physical environment
- Identifying how the total amount of matter in a system remains constant, even though its form and location change

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Give examples of chemical reactions (e.g., synthesis of glycogen, oxidation of glucose) involved in basic functions of organisms in which the reactants and products of the reaction are paired with reactions involving ATP and ADP and an inorganic phosphate.<br>Construct an illustration, in terms of reactants and products, of the chemical reactions of basic functions and ATP<br>and ADP with an inorganic phosphate.<br><br>Construct a representation of the transfer of energy through an ecosystem, starting with the Sun and ending with increased motion of molecules in the environment. Representation should reflect the idea that energy is conserved. Explain, based on the transformation of chemical energy to thermal energy at various trophic levels and on the nature of reactions, the need for<br>constant input of energy into an ecosystem.<br><br>Construct a representation that links the movement of matter (i.e., carbon atom, water molecule) and the transfer of energy through the processes of photosynthesis and cellular respiration. Predict and justify, based on knowledge of energy transfer and matter cycling, what might happen to the mass of a biosystem if the source of energy were limited. | - Detailed chapter outlines for each unit<br>- Answer essential questions<br>- Ecosystem (biome) project<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses |

**B. Matter and Energy Transformations:** Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

| Essential Questions | Enduring Understandings |
|---|---|
| How is matter transferred and energy transferred/ transformed in living systems? | All organisms transfer matter and convert energy from one form to another. Both matter and energy are necessary to build and maintain structures within the organism. |
| **Content Statements** | **Cumulative Progress Indicators** |
| Each recombination of matter and energy results in storage and dissipation of energy into the environment as heat. | Use mathematical formulas to justify the concept of an efficient diet. **(5.3.12.B.2)** |

**Instructional Focus:**

- Explaining how food webs are limited and how pyramidal relationships exist
- Recognizing that all matter tends toward more disorganized states, and that living systems require a continuous input of energy to maintain their chemical and physical organizations
- Recognizing that the chemical bonds of food molecules contain energy, which is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed
    - *Assessments will not include the representations of specific detailed steps of synthesis and decomposition (intermediate steps and molecules, details of dehydration synthesis)*
- Calculating the trends in production, use and transfer of energy from one trophic level to another using data

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Give examples of functions (e.g., removal of wastes, muscular activity, cell division) that are carried out by organisms and that involve the conversion of ATP to ADP (adenosine diphosphate) and an inorganic phosphate.<br><br>Give examples of chemical reactions (e.g., synthesis of glycogen, oxidation of glucose) involved in basic functions of organisms in which the reactants and products of the reaction are paired with reactions involving ATP and ADP and an inorganic phosphate.<br>Construct an illustration, in terms of reactants and products, of the chemical reactions of basic functions and ATP<br>and ADP with an inorganic phosphate.<br><br>Construct a model of a food chain that includes a quantification of the distribution and buildup of a potentially damaging chemical that is introduced into an ecosystem. Predict, using the model, consequences at each trophic level as the relative concentration of the chemical increases. Justification includes changes in the number of organisms at each trophic level,<br>matter cycling, and energy transfer from one level to another.<br><br>In Kcal analyze and quantify the movement of a given quantity of energy through an actual ecosystem | - Detailed chapter outlines for each unit<br>- Answer essential questions<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Energy pyramid analysis<br>- Food chain project |
| | - |

**B. Matter and Energy Transformations:** Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

| Essential Questions | Enduring Understandings |
|---|---|
| How is matter transferred and energy transferred/ transformed in living systems? | All organisms transfer matter and convert energy from one form to another. Both matter and energy are necessary to build and maintain structures within the organism. |

| Content Statements | Cumulative Progress Indicators |
|---|---|
| Continual input of energy from sunlight keeps matter and energy flowing through ecosystems. | Predict what would happen to an ecosystem if an energy source was removed. **(5.3.12.B.3)** |

**Instructional Focus:**

- Tracing the path that energy entering ecosystems as sunlight follows when being transferred by producers into chemical energy through photosynthesis, and then being passed from organism to organism through food webs
    - *Assessments will not include the representations of specific detailed steps of photosynthesis and respiration (intermediate steps and products of the Calvin cycle, Krebs/citric acid cycle, and glycolysis*)
- Recognizing that living systems require a continuous input of energy to maintain their chemical and physical organizations and also understanding that with death (the cessation of energy input), living systems rapidly disintegrate

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Construct a graphical representation of the number of sugar molecules that are broken down into carbon dioxide and the amount of ATP (adenosine triphosphate) that is produced during fermentation (when oxygen is limited) and during cellular respiration (when oxygen is available). Explain, using the representation, common exercise phenomena (e.g., lactic acid buildup, changes in breathing during and after exercise, cool down after exercise).<br><br>Investigate variables that affect the processes of fermentation and/or cellular respiration in living organisms.<br><br>Formulate a scientific question about the relationship between variables (e.g., type of food, temperature, process input, process output) that impact fermentation and/or cellular respiration.<br><br>Gather and record data (e.g., color indicator change, pulse rate, amount and type of product or reactant), using tools to improve accuracy and precision of measurements, and complete multiple trials or use class data.<br><br>Construct graphs and tables of data for changes in the different variable conditions.<br><br>Calculate changes in rate, percent change, averages and measurement error in order to analyze data and discover patterns. Evaluate the data as it relates to the formulated scientific question.<br><br>Coordinate the results of different investigations that have analyzed different variables that impact either fermentation or cellular respiration. Construct a representation of all of the evidence collected from the various studies.<br><br>Make a claim, based on evidence collected from all investigations, about real-world phenomena (e.g., ethanol production, wine or bread making, exercise).<br><br>Give examples of functions that are carried out by organisms and that involve the conversion of ATP to ADP and an inorganic phosphate | **AP Lab 5: Respiration***<br>*Lab Objectives:*<br>*relate oxygen consumption to respiration rate*<br>*test the effect of temperature on the rate of cell respiration rate in ungerminated versus germinated seed in a controlled experiment*<br><br>**AP Lab 4: Chromatography and Photosynthesis***<br>*Lab Objectives:*<br>*separate pigments and calculate their $R_f$ values*<br>*-measure percent of light transmitted to determine rate of photosynthesis*<br>*explain why the rate of photosynthesis varies under different environmental conditions*<br><br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses |

