Biology Standards Alignment

Course Description

Biology is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires a three-unit course with inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

This course investigates the composition, diversity, complexity and interconnectedness of life on Earth. Fundamental concepts of heredity and evolution provide a framework through inquiry-based instruction to explore the living world, the physical environment and the interactions within and between them.

Students engage in investigations to understand and explain the behavior of living things in a variety of scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications.

Science Inquiry and Application

During the years of grades 9 through 12, all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas:

Identify questions and concepts that guide scientific investigations;
Design and conduct scientific investigations;
Use technology and mathematics to improve investigations and communications;
Formulate and revise explanations and models using logic and evidence (critical thinking);
Recognize and analyze explanations and models; and
Communicate and support a scientific argument.

Cells

PRIOR KNOWLEDGE:

Third grade: What is matter? States of Matter. **Fourth Grade**: Conservation of matter.

Seventh Grade: Properties of Matter. Matter was introduced in the elementary grades, and the learning progression continued through middle school to include differences in the physical properties of solids, liquids, and gases, elements, compounds, mixtures, molecules, kinetic and potential energy and the particulate nature of matter.

Future Knowledge: Content in the chemistry syllabus (e.g., electron configuration, molecular shapes, and bond angles) will be developed from concepts in this course.

CONTENT ELABORATION:

Building on knowledge from middle school (cell theory), this topic focuses on the cell as a system itself (single-celled organism) and as part of larger systems (multicellular organism), sometimes as part of a multicellular organism, always as part of an ecosystem. The cell is a system that conducts a variety of functions associated with life. Details of cellular processes such as photosynthesis, chemosynthesis, cellular respiration, cell division and differentiation are studied at this grade level. Additionally, cellular organelles studied are cytoskeleton, Golgi complex and endoplasmic reticulum.

From about 4 billion years ago to about 2 billion years ago, only simple, single-celled microorganisms are found in the fossil record. Once cells with nuclei developed about a billion years ago, increasingly complex multicellular organisms evolved.

Every cell is covered by a membrane that controls what can enter and leave the cell. In all but quite primitive cells, a complex network of proteins provides organization and shape. Within the cell are specialized parts for the transport of materials, energy transformation, protein building, waste disposal, information feedback and movement. In addition to these basic cellular functions, most cells in multicellular organisms perform some specific functions that others do not.

A living cell is composed of a small number of elements, mainly carbon, hydrogen, nitrogen, oxygen, phosphorous and sulfur. Carbon, because of its small size and four available bonding electrons, can join to other carbon atoms in chains and rings to form large and complex molecules. The essential functions of cells involve chemical reactions that involve water and carbohydrates, proteins, lipids and nucleic acids. A special group of proteins, enzymes, enables chemical reactions to occur within living systems.

Cell functions are regulated. Complex interactions among the different kinds of molecules in the cell cause distinct cycles of activities, such as growth and division. Most cells function within a narrow range of temperature and pH. At very low temperatures, reaction rates are slow. High temperatures and/or extremes of pH can irreversibly change the structure of most protein molecules. Even small changes in pH can alter how molecules interact.

The sequence of DNA bases on a chromosome determines the sequence of amino acids in a protein. Proteins catalyze most chemical reactions in cells. Protein molecules are long, usually folded chains made from combinations of the 20 typical amino-acid sub-units found in the cell. The function of each protein molecule depends on its specific sequence of amino acids and the shape the chain takes as a result of that sequence.

Note 1: The idea that protein molecules assembled by cells conduct the work that goes on inside and outside the cells in an organism can be learned without going into the biochemical details. It is sufficient for students to know that the molecules involved are different configurations of a few amino acids and that the different shapes of the molecules influence what they do. The concept of the cell and its parts as a functioning system is more important than memorizing parts of the cell.

Note 2:

Common Misconceptions

The Annenberg Media series *Minds of Our Own* offers *Lessons From Thin Air*, which illustrates the misconceptions that students have about photosynthesis and plant growth, at http://www.learner.org/resources/series26.html.

