Unit Name: The Reproduction and Development of Organisms NGSS 8-15

Content Area: **Science**
Course(s):
Time Period: **Trimester 2**
Length: **9 Lessons**
Status: **Published**

Unit Overview

Unit Name: The Reproduction and Development of Organisms

Unit Summary:

This unit gives students the opportunity for hands-on study of organisms from most of the taxonomic groups of kingdoms. It focuses on the life cycles of several organisms, and contains an in-depth study of two species in particular- a species of cabbage plant and a species of butterfly whose life cycle revolves around the cabbage plant.

The activities of this unit include, among others: growing cabbage plants from seeds and caring for them in order to cross pollinate them and plant the resulting seeds during a Mendelian experiment to allow students to follow the complete life cycle through two generations of plants; view, observe and raise butterfly eggs throughout their entire life cycle and observe and document their feeding and reproductive habits; identify the sexual and asexual structures of a flowering plant.

This unit is mostly laboratory and project based. However, there are many important reading selections from both the STC and Pearson publications. The Pearson Interactive Science series listed in the bibliography is used mainly as a reinforcement for the lab activities and as an additional source of readings, vocabulary, and diagrams. In addition, many other sources of reading materials, videos, and other media are used to enhance the lesson, such as *National Geographic, Smithsonian Magazine, Science Scope* (NSTA), *BrainPop, YouTube, Science Illustrated,* and other relevant books and current events.

Essential Questions

Unit Essential Questions:

- How do plants and some protists and bacteria make their own food?
- How do animals, fungus, most bacteria, and some protists get their energy?
- What is the sun's role in photosynthesis?
- Are there certain types of the sun's light energy that plants use more than others?
- What are the characteristics of the electromagnetic spectrum emitted from the sun?
- What is the relationship between photosynthesis and aerobic and anaerobic respiration? How do materials such as nutrients, wastes, and gases move in and out of cells?
- Why is it important that certain materials freely move in and out of the cell while other materials are restricted? What is a plant?

- How do plants and animals depend on each other?
- What are monocots and dicots and how do they differ? How are organisms built?
- What are the "building blocks" of life?
- What is the difference between multi-cellular and unicellular organisms?
- How do cells fit in to the "big picture" of life?
- What is the difference between a prokaryotic and eukaryotic cell?
- What types of organisms are supported by eukaryotic and prokaryotic cells?
- What are the "parts" or organelles of cells and how do they differ between organisms in each of the six kingdoms?
- How does the light microscope work and what is the difference between light and electron microscopes. What is an organism?
- What are the needs of all living organisms?
- What are the molecules associated with all living organisms?
- What is the difference between living organisms and their associated non-living environments?
- What are the non-living components of an organism's environment that are necessary for life? For what use is a microscope used?
- How is a microscope used?
- What is the significance of each of the parts of a microscope?
- What is the proper method for using, storing, and carrying a microscope?
- What are the different types of microscopes and what are the characteristics of each? What is heredity?
- What are traits and how are they passed on from parent to offspring?
- What are genes?
- Where are traits contained within a cell?
- Who was the gentleman that discovered the mechanisms of heredity studying pea plants?
- What is Meiosis and how is Meiosis related to heredity?
- What is a phenotype and a genotype? What is fungus?
- What importance does fungus have in our everyday lives?
- What products do we as a society use daily that comes from fungus? What is DNA?
- What does DNA stand for and what type of molecule is it?
- Of what material is DNA made? What is Classification?
- How are organisms classified?
- What are the characteristics upon which organisms are based?
- What is a characteristic? How do living organisms grow?
- What is growth?
- How is growth measured?
- How do cells create other cells?
- What are the stages of Mitosis? What is an Animal?
- What differentiates an animal from the other five kingdoms?
- What do animals depend on for their survival? How does the body of any organism operate with its working systems?
- What are the working organ systems of mammals?
- How do the organ systems of mammals compare with those of other organisms?
- How do amphibian's body systems compare with those of mammals? What are protists?
- How are protists classified?
- Why are protists classified based on negative characteristics (what they are *not*) What is bacteria?
- If bacteria are microscopic, why is it dangerous to other organisms?
- How are bacteria useful to humans and other organisms?
- Why are bacteria so important to our existence?