**B. Matter and Energy Transformations:** Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

| Essential Questions | Enduring Understandings |
|---|---|
| How is matter transferred and energy transferred/ transformed in living systems? | All organisms transfer matter and convert energy from one form to another. Both matter and energy are necessary to build and maintain structures within the organism. |
| **Content Statements** | **Cumulative Progress Indicators** |
| Plants have the capability to take energy from light to form sugar molecules containing carbon, hydrogen, and oxygen. | Explain how environmental factors (such as temperature, light intensity, and the amount of water available) can affect photosynthesis as an energy storing process. **(5.3.12.B.4)** |

**Instructional Focus:**

- Recognizing the process of photosynthesis as providing a vital connection between the sun and the energy needs of living systems
- Describing how plants capture energy by absorbing light and use it to form strong chemical bonds between the atoms of carbon-containing molecules
    - *Assessments will not include the representations of specific detailed steps of photosynthesis (intermediate steps and products of the light-dependent and light-independent reactions)*
- Designing independent investigations to determine the effects of changing environmental factors on photosynthesis

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Give examples of chemical reactions (e.g., synthesis of glycogen, oxidation of glucose) involved in basic functions of organisms in which the reactants and products of the reaction are paired with reactions involving ATP and ADP and an inorganic phosphate. Construct an illustration, in terms of reactants and products, of the chemical reactions of basic functions and ATP and ADP with an inorganic phosphate.<br><br>Construct a representation of the transfer of energy through an ecosystem, starting with the Sun and ending with increased motion of molecules in the environment. Representation should reflect the idea that energy is conserved. Explain, based on the transformation of chemical energy to thermal energy at various trophic levels and on the nature of reactions, the need for constant input of energy into an ecosystem.<br><br>Construct a representation that links the movement of matter (i.e., carbon atom, water molecule) and the transfer of energy through the processes of photosynthesis and cellular respiration. Predict and justify, based on knowledge of energy transfer and matter cycling, what might happen to the mass of a biosystem if the source of energy were limited.<br><br>Construct a model of a food chain that includes a quantification of the distribution and buildup of a potentially damaging chemical that is introduced into an ecosystem. Predict, using the model, consequences at each trophic level as the relative concentration of the chemical increases. Justification includes changes in the number of organisms at each trophic level, matter cycling, and energy transfer from one level to another.<br><br>Describe the function of at least one type of organ located in two different plants or in two different animals. Description includes the similarities and differences in the cells that make up the organ, and the similarities and differences in the processes that the cells perform to support the function of the organ in the two organisms | - Detailed chapter outlines for each unit<br>- Answer essential questions<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Cycling of Matter diagram |

**B. Matter and Energy Transformations:** Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

| Essential Questions | Enduring Understandings |
|---|---|
| How is matter transferred and energy transferred/ transformed in living systems? | All organisms transfer matter and convert energy from one form to another. Both matter and energy are necessary to build and maintain structures within the organism. |

| Content Statements | Cumulative Progress Indicators |
|---|---|
| In both plant and animal cells, sugar is a source of energy and can be used to make other carbon-containing (organic) molecules. | Investigate and describe the complementary relationship (cycling of matter and flow of energy) between photosynthesis and cellular respiration. **(5.3.12.B.5)** |

**Instructional Focus:**

- Analyzing and describing how the process of photosynthesis provides a vital connection between the sun and the energy needs of living systems
- Explaining how plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment
    - *Assessments will not include the representations of specific detailed steps of photosynthesis and respiration (intermediate steps and products of the Calvin cycle, Krebs/citric acid cycle, and glycolysis)*

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Give examples of chemical reactions (e.g., synthesis of glycogen, oxidation of glucose) involved in basic functions of organisms in which the reactants and products of the reaction are paired with reactions involving ATP and ADP and an inorganic phosphate. Construct an illustration, in terms of reactants and products, of the chemical reactions of basic functions and ATP and ADP with an inorganic phosphate.<br><br>Construct a representation of the transfer of energy through an ecosystem, starting with the Sun and ending with increased motion of molecules in the environment. Representation should reflect the idea that energy is conserved. Explain, based on the transformation of chemical energy to thermal energy at various trophic levels and on the nature of reactions, the need for constant input of energy into an ecosystem.<br><br>Construct a representation that links the movement of matter (i.e., carbon atom, water molecule) and the transfer of energy through the processes of photosynthesis and cellular respiration. Predict and justify, based on knowledge of energy transfer and matter cycling, what might happen to the mass of a biosystem if the source of energy were limited. | **AP Lab 9: Transpiration***<br>*Lab Objectives:*<br>*- Test the effects of environmental variables on rates of transpiration using a controlled experiment.*<br>*-Make thin sections of stem, identify xylem and phloem cells, and relate the function of these vascular tissues to the structures of their cells.*<br><br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Plant hormone poster |