The website (http://www.neisd.net/curriculum/SchImprov/sci/program/misconceptions_inter.htm#cells**)** provides basic misconceptions for multiple topics as well as explanations of the misconceptions and ways to address these.

Southern Nevada RPDP: (**http://rpdp.net/sciencetips_v2/L12B3.htm#top**) provides a comprehensive list of student misconceptions as aligned to the standards.

Visions into Practice

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Investigate the effect of different chemicals on the growth of algal colonies. Use mathematics to explain why even under ideal situations the colonies cannot continue exponential growth.

Plan and design an investigation to determine the factors that affect the activity of enzymes on their substrates.

Research and provide a written explanation of how unicellular organisms are used for industrial purposes.

Heredity

PRIOR KNOWLEDGE:

Third grade: Plants and Animal life cycles and offspring resemble their parents.

Eighth Grade: Reproduction, Mendelian Genetics, inherited traits and diversity of species), this topic focuses on the explanation of genetic patterns of inheritance. In middle school, students learn that living things are a result of one or two parents, and traits are passed on to the next generation through both asexual and sexual reproduction. In addition, they learn that traits are defined by instructions encoded in many discrete genes and that a gene may come in more than one form called alleles.

Future Knowledge: No further information on heredity will be taught

CONTENT ELABORATION:

At the high school level, the explanation of genes is expanded to include the following concepts:

Life is specified by genomes. Each organism has a genome that contains all of the biological information needed to build and maintain a living example of that organism. The biological information contained in a genome is encoded in its deoxyribonucleic acid (DNA) and is divided into discrete units called genes.

"Genes are segments of DNA molecules. The sequence of DNA bases in a chromosome determines the sequence of amino acids in a protein. Inserting, deleting or substituting segments of DNA molecules can alter genes.

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 environments.

Gene mutations (when they occur in gametes) can be passed on to offspring.

Genes code for protein. The sequence of DNA bases in a chromosome determines the sequence of amino acids in a protein.

"The many body 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. Different genes are active in different types of cells, influenced by the cell's environment and past history." (AAAS)

In high school biology, Mendel's laws of inheritance (introduced in grade 8) are interwoven with current knowledge of DNA and chromosome structure and function to build toward basic knowledge of modern genetics. Sorting and recombination of genes in sexual reproduction and meiosis specifically result in a variance in traits of the offspring of any two parents and explicitly connect the knowledge to evolution.

The gene interactions described in middle school were limited primarily to dominance and co-dominance traits. In high school genetic mechanisms, both classical and modern including incomplete dominance, sex-linked traits, goodness of fit test (Chi-square) and dihybrid crosses are investigated through real-world examples. Genes that affect more than one trait (pleiotropy), traits affected by more than one gene (epistasis) and polygenetic traits can be introduced using simple real-world examples.

Additionally, genes that modify or regulate the expression of another gene should be included in explorations at the school level. Dihybrid crosses can be used to explore linkage groups. Modern genetics techniques, such as cloning must be explored in this unit.

It is imperative that the technological developments that lead to the current knowledge of heredity be included in the study of heredity. For example, the development of the model for DNA structure was the result of the use of technology and the studies and ideas of many scientists. Watson and Cricket developed the final model, but did not do the original studies.

Common Misconceptions

The University of Utah provides information about misconceptions related to cloning.

Weber State University provides a list for misconceptions in biology. Scroll down to *Standard II* to address misconceptions about pattern of inheritance.

Southern Nevada RPDP (http://rpdp.net/sciencetips_v2/L12D2.htm#misconcept) provides a comprehensive list of misconceptions in genetics and heredity.

Visions into Practice

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Develop a timeline from Mendel's, Darwin's and Wallace's work to the present day.

Design and implement an investigation to test the effect of low doses of different common chemicals (e.g., boric acid, acetone or vinegar) on the development of a plant from seed to adult. Represent the data in a way that demonstrates the relationship, if any, between the chemical and changes in the development pattern. Explain how the investigation is similar to or different from the processes that occur in the natural environment.

Note: Only plants should be used in this experiment.

Evolution

PRIOR KNOWLEDGE:

Third grade: What is matter? States of Matter. **Fourth Grade**: Conservation of matter.