Content

Unit Enduring Understandings (Content):

- Kingdom Plantae includes eukaryotic, multicellular producers, such as trees, plants, and moss, both terrestrial and aquatic.
- Plant cells and certain protist cells are specialized to perform photosynthesis due to the presence of chloroplasts.
- Some Plants reproduce by producing seeds, while others reproduce by spores.
- Plant cells differ from members of other kingdoms due to their cell walls, central vacuole, and chloroplasts.
- Photosynthesis and aerobic respiration are complex processes that form a cycle between plants and animals that sustains each.
- The raw materials of photosynthesis are the products of aerobic respiration; the raw materials of aerobic respiration are the products of photosynthesis.
- Photosynthesis occurs when the chloroplasts, which contain the light-capturing pigment chlorophyll, combine light energy from the sun with carbon dioxide and water to create sugar, water, and oxygen as by-products.
- Most plants use red and blue light to photosynthesize; green light is "thrown away" or reflected from the plant. This is why most plants appear green. Photosynthesis and aerobic respiration are complex processes that form a cycle between plants and animals that sustains each.
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- Most plants use red and blue light to photosynthesize; green light is "thrown away" or reflected from the plant. This is why most plants appear green.
- Fermentation is a process that aerobic cells use to create energy when oxygen levels are low. Cell and organelle membranes are considered semi-permeable, allowing some materials thorough while restricting others.
- Diffusion is the process of materials moving along a concentration gradient from an area of high concentration to an area of low concentration across a cell membrane.
- Passive transport is a type of diffusion where materials are moving along a concentration gradient, but require energy to move across the cell membrane.
- Osmosis is the diffusion of water across a semi-permeable membrane.
- Active Transport occurs when materials move across a membrane from an area of low concentration to an area of high concentration, against a concentration gradient. This process requires energy from the cell and is common in neurons.
- Cells group together with similar cells to create tissues; groups of similar tissues form organs; organs function together to form organ systems; organ systems support entire organisms.
- The Cell Theory states the following: All living organisms are composed of cells; The cell is the basic unit of structure and function in living organisms; All cells arise from existing cells.
- Populations are groups or organisms that live in the same area at the same time; Communities are comprised of two or more populations occupying a given area at one time; Ecosystems consist of the

community and all associated non-living components of an area.

- All organisms require, in some capacity, the following: food, water, air (varying gases), and shelter.
- Biomolecules, such as proteins, carbohydrates, lipids, and nucleic acids are produced, consumed, and rearranged by living organisms for their individual metabolic needs and body structures.
    - Proper mounting, focusing, and usage techniques of the compound light microscope are important for understanding life science concepts.
    - Microscopes are precision scientific tools that can help us view and comprehend objects that we would otherwise not see.
    - Comprehension of the microscope as a "working system" is paramount to its proper and successful use in the laboratory.
    - Meiosis is a process by which the gametes or sex cells (sperm and egg) are created through two nuclear divisions.
    - The end result of Meiosis is four genetically different haploid germ cells. (sperm or egg)
    - Heredity is the study of genetics.
    - Gregor Mendel performed many simple, yet statistically-sound experiments on pea plants, in which he was able to demonstrate the relationship between "visible" genes and "hidden" genes. (Dominant and recessive)
    - Mendel's experiments disproved "blending" of traits in certain organisms.
    - Some organism's traits "mix" under inheritance patterns called "incomplete dominance" and "codominance".
    - Genes are the instructional units of the DNA. (Hair color, eye color, attached ear lobes, etc)
    - Alleles are alternate forms of a gene. (Brown vs. blonde hair, brown vs. blue eyes, etc.)
    - Traits are physical characteristics of an organism.
    - All organisms do not display dominant and recessive traits.
    - Some traits do not have dominance over others and can occur together, these traits are considered "codominant".
    - Punnett squares, devised by Sir Reginald Punnett, are useful tools designed to predict the outcome of a genetic cross.
    - The predicted outcome of Monohybrid and Dihybrid crosses can be demonstrated by the use of Punnett Squares.
    - Determine the sex of the offspring by creating a karyotype of the chromosomes.
    - Kingdom Fungi includes eukaryotic, multicellular consumers that break down dead organic matter, and includes the mushrooms, molds, and mildews.
    - Fungi reproduce using spores, or budding (sexual and asexual).
    - DNA (deoxyribonucleic acid), and proteins constitute chromosomes.
    - Chromosomes are found in the nucleus of eukaryotic cells and contain genetic instructions for the maintenance of the cell and the organism they support.
    - Chromosomes contain genes, the instructional units of the chromosome.
    - Molecules of DNA resemble a double helix, consisting of a backbone of alternating deoxyribose and phosphate molecules, and nitrogen bases connecting the two backbones at the deoxyribose molecules.
    - The four nitrogen bases associated with the DNA molecule are guanine, cytosine, thymine, and adenine.
    - Cytosine forms bonds with guanine and thymine bonds with adenine within a DNA molecule.
    - DNA replication is considered "semiconservative".
    - Cancer often results from a DNA mutation in dividing cells.
    - Organisms are classified based on external physical characteristics
    - Organisms are increasingly being classified based on their DNA similarities
    - Classification is based on a hierarchal system: Kingdom, Phylum, Class, Order Family, Genus, Species
    - Latin and Greek names and words are used to classify all living organisms
    - All living organisms are classified in this system: Protists, Bacteria, Fungus, Plants, Animals