**B. Matter and Energy Transformations:** Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

| Essential Questions | Enduring Understandings |
|---|---|
| How is matter transferred and energy transferred/ transformed in living systems? | All organisms transfer matter and convert energy from one form to another. Both matter and energy are necessary to build and maintain structures within the organism. |
| **Content Statements** | **Cumulative Progress Indicators** |
| All organisms must break the high-energy chemical bonds in food molecules during cellular respiration to obtain the energy needed for life processes. | Explain how the process of cellular respiration is similar to the burning of fossil fuels. **(5.3.12.B.6)** |

**Instructional Focus:**

- Examining how the breakdown of some food molecules enables the cell to store energy in specific molecules that are used to carry out the many functions of the cell
- Tracing the process in which nutrients are transported to cells to serve as building blocks for the synthesis of structures and as reactants for cellular respiration
    - *Assessments will not include the representations of specific detailed steps of respiration (intermediate steps and products of the Krebs/citric acid cycle and glycolysis)*
- Recognizing that food molecules are taken into cells and react to provide the chemical constituents needed to synthesize other molecules, and knowing that the breakdown and synthesis are made possible by enzymes
    - *Assessments will not include the representations of specific detailed steps of synthesis and decomposition (intermediate steps and molecules, details of dehydration synthesis)*

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Construct a graphical representation of the number of sugar molecules that are broken down into carbon dioxide and the amount of ATP (adenosine triphosphate) that is produced during fermentation (when oxygen is limited) and during cellular respiration (when oxygen is available). Explain, using the representation, common exercise phenomena (e.g., lactic acid buildup, changes in breathing during and after exercise, cool down after exercise).<br><br>Give examples of functions (e.g., removal of wastes, muscular activity, cell division) that are carried out by organisms and that involve the conversion of ATP to ADP (adenosine diphosphate) and an inorganic phosphate.<br><br>Give examples of chemical reactions (e.g., synthesis of glycogen, oxidation of glucose) involved in basic functions of organisms in which the reactants and products of the reaction are paired with reactions involving ATP and ADP and an inorganic phosphate. Construct an illustration, in terms of reactants and products, of the chemical reactions of basic functions and ATP and ADP with an inorganic phosphate.<br><br>Give examples of several enzyme-catalyzed reactions that occur in living systems, and describe the importance of each reaction for the organism. Explain why an organism that has a deficiency of one of the enzymes is unable to perform a particular life function. | - Detailed chapter outlines for each unit<br>- Answer essential questions<br>- Corresponding worksheets<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses |

**5.3 Life Science:** Life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

**C. Interdependence:** All animals and most plants depend on both other organisms and their environment to meet their basic needs.

| Essential Questions | Enduring Understandings |
|---|---|
| How are organisms dependant on each other? | The survival of organisms is affected by interactions with each other and their environment, and can be altered by human manipulation. |
| **Content Statements** | **Cumulative Progress Indicators** |
| Biological communities in ecosystems are based on stable interrelationships and interdependence of organisms. | Analyze the interrelationships and interdependencies among different organisms, and explain how these relationships contribute to the stability of the ecosystem. **(5.3.12.C.1)** |

**Instructional Focus:**

- Analyzing the interactions between organisms that result from the ability to produce populations of infinite size in an environment where resources are finite
- Providing evidence of how organisms both cooperate and compete in ecosystems
- Using evidence to explain why interrelationships and interdependencies of organisms may generate stable ecosystems

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Describe the abiotic characteristics of an ecosystem: its boundaries, its components, its inputs and outputs, and its interactions, as well as the boundaries and other characteristics of overlapping ecosystems.<br><br>Analyze data (e.g., mean, mode, spread of data, sampling error) that show the number of different species and the number of organisms within a species in two or more ecosystems over time (one of the ecosystems has more fluctuations than the other). Make a claim about the relative stability of each ecosystem. Devise a measure of relative stability, taking into account whether the stability is simply a lack of fluctuation of organism numbers, or if the stability should be measured based on a regular recurrence of a cyclical pattern of variation in an ecosystem.<br><br>Gather information — and, when appropriate, numerical data — from print and electronic resources about the stability of various ecosystems, in terms of changes in the biotic and abiotic components of those ecosystems over time. Make a claim, based on this information and/or data, about whether the ecosystem is stable or unstable, and describe which conditions/<br>factors indicate stability or instability.<br><br>Analyze data that depict changes in the abiotic components of an ecosystem and changes in the biotic components of an ecosystem over time (e.g., percent change, average change, correlation and proportionality). Evaluate claims of possible relationships between the changes in the abiotic components and the biotic components of the environment. | **AP Lab 11: Animal Behavior***<br>*Lab Objectives:*<br>*- Describe some aspects of animal behavior, such as orientation, behavior, agonistic behavior, dominance display, or mating behavior. (*Interdependence in Nature)<br>*- Understand the adaptiveness of the behaviors studied.*<br><br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Ecosystem/Biome project<br>- Ecosystem webquest |

| **C. Interdependence:** All animals and most plants depend on both other organisms and their environment to meet their basic needs. | |
|---|---|
| **Essential Questions** | **Enduring Understandings** |
| How are organisms dependant on each other? | The survival of organisms is affected by interactions with each other and their environment, and can be altered by human manipulation. |
| **Content Statements** | **Cumulative Progress Indicators** |
| Stability in an ecosystem can be disrupted by natural or human interactions. | Model how natural and human-made changes in the environment will affect individual organisms and the dynamics of populations. **(5.3.12.C.2)** |