Seventh Grade: Properties of Matter. Matter was introduced in the elementary grades, and the learning progression continued through middle school to include differences in the physical properties of solids, liquids, and gases, elements, compounds, mixtures, molecules, kinetic and potential energy and the particulate nature of matter.

Future Knowledge: Content in the chemistry syllabus (e.g., electron configuration, molecular shapes, and bond angles) will be developed from concepts in this course.

CONTENT ELABORATION:

At the elementary school level, evolution concepts include the relationship between organisms and the environment, parent and offspring, and an introduction to the fossil record and extinction. At the middle school level, concepts include biodiversity (as part of biomes) and speciation, further exploration of the fossil record and Earth history, changing environmental conditions (abiotic factors), natural selection and biological evolution.

Biological evolution explains the natural origins for the diversity of life. Emphasis shifts from thinking in terms of selection of individuals with a particular trait to changing proportions of a trait in populations. The study of evolution must include Modern Synthesis, the unification of genetics and evolution and historical perspectives of evolutionary theory. The study of evolution must include gene flow, mutation, speciation, natural selection, genetic drift, sexual selection and Hardy Weinberg's law.

The basic concept of biological evolution is that the Earth's present-day species descended from earlier, common ancestral species. At the high school level, the term natural selection is used to describe the process by which traits become more or less common in a population due to consistent environmental effects upon the survival or reproduction of the individual with the trait. Mathematical reasoning must be applied to solve problems, (e.g., use Hardy Weinberg's law to explain gene frequency patterns in a population).

Modern ideas about evolution provide a natural explanation for the diversity of life on Earth as represented in the fossil record, in the similarities of existing species and in modern molecular evidence. From a long-term perspective, evolution is the descent with modification of different lineages from common ancestors.

Different phenotypes result from new combinations of existing genes or from mutations of genes in reproductive cells. At the high school level, the expectation is to combine grade-8 knowledge with explanation of the internal structure and function of chromosomes. Natural selection works on the phenotype.

Populations evolve over time. Evolution is the consequence of the interactions of:

1. The potential for a population to increase its numbers;
2. The genetic variability of offspring due to mutation and recombination of genes; 3. A finite supply of the resources required for life; and
4. The differential survival and reproduction of individuals with the specific phenotype.

Mutations are described in the content elaboration for Heredity. Apply the knowledge of mutation and genetic drift to real-world examples.

Recent molecular-sequence data generally, but not always, support earlier hypotheses regarding lineages of organisms based upon morphological comparisons.

Heritable characteristics influence how likely an organism is to survive and reproduce in a particular environment. When an environment changes, the survival value of inherited characteristics may change. This may or may not cause a change in species that inhabit the environment. Formulate and revise explanations for gene flow and sexual selection based on real-world problems.

Common Misconceptions

The Southern Nevada Regional Professional Development Center provides a list of common student naïve conceptions about evolution.

Visions into Practice

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Manipulate variables (e.g., distribution of traits, number of organisms and change in environmental conditions) in a simulation that represents natural selection in terms of how changes in environmental conditions can result in selective pressure on a population of organisms. Analyze the data to determine the relationship, if any, between the environmental changes and the population. Explain how each part of the simulation is similar to or different from the process of natural selection.

Diversity and Independence of Life

PRIOR KNOWLEDGE:

Third grade: What is matter? States of Matter. **Fourth Grade:** Conservation of matter.

Seventh Grade: Properties of Matter. Matter was introduced in the elementary grades, and the learning progression continued through middle school to include differences in the physical properties of solids, liquids, and gases, elements, compounds, mixtures, molecules, kinetic and potential energy and the particulate nature of matter.

Future Knowledge: Content in the chemistry syllabus (e.g., electron configuration, molecular shapes, and bond angles) will be developed from concepts in this course.

CONTENT ELABORATION:

Building on knowledge from elementary school (interactions of organisms within their environment and the law of conservation of matter and energy, food webs) and from middle school (flow of energy through organisms, biomes and biogeochemical cycles), this topic focuses on the study of diversity and similarity at the molecular level of organisms. Additionally the effects of physical/chemical constraints on all biological relationships and systems are investigated.