- Kingdom Archaebacteria include microscopic, prokaryotic, one-celled organisms that typically live in low-oxygen environments, salt flats, hot springs, and glacial ice.
- Kingdom Eubacteria include microscopic, prokaryotic, one-celled organisms that are typically associated with animal and plant bodies, and can be beneficial or detrimental.
- Kingdom Protista includes both unicellular and multicellular eukaryotic organisms that do not fit into any of the other five kingdoms. Examples include the plant-like protists, such as kelp, algae, and diatoms; the fungus-like protists such as slime and water molds; and the animal-like protists, such as amoebas, ciliates, and other protozoa.
- Kingdom Plantae includes eukaryotic, multicellular producers, such as trees, plants, and moss, both terrestrial and aquatic.
- Kingdom Fungi includes eukaryotic, multicellular consumers that break down dead organic matter, and includes the mushrooms, molds, and mildews.
- Kingdom Animalia includes the eukaryotic, multicellular consumers, and includes many diverse invertebrates and vertebrates.
- Kingdom Animalia is divided into many diverse phyla, each with unique characteristics.
- The Cell cycle is the process of one cell becoming two during interphase, mitosis, and cytokinesis.
- During interphase of the cell cycle, the DNA is replicated and organelles are prepared for distribution.
- During Mitosis, the nucleus is involved in a process where the chromosomes and cell organelles are rearranged and prepared for distribution in each of two new cells that will ultimately form.
- The end result of Mitosis is two identical somatic (body) cells.
- Kingdom Animalia includes the eukaryotic, multicellular consumers, and includes many diverse invertebrates and vertebrates.
- Kingdom Animalia is divided into many diverse phyla, each with unique characteristics.
- Chordates are the most complex phyla of Kingdom Animalia because of the presence of complex nerve cords and associated nervous system, as well as other body structures.
- Invertebrates and vertebrates are animals with very different body plans and structures
- Invertebrates are animals without backbones
- Vertebrates are animals with backbones
- Animals are very diverse, and include Mollusks, Annelids, Arthropods, Echinoderms, Fishes, Amphibians, Reptiles, Birds, and Mammals.
- Chordates are the most complex phyla of Kingdom Animalia because of the presence of complex nerve cords and associated nervous system, as well as other body structures.
- Human body systems are complex working systems composed of individual organs, each of which has a particular function to sustain the organ system and hence, the organism.
- Human organ systems include the following systems: integumentary, muscular, skeletal, circulatory, respiratory, nervous, lymphatic, digestive, endocrine, urinary, and male and female reproductive.
- Kingdom Protista includes both unicellular and multicellular eukaryotic organisms that do not fit into any of the other five kingdoms. Examples include the plant-like protists, such as kelp, algae, and diatoms; the fungus-like protists such as slime and water molds; and the animal-like protists, such as amoebas, ciliates, and other protozoa.
- Kingdom Archaebacteria include microscopic, prokaryotic, one-celled organisms that typically live in low-oxygen environments, salt flats, hot springs, and glacial ice.
- Kingdom Eubacteria include microscopic, prokaryotic, one-celled organisms that are typically associated with animal and plant bodies, and can be beneficial or detrimental.

Skills

Unit Learning Targets (Skills):