**Instructional Focus:**

- Identifying situations where humans intentionally and unintentionally modify ecosystems as a result of population growth, technology, and consumption
- Providing evidence of how human destruction of habitats threatens current local and global ecosystem stability
- Predicting how direct harvesting, pollution, atmospheric changes, and other factors will affect population dynamics in a given ecosystem based on data and accepted mathematical models
- Predicting how natural disasters such as hurricanes, floods, volcanoes will affect population dynamics in a given ecosystem based on data and accepted mathematical models

| **Desired Results** | **Investigations, Labs, and Sense Making Experiences** |
|---|---|
| Describe the abiotic characteristics of an ecosystem: its boundaries, its components, its inputs and outputs, and its interactions, as well as the boundaries and other characteristics of overlapping ecosystems.<br><br>Analyze data that depict changes in the abiotic components of an ecosystem and changes in the biotic components of an ecosystem over time (e.g., percent change, average change, correlation and proportionality). Evaluate claims of possible relationships between the changes in the abiotic components and the biotic components of the environment.<br><br>Predict what will happen to the number of organisms of a given species in an ecosystem following a temporary biotic or abiotic change in that ecosystem (e.g., a very cold winter or a disease that kills large numbers of one of the species in the ecosystem) and what will happen after conditions return to what they were before the disruption. Justification for the prediction is based on knowledge of how ecosystems typically respond to temporary changes in environmental conditions, how this particular ecosystem has responded to such changes in the past, and the scale of these particular changes. | - Detailed chapter outlines for each unit<br>- Answer essential questions<br>- Corresponding worksheets<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses and essay<br>1. Discussion: Human Impact on Ecosystem especially the Carbon/Oxygen cycle |

**5.3 Life Science:** Life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

**D. Heredity and Reproduction:** Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.

| Essential Questions | Enduring Understandings |
|---|---|
| How is genetic information passed through generations? | There are predictable patterns of inheritance, and the variation that exists within a species is related to its mode of reproduction (sexual or asexual). |
| **Content Statements** | **Cumulative Progress Indicators** |
| Genes are segments of DNA molecules located in the chromosome of each cell. DNA molecules contain information that determines a sequence of amino acids, which result in specific proteins. | Explain the value and potential applications of genome projects. **(5.3.12.D.1)** |

**Instructional Focus:**

- Recognizing that the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (adenine, thymine, guanine, and cytosine)
  - *Assessments will not include the identification of the structure of specific nucleotides or the nature of bonding between DNA strands*
- Explaining how the chemical and structural properties of DNA allow for genetic information to be both encoded in genes and replicated
  - *Assessments will not include the individual detailed steps of the processes of transcription and translation*
- Identifying that hereditary information is contained in genes, located in the chromosomes of each cell, and each gene carries a single unit of information
- Providing specific examples of how an inherited trait of an individual can be determined by one or many genes and a single gene can influence more than one trait
- Analyzing the current and potential impact of genome projects on human health (e.g. pathogenic bacteria or disease vectors) or species with commercial importance (e.g. livestock and crop plants)

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Construct a representation that illustrates the process of the production of the amino acid sequence of a section of a given protein molecule from an organism. Representation should first show the relationship between these amino acids and a sequence of nucleotide bases in RNA, and then show the relationship between that sequence of nucleotide bases in RNA and the sequence of bases in DNA.<br><br>Describe how traits in organisms are the result of DNA structure. Include ideas about the connection between traits and proteins, the connection between protein structure and the sequence of bases in RNA, and the connection between RNA sequence and DNA sequence.<br><br>Analyze the primary structure (amino acid sequence) of specific proteins (e.g., insulin and hemoglobin). Create a table showing which amino acids make up each protein molecule, and the numbers of each amino acid that make up these proteins.<br><br>Evaluate and, if necessary, revise representations that illustrate the processes of transcription and translation to show how the sequence of nucleotide bases produces a complementary strand of bases in RNA (ribonucleic acid), and how each sequence of three bases in RNA codes for specific amino acids that are linked together to make proteins.<br><br>Give examples, using information gathered from print and electronic resources, of traits that result from specific proteins. Include examples of the following types of proteins: structural, regulatory and enzymatic. Examples should span structural, behavioral and physiological traits.<br><br>Give examples, using information gathered from print and electronic resources, of | - Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Corresponding worksheets<br>- Discussions and discussion analyses<br>- Amino acid diagram |

| | |
|---|---|
| traits that depend on the quantity of protein produced, which, in turn, is dependent on the number of copies of a particular version of a gene. Predict and justify how zero, one or two copies of a particular version of a gene might affect the expression of a particular trait.<br><br>Identify functions performed by DNA segments that do not code for proteins. | |