The great diversity of organisms and ecological niches they occupy result from more than 3.5 billion years of evolution. Some ecosystems can be reasonably persistent over hundreds or thousands of years. Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change as geological or biological conditions vary. Misconceptions about population growth capacity, interspecies and intra-species competition for resources, and what occurs when a species immigrates to or emigrates from ecosystems are included in this topic. Technology must be used to access real-time/authentic data to study population changes and growth in specific locations.

Classification systems are frameworks developed by scientists for describing the diversity of organisms, indicating the degree of relatedness between organisms. Recent molecular-sequence data generally support earlier hypotheses regarding lineages of organisms based upon morphological comparisons. Both morphological comparisons and molecular evidence must be used to describe biodiversity (cladograms can be used to address this).

Organisms transform energy (flow of energy) and matter (cycles of matter) as they survive and reproduce. The cycling of matter and flow of energy occurs at all levels of biological organization, from molecules to ecosystems. At the high school level, the concept of energy flow as unidirectional in ecosystems is explored.

Mathematical graphing and algebraic knowledge (at the high school level) must be used to explain concepts of carrying capacity and homeostasis within biomes. Use real-time data to investigate population changes that occur locally or regionally. Mathematical models can include exponential growth model and the logistic growth model. The simplest version of the logistic growth model is $dN/dt = rN (K-N/K)$; the only new variable added to the exponential model is K for carrying capacity.

Note 1: Exponential growth equation in simplest form, change in population size *N* per unit time *t* is a product of *r* (the per capita reproductive rate) and *N* (population size.

Note 2: Carrying capacity is defined as the population equilibrium sized when births and deaths are equal; hence dN/dt = zero.

Note 3: Constructing food webs/food chains to show interactions between organisms within ecosystems was covered in upper elementary school and middle school; constructing them as a way to demonstrate content knowledge is not appropriate for this grade. Students may use these diagrams to help explain real-world relationships or events within an ecosystem, but not to identify simple trophic levels, consumers, producers, predator-prey and symbiotic relations.

Common Misconceptions

Binghamton University provides a general list for of naïve concepts for life science called Overcoming Ecological Misconceptions.

Southern Nevada RPDP (http://rpdp.net/sciencetips_v2/L12D1.htm#misconcept; http://rpdp.net/sciencetips_v2/L12D3.html); has an extensive list of student misconceptions concerning evolution.

Vision into Practice:

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

Construct a model to exemplify biomagnification in an ecosystem such as mercury in Lake Erie. Include a quantification of the distribution and buildup of the potentially damaging molecule that was introduced into the ecosystem. Within the model, predict and explain why the consequences occur at each trophic level as the relative concentration of the chemical increases. Include in your justification the changes in the number of organisms at each trophic level, matter cycling and energy transfer from one level to another.

Structure and Function of Cells
Academic Learning Targets

The student will be able to:

- describe how temperature influences reaction rates
- describe how enzymes enable chemical reactions in living systems
- explain how pH can effect protein structure
- evaluate how the structure of water makes it a good solvent
- identify the basic elements of life
- explain why carbon is the basis of life
- explain how water, carbohydrates, proteins, nucleic acids and lipids are essential to cell structure and functions
- describe the structure of a protein
- describe what influences protein shape and function
- describe how a cell can act as a single system
- use the fossil record to develop a timeline from the first types of cells to multicellular organisms (pg 405-407)
- describe how a cell can act as part of a multicellular organism
- explain how a cell conducts functions associated with life
- describe the function and structure of the cell membrane
- describe the structure and function of the cellular structures that deal with transport of materials
- describe the structure and functions of the cellular structures that deals with energy transformation
- describe the structure and function of cellular structures that deal with protein building
- describe the structure and function of cellular structures that deal with waste disposal
- describe the structure and function of cellular structures that deal with information feedback
- describe the structure and function of cellular structures that deal with movement
- describe how cellular organelles function as a system

Essential Vocabulary/Concepts:

Prior Vocabulary:

Cell Theory
Single Cell Organism
Ecosystem

Vocabulary/Concepts:

Unicellular
Cytoskeleton
Endoplasmic Reticulum
Carbohydrate
Lipid
Nucleic Acid
Organelle
Golgi Complex
Membrane
Protein
Amino Acid
Enzyme

Interventions

- **Cell Structure and Function -- Major Concepts and Learning Activities:** http://serendip.brynmawr.edu/exchange/files/cell%20structure%20function.pdf; additional presentation materials, activities, and interactives
- **Animal Cell/Plant Cell virtual labs,** http://www.biologycorner.com/worksheets/cheekcell-virtual.html; three virtual microscope where they can practice technique

Extensions

- **Chemistry Tutorial from The Biology Project:** http://www.biology.arizona.edu/biochemistry/tutorials/chemistry/problems.html; offers practice quizzes to review basic chemistry in biology
- **Concepts in Biochemistry: Interactive Cell Structure Module:** http://www.wiley.com/legacy/college/boyer/0470003790/animations/cell_structure/cell_structure.htm; An interactive tour of major cell types and their internal structures.

Cellular Processes
Academic Learning Targets

The student will be able to:

- compare and contrast how autotrophs and heterotrophs obtain energy
- describe how ATP works
- describe the light and dark reactions of photosynthesis
- explain the process of cellular respiration
- explain cell differentiation as a functional modification within a multicellular organism
- compare cellular division in eukaryotes and prokaryotes
- describe the steps of cellular division
- describe how cellular interactions regulate the cell cycle

Essential Vocabulary/Concepts

Prior Vocabulary:
Cell Theory
Single Cell Organism
Ecosystem

Vocabulary/Concepts:
Photosynthesis
Cellular Respiration
Cell Division
Differentiation
pH
Energy Transformation
Chemosynthesis
Feedback

Interventions

- **How do biological organisms use energy?** http://serendip.brynmawr.edu/exchange/bioactivities/energy; introduce/review cellular respiration.
- **Illuminating Photosynthesis Interactive:** http://www.pbs.org/wgbh/nova/nature/photosynthesis.html;
- **CellsALIVE! Interactive:** http://www.cellsalive.com/mitosis.htm**;** animal and plant mitosis and meiosis.
- **Chromosome Shuffle:** http://www.accessexcellence.org/AE/AEC/AEF/1996/meyer_chromosome.php; Students model cellular division as giant chromosomes

Extensions

- **Mitosis and Meiosis Resource List:** http://www.nclark.net/MitosisMeiosis; a comprehensive list of activities, labs, and interactive lessons
- **Cellular respiration and Photosynthesis resource list:** http://www.nclark.net/PhotoRespiration; a comprehensive list of activities, labs and interactive lessons
- **SePUP Cell Cycle Game:** http://sepuplhs.org/high/sgi/teachers/cell_sim.html

Modern Genetics
Academic Learning Targets

The student will be able to:

- Identify and summarize the stages of meiosis
- Summarize how the process of meiosis produces genetic recombination
- Explain how DNA and chromosomes structure intertwine with Mendel's Laws of Inheritance
- Describe how genetic recombination occurs in sexual reproduction
- Explain how genetic variation occurs in meiosis
- Describe and analyze problems dealing with incomplete dominance
- Describe and analyze problems dealing with sex-linked traits
- Describe and analyze problems dealing with dihybrid crosses
- Explain how a Chi Square test can be used as a validity test for genetic crosses
- Describe pleiotropy using an example
- Describe epistasis using an example
- Explain the concept of polygenic traits using an example
- Explain the concept of linked genes and use a dihybrid cross to explore linked groups.
- Describe how technological developments led to current knowledge of heredity

Essential Vocabulary/Concepts

Prior Vocabulary/Concepts:

Offspring
Reproduction
Mendelian Genetics
Inherited Traits
Diversity of Species
Asexual/Sexual Reproduction
Codominance
Dominance
Alleles
Genes
Traits

Vocabulary/Concepts:

Gamete
Recombination
Sexual Reproduction
Meiosis
Incomplete Dominance
Sex-Linked Traits
Chi-Square
Dihybrid Cross
Pleiotropy
Epistasis
Polygenic
Cloning