- View *Elodea* leaves under microscope and identify parts
- Plant organs, such as leaves, roots, and stems will be studied in detail and differences between monocots and dicots will be noted. Extract and separate photosynthetic pigments from plant leaves
- Distinguish between chlorophyll, carotenoids, and xanthophyll pigments
- View the by-products of photosynthesis (oxygen) being produced in aquatic plant cells.
- Recognize the process of diffusion and osmosis using salt water and distilled water.
- Measure the amount of solute and/or solution that diffuses from one side of a semi-permeable membrane to the other
- Predict the movement of particles of difference substances within a hypotonic vs. a hypertonic environment
- View movies of cells expelling and engulfing large amounts of particles during exocytosis and endocytosis respectively.
- Identify the hierarchy of atomic and cellular relationships
- Realize the important differences between eukaryotic and prokaryotic cells
- Relate the function of cellular organelles to parts of a city.
- Act out roles of organelles in the cell, both plant and animal cells
- Successfully use the microscope to view various plant and animal cells
- Create a wet-mount slide with green algae or *Elodea*
- Identify carbohydrates, lipids, nucleic acids, and proteins based on their molecular structure
- Ascertain the presence of lipids, carbohydrates, and proteins using various tests
- Study vocabulary: microscope parts and their functions
- Display the correct order or operations when using a microscope
- Make a wet-mount slide
- Prediction of traits of offspring from parents if genetics are known.
- Recognition of the differences between cells undergoing Mitosis and Meiosis.
- Identification of genes specifically located on the chromosomes.
- Determination of phenotypes from given genotypes using a Punnett Square.
- Identify several types of fungus and lichens based on external characteristics: *Club Fungi, Thread Fungi, Sac Fungi, and Imperfect Fungi*
- Identify spores, the reproductive structures of fungi.
- Students create a DNA double-helix model using pop-beads with students focusing on the placement of bonds between phosphate, deoxyribose, and the four nitrogen bases
- Perform an extraction of DNA from student's cheek cells.
- Use a dichotomous key to identify organisms based on their external characteristics
- Identify organisms based on characteristics of each of the Six Kingdoms: Archaebacteria, Eubacteria, Protista, Fungi, Plantae, and Animalia
- View a variety of cells and tissues from organisms of all six kingdoms under the microscope, including archaebaacteria, eubacteria, protist, fungus, plant, and animal, and discuss how cells form tissues and organs.
- Create cell models displaying the chromosomes in various stages of mitosis
- Identify the animal and plant cell in each phase of the cell cycle

- Recognize that the chromosomes are made up of the DNA and associated proteins within the nucleus of eukaryotic cells.
- Identify structures on preserved specimens that allow them a better chance of survival
- Careful and deliberate dissections of vertebrates, both virtual and real, allow us to view the relationship between our bodies and the bodies of other organisms.
- Learn the proper methods for dissecting an amphibian (grass frog) and an mammal (fetal pig), including organ removal, study, and identification on a virtual dissections using the *Frog Guts* program
- Identify dissecting tools based on their proper use during dissection. These tools include a blunt probe, sharp probe, surgical scissors, scalpel, eye dropper, forceps.
- Identify each organ's function and structure
- Determine each organ's system based on its function
- Recognize organs that function within two or more organ systems
- Identify the structure and function of the following systems in mammals and amphibians: integumentary, muscular, immune, skeletal, circulatory, respiratory, nervous, lymphatic, digestive, endocrine, urinary, and male and female reproductive.
    - Identify structures on plastic models of humans and frog: eye, ear, heart, lungs, and digestive system.
    - View and draw live and preserved protists using digital microscopes and laptop computers including *Euglena, Amoeba, Paramecium.*
    - Learn and perform proper techniques for culturing bacteria
    - Practice proper hand-washing techniques by using powder that is sensitive to fluorescent light. Powder, which simulates location of bacterial colonies on hands, is rubbed on hands; hands are placed under a black light, which makes the powder visible. Students then wash their hands and hands are then placed back under the black light to make "invisible bacteria" visible.

Assessments

Evidence of Learning:

The majority of this unit is an inquiry-based hands-on approach to learning. It consists of laboratory activities which vary in their intensity, approach, skill, and evaluative measurements. For example, some of the lab activities are "walk-through" labs, where the student is guided through a procedure and a process, and is asked to make connections among the main concepts presented in the activity and associated readings. Other lab activities consist of a problem that is presented to the student, which he or she must solve by designing an experiment (which is then peer and teacher evaluated before proceeding with the lab activity) and collecting data. Regardless of the lab activity, students are evaluated based on the quality and presentation of the collected data in graphic organizers; the efficacy and accuracy of the experimental design; the connections made between the experimental design, the data collected, and the conclusion of the laboratory report- i.e. "tying it all together to see the big picture"; and lab etiquette and adherence to safety rules.

Other evidence for learning includes several short 5-10 question quizzes, and end-of-unit lab practical (hands-on) test, end-of-unit paper test based on the labs, and several creative projects, which may include posters, skits, songs and poems, presentations, and Invention Fair projects (Invention Fair projects span several units and may not be completed within any one single unit presented within Folsom School's Science Curriculum).