**D. Heredity and Reproduction:** Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.

| Essential Questions | Enduring Understandings |
|---|---|
| How is genetic information passed through generations? | There are predictable patterns of inheritance, and the variation that exists within a species is related to its mode of reproduction (sexual or asexual). |
| **Content Statements** | **Cumulative Progress Indicators** |
| Inserting, deleting, or substituting DNA segments can alter the genetic code.<br><br>An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on the offspring's success in its environment. | Predict the potential impact on an organism (no impact, significant impact) given a change in a specific DNA code, and provide specific real world examples of conditions caused by mutations. **(5.3.12.D.2)** |

**Instructional Focus:**

- Recognizing that changes in DNA (mutations) occur spontaneously at low rates, and some of these changes make no difference to the organism, whereas others can change cells and organisms
- Explaining that only mutations in germ cells can create the variation that changes an organism's offspring
  - *Assessments will not include the specific detailed steps of meiosis*
- Tracing the progression of conditions that result from genetic mutation in a variety of different organisms

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Explain, based on knowledge of how sex cells form in sexually reproducing organisms, why there is variation among offspring, even within the same family.<br><br>Explain, using information on a particular error in copying DNA during replication for a specific trait (e.g., insertion, deletion or substitution), why there could be an alteration in that trait. Justification is based on knowledge of the relationship among DNA, proteins and traits.<br><br>Explain why an insertion, deletion or substitution of an individual nucleotide base affects not only the amino acid sequence of the proteins that are produced but also the protein structure that result from the altered amino acid sequence.<br><br>Give examples, using evidence gathered from print and electronic resources, of genetic diseases (e.g., cystic fibrosis, sicklecell anemia, Tay-Sachs disease or phenylketonuria) that result from mutations to a single gene. Identify, for each example, the specific type of mutation that causes the change in amino acid sequence and ultimately the change in the protein that is produced.<br><br>Estimate and justify how many variations are possible in the set of chromosomes (DNA molecules) that the sex cells of a particular organism (e.g., mosquito, fruit fly or other organism with a low number of chromosomes) receive during sex cell formation. Construct a model that includes a label for each chromosome and that illustrates some of the possible combinations<br>of chromosomes that will be present in the sex cells that are produced.<br><br>Construct a model of a particular gene on a pair of DNA molecules. Construct a new model that incorporates the DNA molecule model into a model of homologous chromosomes in a cell nucleus.<br><br>Give examples, using information gathered from electronic resources, print and of traits that result from specific proteins. Include examples of the following types of proteins: structural, regulatory and enzymatic. Examples should span structural, behavioral and physiological traits. | **AP Lab 3b:Meiosis***<br>*Lab Objectives:*<br>*-Use chromosome models to demonstrate the activity of chromosomes during meiosis I and meiosis II*<br>*-Describe how independent assortment and crossing over can generate genetic variation among the products of meiosis*<br>*-Compare and contrast the results of meiosis and mitosis*<br>*-Calculate the map distance of a particular gene from a chromosome's center or between two genes using a model organism*<br>*- Compare and contrast the results of meiosis and mitosis in plant cells*<br>*- Compare and contrast the results of meiosis and mitosis in animal cells*<br><br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Corresponding worksheets<br>- Discussions and discussion analyses |

| | |
|---|---|
| Give examples, using information gathered from print and electronic resources, of traits that depend on the quantity of protein produced, which, in turn, is dependent on the number of copies of a particular version of a gene. Predict and justify how zero, one or two copies of a particular version of a gene might affect the expression of a particular trait. | |

**D. Heredity and Reproduction:** Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.

| Essential Questions | Enduring Understandings |
|---|---|
| How is genetic information passed through generations? | There are predictable patterns of inheritance, and the variation that exists within a species is related to its mode of reproduction (sexual or asexual). |
| **Content Statements** | **Cumulative Progress Indicators** |
| Sorting and recombination of genes in sexual reproduction result in a great variety of possible gene combinations in the offspring of any two parents. | Demonstrate through modeling how the sorting and recombination of genes during sexual reproduction has an effect on variation in offspring (meiosis, fertilization). **(5.3.12.D.3)** |

**Instructional Focus:**

- Explaining the process where an egg and sperm unite to begin the development of a new individual, and how that new individual receives genetic information from its parents
    - *Assessments will not include the specific detailed steps of meiosis, fertilization and early embryological development*
- Explaining how sexually produced offspring are never identical to either of their parents
- Understanding how new heritable characteristics can result from new combinations of existing genes in reproductive cells
- Recognizing how heritable characteristics can strongly influence what capabilities an organism will have, therefore influencing how likely it is to survive and reproduce

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Explain, based on knowledge of how sex cells form in sexually reproducing organisms, why there is variation among offspring, even within the same family.<br><br>Construct a representation — or several representations — of sex cell formation, demonstrating that the DNA of the daughter cells is different from the DNA of the parent cell. Representation includes the process of replication, the separation of homologous chromosomes (first stage of meiosis), and the separation of the replicated chromosomes to create cells with just a single version of each chromosome (second stage of meiosis).<br><br>Observe the variation of traits among the individual organisms within a population. Explain, based on the transmission of genetic information, why there is so much variation within the population.<br><br>Estimate and justify how many variations are possible in the set of chromosomes (DNA molecules) that the sex cells of a particular organism (e.g., mosquito, fruit fly or other organism with a low number of chromosomes) receive during sex cell formation. Construct a model that includes a label for each chromosome and that illustrates some of the possible combinations<br>of chromosomes that will be present in the sex cells that are produced.<br><br>Construct a model of a particular gene on a pair of DNA molecules. Construct a new model that incorporates the DNA molecule model into a model of homologous chromosomes in a cell nucleus | .<br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Corresponding worksheets<br>- Discussions and discussion analyses<br>- Meiosis diagram |

**5.3 Life Science:** Life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of natural systems can be modeled and predicted through the use of mathematics.