Interventions

- **Enlivening Genetics Education!:** http://www2.edc.org/weblabs/; No student worksheets included, does include EPISTASIS in Baby Boom activity.
- **The American Society of Human Genetics (ASHG) - Curriculum Content Review:** http://www.ashg.org/education/pdf/Resources_CCRC.pdf; A comprehensive list with links that evaluates the topics discussed in a variety of lessons. Also lists costs associated with the resources.
- **The Chi-Square is a "Ratio-Ruling":** http://www.synapses.co.uk/genetics/chisqr.html; A good primer on what Chi-square is and how to utilize this probability tool. Includes review and practice exercises, but not interactive.
- **Chi-Square Tests:** http://inspire.stat.ucla.edu/unit_13/index.php; An online unit for genetics probability. Includes practice items, simulations, and activity ideas.

Extensions

- **The American Society of Human Genetics (ASHG) - Curriculum Content Review:** http://www.ashg.org/education/pdf/Resources_CCRC.pdf; A comprehensive list with links that evaluates the topics discussed in a variety of lessons. Also lists costs associated with the resources.

Structure and Function of DNA in Cells

Academic Learning Targets

The student will be able to:

- Summarize the experiments that led to the discovery of DNA.
- Diagram/label the basic structure of DNA & chromosomes.
- Summarize the role of the enzymes in DNA replication and how leading and lagging strands are synthesized differently.

Essential Vocabulary/Concepts

Prior Vocabulary/Concepts:

Offspring
Reproduction
Mendelian Genetics
Inherited Traits
Diversity of Species
Asexual/Sexual Reproduction
Traits
Genes
Alleles
Dominance
Codominance

Vocabulary/Concepts:

Amino Acid
Protein
Insertion
Deletion
Substitution
Chromosome

Interventions

- **The Biology Corner: DNA resources:** http://www.biologycorner.com/bio2/index2.html#DNA; A listing of resources for teaching DNA structure and replication.
- **Molecular Biology Overview:** http://serendip.brynmawr.edu/exchange/bioactivities/MolBio; A good introductory primer with associated student activities and interactive lessons for teaching DNA to RNA to Protein.

Extensions

- **Genetics Resource List:** http://www.nclark.net/Genetics; A comprehensive list of Mendelian and Molecular Genetics resources at a variety of levels

Genetic Mechanisms and Inheritance

Academic Learning Targets

The student will be able to:

- describe how DNA bases code for amino acids and proteins
- explain how mRNA, rRNA, and tRNA are involved in the transcription and translation of genes
- summarize the role of RNA polymerase and DNA in the synthesis and translation of mRNA into a protein

Essential Vocabulary/Concepts

Prior Vocabulary/Concepts:
Offspring
Reproduction
Mendelian Genetics
Inherited Traits
Diversity of Species
Traits
Asexual/Sexual Reproduction
Genes
Alleles
Dominance
Codominance

Vocabulary/Concepts:
Mutation
Genetic Code

Interventions

- **The Biology Corner: DNA resources:** http://www.biologycorner.com/bio2/index2.html#DNA; A listing of resources for teaching DNA structure and replication.
- **Molecular Biology Overview:** http://serendip.brynmawr.edu/exchange/bioactivities/MolBio; A good introductory primer with associated student activities and interactive lessons for teaching DNA to RNA to Protein.

Extensions

- **Genetics Resource List:** http://www.nclark.net/Genetics; A comprehensive list of Mendelian and Molecular Genetics resources at a variety of levels

Mutations
Academic Learning Targets

The student will be able to:

- explain how a genome is encoded in DNA
- describe the structure of a protein
- describe what influences protein shape and function
- explain the concept of a gene in terms of DNA
- describe cell differentiation as related to gene regulation and control
- explain how different genes can be active/inactive in different cells
- compare how deletions, insertions, and substitutions in DNA alter genes
- explain possible results of an altered gene
- describe how gene mutations can be passed on to offspring

Essential Vocabulary/Concepts

Prior Vocabulary/Concepts:

Offspring
Reproduction
Mendelian Genetics
Inherited Traits
Diversity of Species
Asexual/Sexual Reproduction
Traits
Alleles
Genes
Dominance
Codominance

Vocabulary/Concepts:

Altered Gene
Gene Mutation

Interventions

- **The Biology Corner: DNA resources:** http://www.biologycorner.com/bio2/index2.html#DNA; A listing of resources for teaching DNA structure and replication.
- **Molecular Biology Overview:** http://serendip.brynmawr.edu/exchange/bioactivities/MolBio; A good introductory primer with associated student activities and interactive lessons for teaching DNA to RNA to Protein.