**E. Evolution and Diversity:** Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

| Essential Questions | Enduring Understandings |
|---|---|
| How does natural selection encourage inter and intra-specific diversity over time? | The diversity and changing of life forms over many generations is the result of natural selection, in which organisms with advantageous traits survive, reproduce, and pass those traits to offspring. |
| **Content Statements** | **Cumulative Progress Indicators** |
| New traits may result from new combinations of existing genes or from mutations of genes in reproductive cells within a population. | Account for the appearance of a novel trait that arose in a given population. **(5.3.12.E.1)** |

**Instructional Focus:**

- Recognizing how heritable characteristics can strongly influence how likely an individual is to survive and reproduce
- Describing how evolution involves changes in the genetic make-up of whole populations over time, not changes in the genes of an individual organism
- Analyzing natural selection simulations and use the data generated to describe how environmentally favored traits are perpetuated over generations resulting in species survival, while less favorable traits decrease in frequency or may lead to extinction

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Provide evidence — reported in print and electronic resources, and regarding similarities and differences between organisms from the fossil record and preserved DNA — that supports the idea of descent with modification. Explain how similarities and differences among organisms support the idea of descent with modification.<br><br>Give examples of how, following a change in environmental conditions, variation in traits within a specific population of organisms might affect the survival and reproductive ability of some of the organisms in that population, but not other organisms in the same population. Give examples of other environmental changes that may not affect the survival and reproduction of any of these organisms. Describe the type of data needed to determine whether the survival or reproductive success of individual organisms was due to the genetic variation within the population.<br><br>Explain similarities and differences between populations (e.g., dogs, horses, crops) undergoing artificial selection and populations undergoing natural selection. Describe the roles that humans play in artificial selection and how these roles are similar to the natural processes that take place in natural selection.<br><br>Give examples, using information gathered from print and electronic resources, of observations made by Charles Darwin of variation within species and of changes in environmental conditions that he used in the development of his theory of natural selection. For each example, explain how the observations support the theory of natural selection | **AP Lab 8: Population Genetics and Evolution***<br>*Lab Objective:*<br>*discuss natural selection and other causes of microevolution and deviations from the conditions required to maintain Hardy-Weinberg equilibrium*<br><br>- Pro vs con evolution research paper<br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Corresponding worksheets |

**E. Evolution and Diversity:** Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

| Essential Questions | Enduring Understandings |
|---|---|
| How does natural selection encourage inter and intra-specific diversity over time? | The diversity and changing of life forms over many generations is the result of natural selection, in which organisms with advantageous traits survive, reproduce, and pass those traits to offspring. |
| **Content Statements** | **Cumulative Progress Indicators** |
| Molecular evidence (e.g., DNA, protein structures, etc.) substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched. | Estimate how closely related species are, based on scientific evidence (e.g., anatomical similarities, similarities of DNA base and/or amino acid sequence). **(5.3.12.E.2)** |

**Instructional Focus:**

- Identifying, explaining and demonstrating how technology can be used to determine evolutionary relationships among species (gel electrophoresis, DNA/amino acid sequences)
  - *Assessments will not include the mechanisms of biotechnologies such as PCR, electrophoresis*
- Integrating scientific information from a variety of disciplines to provide evidence for the relatedness of species on Earth (geology, comparative anatomy, biochemistry, and taxonomy)

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Construct a simple model (e.g., phylogenetic tree), based on anatomical evidence (physical traits), of the degree of relatedness among various organisms. If necessary, revise the model based on the inclusion of new molecular (i.e., DNA and/or amino acid) evidence.<br><br>Explain, in terms of preserved DNA sequences, why specific extinct or extant organisms within a line of descent are considered to be either closely or more distantly related (i.e., share a common ancestor).<br><br>Explain similarities and differences between populations (e.g., dogs, horses, crops) undergoing artificial selection and populations undergoing natural selection. Describe the roles that humans play in artificial selection and how these roles are similar to the natural processes that take place in natural selection.<br><br>Give examples, using information gathered from print and electronic resources, of different organisms whose classification as members of different "species" is questionable. After evaluating the two different proposed definitions of the term "species" that led to the controversial classification of the organisms, make and justify a claim about whether or not the organisms provided as examples should be considered members of different species or of the same species | **AP Lab 11: Animal Phyla Observation**<br>*Lab Objectives:*<br>*-observe basic differences in animal phyla*<br>*-classify animals into their proper phyla*<br><br>- Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Candy classification lab<br>- Corresponding worksheets |

**E. Evolution and Diversity:** Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

| Essential Questions | Enduring Understandings |
|---|---|
| How does natural selection encourage inter and intra-specific diversity over time? | The diversity and changing of life forms over many generations is the result of natural selection, in which organisms with advantageous traits survive, reproduce, and pass those traits to offspring. |
| **Content Statements** | **Cumulative Progress Indicators** |
| The principles of evolution (including natural selection and common descent) provide a scientific explanation for the history of life on Earth as evidenced in the fossil record and in the similarities that exist within the diversity of existing organisms. | Provide a scientific explanation for the history of life on Earth using scientific evidence (e.g., fossil record, DNA, protein structures, etc.). **(5.3.12.E.3)** |