Extensions

- **Genetics Resource List:** http://www.nclark.net/Genetics; A comprehensive list of Mendelian and Molecular Genetics resources at a variety of levels

Mechanisms of Evolution
Academic Learning Targets

The student will be able to:

- use the fossil record to explain the diversity of life on Earth
- describe historical perspectives of evolution
- explain how natural selection is influenced by the environment
- define the process of natural selection, speciation, and homologous structures
- design and conduct an experiment using natural selection
- use molecular-sequence data and morphological comparisons to support or reject lineages of organisms
- use modern molecular evidence to explain evolution and the diversity of life on Earth
- state and defend four interactions that explain how populations evolve over time (increase population, gene variability, finite resources, survival and reproduction rates)
- use Hardy-Weinberg's law to explain gene frequency in populations
- explain evolution in terms of changing proportions of a trait in populations
- explain and use examples of speciation

explain genetic drift using an example

- explain and use an example of gene flow
- apply the concept of mutation and genetic drift to real world examples
- explain the concept of sexual selection and give examples
- formulate and revise explanations for gene flow and sexual selection based on real-world problems
- explain the concept of descent with modification

describe the basic concept of biological evolution

Essential Vocabulary/Concepts

Prior Vocabulary/ Concepts:

Evolution
Parent
Offspring
Fossil Record
Extinction
Biodiverisity
Biological Evolution
Natural Selection
Abiotic Factors
Speciation
Biomes

Vocabulary/Concepts:

Trait
Evolution
Gene Flow
Mutation
Speciation
Natural Selection
Genetic Drift
Phenotype
Genetic Variability
Recombination
Population
Hardy-Weinberg
Sexual Selection

Interventions

- **Getting into the Fossil Record** - http://teacherweb.com/ME/Deering/LeGage/On-Line-Fossil-Lab-1.pdf -Students explore a website to learn about the history of life much as scientists use fossils to on Earth and the fossil record.
- **PBS Evolution Website:** http://www.pbs.org/wgbh/evolution/educators/lessons/index.html - 7 lessons that explore the theory of evolution.

Extensions

- **Fossil Hunt:** http://www.accessexcellence.org/AE/AEC/AEF/1996/coleman_fossil.php; students reconstruct a book reconstruct history.
- **Hardy-Weinberg Equilibrium:** www.Explorelearning.com; Students analyze population data then determine how initial allele percentages will affect the equilibrium state of the population.

Diversity of Life
Academic Learning Targets

The student will be able to:

- Use cladograms to explain biodiversity. (Focusing on morphological comparisons and molecular evidence).
- Relate how recent molecular-sequence data generally support earlier hypotheses regarding lineages of organisms based upon morphological comparisons.
- Explain that variation of organisms with a species is due to population genetics and gene frequency.

Essential Vocabulary/Concepts

Prior Vocabulary/ Concepts:

Evolution
Parent
Offspring
Fossil Record
Extinction
Biodiverisity
Biological Evolution
Natural Selection
Abiotic Factors
Speciation
Biomes

Vocabulary/Concepts:

Diversity
Classification system
Morphological comparisons
Cladogram

Interventions

- **Cladistics is a Zip...baggie**: http://www.indiana.edu/~ensiweb/lessons/clad.bag.html; Students use a series of nested plastic bags to make a 3-dimensional Venn diagram to illustrate the hierarchical grouping of organisms based on their shared derived characters, thus forming the basis of a cladogram.
- **The Missing Link**: http://www.pbs.org/wgbh/nova/education/activities/2905_link.html; *NOVA*'s "Hardware Organism" This lab has students classify types of screws and nails and develop a cladogram for them.