**Instructional Focus:**

- Recognizing that a change in a species over time does not follow a set pattern or timeline
- Explaining how the millions of different species on Earth today are related by common ancestry using evidence
- Using natural selection and its evolutionary consequences to provide a scientific explanation for the fossil record of ancient life forms, and the molecular similarities observed among the diverse species of living organisms
    - *Assessments will not include the classification of organisms in taxa*

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Compare the effects of a significant environmental change on a population with great genetic diversity and the effects of such a change on a population with little genetic diversity. In each instance, indicate the environmental change, the organisms within the species that were affected, and the organisms that were not affected. Explain why genetic variation among organisms within the species affected the survival of the species.<br><br>Construct a model or run a simulation that represents natural selection in terms of how changes in environmental conditions can result in selective pressure on a population of organisms.<br><br>Gather and record data from the model or simulation on the composition (e.g., distribution of traits, number of organisms, change in environmental conditions) of a population under varying environmental conditions. Complete multiple trials or use class data.<br><br>Represent the data in a way that demonstrates the relationship, if any, between the nvironmental changes and the population.<br><br>Calculate measures of central tendencies (i.e., mean, median, mode), represent spread of data (e.g., range), and determine error (e.g., number of **outliers**) of each variable in order to analyze the data and make a claim about the patterns observed.<br><br>Explain how each part of the model or simulation is similar to, or different from, the process of natural selection.<br><br>Predict and justify, based on ideas about natural selection, what might happen to a population of organisms after many generations if the population becomes geographically isolated from another population of the same species, and if the two groups experience different **biotic** and/or environmental conditions. | - Detailed chapter outlines for each unit<br>- Answer essential questions<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Corresponding worksheets |

**E. Evolution and Diversity:** Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

| Essential Questions | Enduring Understandings |
|---|---|
| How does natural selection encourage inter and intra-specific diversity over time? | The diversity and changing of life forms over many generations is the result of natural selection, in which organisms with advantageous traits survive, reproduce, and pass those traits to offspring. |
| **Content Statements** | **Cumulative Progress Indicators** |
| Evolution occurs as a result of a combination of the following factors:<br>• Ability of a species to reproduce<br>• Genetic variability of offspring due to mutation and recombination of genes<br>• Finite supply of the resources required for life<br>• Natural selection, due to environmental pressure, of those organisms better able to survive and leave offspring | Account for the evolution of a species by citing specific evidence of biological mechanisms. **(5.3.12.E.4)** |

**Instructional Focus:**

- Discussing how environmental pressure, genetic drift, mutation and competition for resources influence the evolutionary process
- Predicting possible evolutionary implications for a population due to environmental changes over time (e.g., volcanic eruptions, global climate change, pollution)

| Desired Results | Investigations, Labs, and Sense Making Experiences |
|---|---|
| Give examples of how, following a change in environmental conditions, variation in traits within a specific population of organisms might affect the survival and reproductive ability of some of the organisms in that population, but not other organisms in the same population. Give examples of other environmental changes that may not affect the survival and reproduction of any of these organisms. Describe the type of data needed to determine whether the survival or reproductive success of individual organisms was due to the genetic variation within the population.<br><br>Explain similarities and differences between populations (e.g., dogs, horses, crops) undergoing artificial selection and populations undergoing natural selection. Describe the roles that humans play in artificial selection and how these roles are similar to the natural processes that take place in natural selection.<br><br>Predict and justify, based on ideas about natural selection, what might happen to a population of organisms after many generations if the population becomes geographically isolated from another population of the same species, and if the two groups experience different **biotic** and/or environmental conditions. | - Detailed chapter outlines for each unit<br>- Literature review research papers based on current scientific articles<br>- Discussions and discussion analyses<br>- Corresponding worksheets |

**5.1 Science Practices:** Science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

**A. Understand Scientific Explanations**: Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

| Essential Question | Enduring Understanding |
|---|---|
| How do we build and refine models that describe and explain the natural and designed world? | Measurement and observation tools are used to categorize, represent and interpret the natural world. |

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Mathematical, physical, and computational tools are used to search for and explain core scientific concepts and principles. | Refine interrelationships among concepts and patterns of evidence found in different central scientific explanations. **(5.1.12.A.1)** |

**Instructional Focus:**

- Learning facts, concepts, principles, theories and models; then
- Developing an understanding of the relationships among facts, concepts, principles, theories and models; then
- Using these relationships to understand and interpret phenomena in the natural world

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Interpretation and manipulation of evidence-based models are used to build and critique arguments/explanations. | Develop and use mathematical, physical, and computational tools to build evidence-based models and to pose theories. **(5.1.12.A.2)** |

**Instructional Focus:**

- Using tools, evidence and data to observe, measure, and explain phenomena in the natural world
- Developing evidence-based models based on the relationships among fundamental concepts and principals
- Constructing and refining explanations, arguments or models of the natural world through the use of quantitative and qualitative evidence and data

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence. | Use scientific principles and theories to build and refine standards for data collection, posing controls, and presenting evidence. **(5.1.12.A.3)** |

**Instructional Focus:**

- Understanding that data differs in quality and strength of explanatory power based on experimental design
- Evaluating strength of scientific arguments based on the quality of the data and evidence presented
- Critiquing scientific arguments by considering the selected experimental design and method of data analysis

**5.1 Science Practices:** Science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

**B. Generate Scientific Evidence Through Active Investigations:** Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.

| Essential Question | Enduring Understanding |
|---|---|
| What constitutes useful scientific evidence? | Evidence is used for building, refining, and/or critiquing scientific explanations. |

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations. | Design investigations, collect evidence, analyze data, and evaluate evidence to determine measures of central tendencies, causal/correlational relationships, and anomalous data. **(5.1.12.B.1)** |

**Instructional Focus:**

- Asking a question and deciding what to measure in order to answer the question
- Developing strategies for obtaining measurements, then systematically collecting data
- Structuring the gathered data, then interpreting and evaluating the data
- Using the empirical results to determine causal/correlational relationships

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Mathematical tools and technology are used to gather, analyze, and communicate results. | Build, refine, and represent evidence-based models using mathematical, physical, and computational tools. **(5.1.12.B.2)** |

**Instructional Focus:**

- Using mathematics in the collection and treatment of data and in the reasoning used to develop concepts, laws and theories
- Using tools of data analysis to organize data and formulate hypotheses for further testing
- Using existing mathematical, physical, and computational models to analyze and communicate findings

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Empirical evidence is used to construct and defend arguments. | Revise predictions and explanations using evidence, and connect explanations/arguments to established scientific knowledge, models, and theories. **(5.1.12.B.3)** |

**Instructional Focus:**

- Making claims based on the available evidence
- Explaining the reasoning, citing evidence, behind a proposed claim
- Connecting the claim to established concepts and principles

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Scientific reasoning is used to evaluate and interpret data patterns and scientific conclusions. | Develop quality controls to examine data sets and to examine evidence as a means of generating and reviewing explanations. **(5.1.12.B.4)** |

**Instructional Focus:**

- Analyzing experimental data sets using measures of central tendency
- Representing and describing mathematical relationships among variables using graphs and tables
- Using mathematical tools to construct and evaluate claims

**5.1 Science Practices:** Science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

**C. Reflect on Scientific Knowledge:** Scientific knowledge builds on itself over time.

| Essential Question | Enduring Understanding |
|---|---|
| How is scientific knowledge constructed? | Scientific knowledge builds upon itself over time. |

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Refinement of understandings, explanations, and models occurs as new evidence is incorporated. | Reflect on and revise understandings as new evidence emerges. **(5.1.12.C.1)** |

**Instructional Focus:**

- Reflecting on the status of one's own thinking and learning (i.e. uncovering how a student knows what they know and why)
- Understanding that scientific knowledge can be revised as new evidence emerges

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Data and refined models are used to revise predictions and explanations. | Use data representations and new models to revise predictions and explanations. **(5.1.12.C.2)** |

**Instructional Focus:**

- Recognizing that predictions or explanations can be revised on the basis of seeing new data and evidence
- Using data and evidence to modify and extend investigations
- Understanding that explanations are increasingly valuable as they account for the available evidence more completely

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Science is a practice in which an established body of knowledge is continually revised, refined, and extended as new evidence emerges. | Consider alternative theories to interpret and evaluate evidence-based arguments. **(5.1.12.C.3)** |

**Instructional Focus:**

- Understanding that there might be multiple interpretations of the same phenomena
- Stepping back from evidence and explanations to consider whether another interpretation of a particular finding is plausible with respect to existing scientific evidence
- Considering alternative perspectives worthy of further investigations

**5.1 Science Practices:** Science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

**D. Participate Productively in Science:** The growth of scientific knowledge involves critique and communication, which aresocial practices that are governed by a core set of values and norms.

| Essential Question | Enduring Understanding |
|---|---|
| How does scientific knowledge benefit – deepen and broaden - from scientists sharing and debating ideas and information with peers? | The growth of scientific knowledge involves critique and communication - social practices that are governed by a core set of values and norms. |

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work. | Engage in multiple forms of discussion in order to process, make sense of, and learn from others' ideas, observations, and experiences. **(5.1.12.D.1)** |

**Instructional Focus:**

- Seeing oneself as an effective participant and contributor in science
- Interacting with others to test new ideas, soliciting and providing feedback, articulating and evaluating emerging explanations, developing shared representations and models, and reaching consensus
- Developing a sense of appropriate trust and skepticism when evaluating others' claims, evidence and reasoning

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Science involves using language, both oral and written, as a tool for making thinking public. | Represent ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams. **(5.1.12.D.2)** |

**Instructional Focus:**

- Constructing literal representations from empirical evidence and observations
- Presenting and defending a scientific argument using literal representations
- Evaluating others' literal representations for consistency with their claims, evidence and reasoning
- Moving fluently between representations such as graphs, data, equations, diagrams and verbal explanations

| Content Statement | Cumulative Progress Indicator |
|---|---|
| Ensure that instruments and specimens are properly cared for and that animals, when used, are treated humanely, responsibly, and ethically. | Demonstrate how to use scientific tools and instruments and knowledge of how to handle animals with respect for their safety and welfare. **(5.1.12.D.3)** |

**Instructional Focus:**

- Selecting and using appropriate instrumentation to design and conduct investigations
- Understanding, evaluating and practicing safe procedures for conducting science investigations
- Demonstrating appropriate digital citizenship (i.e., cyber-safety and cyber-ethics) when accessing scientific data from collaborative spaces. (See NJCCCS 8.1 and 9.1)
- Ensuring that living organisms are properly cared for and treated humanely, responsibly, and ethically