Extensions

- **Microevolution**: **www.e**xplorelearning.com; Students observe the effect of predators on a population of parrots with three possible genotypes. The initial percentages and fitness levels of each genotype can be set. Determine how initial fitness levels affect genotype and allele frequencies through several generations. Compare scenarios in which a dominant allele is deleterious, a recessive allele is deleterious, and the heterozygous individual is fittest.

Diversity and Independence of Life
Academic Learning Targets

The student will be able to:

- classify organisms using various classification systems
- compare methods of classifying organisms & the categories used
- write a scientific name using binomial nomenclature
- compare/contrast species concepts
- describe methods used to reveal phylogeny & cladogram construction
- classify organisms using the currently accepted system

Essential Vocabulary/Concepts

Prior Vocabulary/Concepts:
Diversity of Life
Law of Conservation of Matter and Energy
Food Webs
Biomes
Biogeochemical Cycle

Vocabulary/Concepts:
Biodiversity
Morphology
Cladogram/Classification

Interventions

- **Develop a Classification System**: http://www.sciencelearn.org.nz/Contexts/Life-in-the-Sea/Teaching-and-Learning-Approaches/Develop-a-classification-system; This lesson provides students the opportunity to create their own classification system for a number of marine organisms.
- **Interpreting Graphics - Taxonomy:** http://www.biologycorner.com/worksheets/taxonomy_interpret.html ; Students use an image to interpret taxonomy of different creatures.

Extensions

- **Primate Classification:** http://www.indiana.edu/~ensiweb/lessons/primclas.html#anchor980882; This lesson uses current classification system to properly name primates.

Ecosystems
Academic Learning Targets

The student will be able to:

- explain interspecies and intra-species competition in terms of an ecological niche
- explain the effects of intraspecies and interspecies competition
- explain how ecosystems can have cyclic fluctuations around a rough equilibrium
- describe the flow of energy and cycles of matter as organism survive and reproduce
- explain the concept of energy flow as unidirectional in an ecosystem
- describe how geological and biological conditions can change ecosystems
- demonstrate how even though ecosystems have cyclical fluctuations around a state of equilibrium they can remain relatively consistent over hundreds or thousands of years.
- determine the factors that limit the number of organisms that an ecosystem can support.
- \describe population growth capacity
- use real-time data to compare exponential and logistic growth models.
- use technology to access authentic data to study population changes and growth
- use mathematical graphing and algebraic knowledge to explain concepts of carrying capacity and homeostasis in biomes
- describe the effects of immigration and emigration on an ecosystem
- use food webs/chains to explain relationships or events within an ecosystem (biomagnification; habitat destruction)

Essential Vocabulary/Concepts

Prior Vocabulary/Concepts:

Diversity of Life
Law of Conservation of Matter and Energy
Food Webs
Biomes
Biogeochemical Cycle

Essential Vocabulary/Concepts:

Niche
Equilibrium
Growth capacity
Immigration
Emmigration
Biodiversity
Morphology
Cladogram
Ecosystems
Homeostasis
Classification
Resources
Competition
Intraspecies
Interspecies

Interventions

- **Biome and Ecology Unit:** http://www.accessexcellence.org/AE/AEC/AEF/1996/tomlinson_ecology.php; project designed to review ecology and biome topics.
- **Focus on Air Quality**: http://www.pbs.org/now/classroom/airquality.html; utilizes air quality to investigate biogeochemical cycles and human impact
- **Skeeter Populations and Exponential Growth:** http://www.learner.org/workshops/algebra/workshop8/lessonplan2b.html; exploring population growth within a simulated population.

Extensions

- **Intraspecific Competition Lab:** http://www.faculty.virginia.edu/evolutionlabs/GSUEvoLab5.htm; This lab explores the effect overplanting an area has on plant growth
- **Prairie Ecosystem :** www.explorelearning.com; **investigate** feeding relationships to determine the food chain. Bar graphs and line graphs show changes in populations over time.
- **Estimating Population Size:** www.Explorelearning.com; **use** capture/recapture method to estimate the population of fish in pond.