Lessons/Learning Scenarios

Lesson 1: "Wisconsin Fast Plants" Trimester Three

Objectives and Learning Activities:

- Students prepare the equipment for the maintenance and development of the Wisconsin Fast Plants (Cabbage plant species)
- Sow the cabbage plant seeds in the growing system created by the students
- Examine the role of water and minerals in the growth and development of plants
- Become familiar with the life cycles of cabbage plants and plants in general
- Document (draw, measure, describe) the germination, development, and growth of a cabbage plant, corn plant, and bean plant
- Explore the similarities and differences between monocot and dicot seeds and plants
- Draw and label the root, stems, and leaves, both macro and micro sections of monocots and dicots

Concepts:

- The seed is a stage in the life cycle of a flowering plant
- Plants require specific nutrients and specific quantities of these nutrients for optimum growth and development
- Different species of plants require a specific amount of each nutrient for optimal growth
- A corn plant is a monocot, which is characterized by having one cotyledon in its seed and parallel veins in its leaves, as well as specific patterns of cells within its stems, leaves, and roots
- Bean and cabbage plants are dicots, which are characterized by having two cotyledons their seeds and parallel veins in their leaves, as well as specific patterns of cells within their stems, leaves, and roots

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 2: "The Cabbage White Butterfly: From Egg to Adult" Trimester Three

Objectives and Learning Activities:

- Students explain the meaning of the word *"Lepidoptera"* the order of insects to which butterflies and moths belong
- Explain the life cycle stages of the cabbage white butterfly
- Measure the length of an egg and the length of the body of a newly hatched cabbage white butterfly larva
- Measure and record the body length of a cabbage white larva every three days for three weeks
- Observe the food preferences of a cabbage white larva by offering different species of plants as food sources
- Observe the food preferences of a cabbage white adult butterfly by offering different colors of nectar and observing frequency of certain colors of excrement

- Investigate the anatomy of an adult cabbage white butterfly; draw, label, and describe each part

Concepts:

- Butterflies belong to a class of arthropods called insects
- Butterflies undergo for life stages: egg, larva, pupa, and adult
- The process by which a butterfly develops through its four life stages is called metamorphosis
- Many organisms eat only very specific food types, which co-evolution explains
- Narrow food preferences can limit habitat options for an organism
- The excrement of animals often reveals information about the foods they eat

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 3: "The Cell Cycle" Trimester Three

Objectives and Learning Activities:

- Students will investigate the structures of the cell that are involved in asexual and sexual cell division
- Students learn and sing a song about the mechanics of chromosome formation and movement during the cell cycle: "Ode To Mitosis"
- Depict the behavior of chromosomes during interphase and all phases of the cell cycle
- Construct models that illustrate interphase and the other stages of the cell cycle: prophase, metaphase, anaphase, telophase, and cytokinesis, and describe, in words, what occurs
- Compare and contrast cytokinesis in plant and animal cells
- Students extract DNA from their own cheek cells and create a necklace to preserve the DNA

Concepts:

- Interphase is the period of time between the formation of the daughter cells and cell division
- Mitosis involves the steps in the segregation of duplicated chromosomes into two daughter cells. It is a continuous process that may be divided into distinct phases identified by specific events occurring within the cell
- Cytokinesis follows mitosis and is the process by which one cell splits into two
- Cell division, which includes mitosis and cytokinesis, is necessary for growth and reproduction
- The result of cell division is that every body-cell in an organism contains identical set of chromosomes (DNA)
- DNA along a chromosome runs in three-sequence units called codons.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Skit, poem, video, poster, etc
- Secret DNA Code Sentence Project
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 4: "Genetics with Cabbage Plants and Paper Monsters" Trimester Three

Objectives and Learning Activities:

- Students scrutinize the Wisconsin Fast Plants sprouts for ideas about which inherited traits are different from the F_1 generation seedlings from which these seeds were harvested
- Demonstrate how certain genes interact in pairs to express dominant or recessive traits
- Discover by experimentation how Gregor Mendel established the fundamentals of modern heredity
- Pair genes using a Punnett Square
- Observe evidence of the advantage of using large sample sizes when conducting an inquiry
- Identify homozygous (purebred) and heterozygous (hybrid) gene pairs
- Demonstrate an understanding of the difference between genotype and phenotype
- Use Punnett Squares to predict the probability of the outcome of a cross between two individuals
- Create a "Paper Monster Family" by creating fictitous traits, both dominant and recessive, and allowing the laws of probability (by coin flipping) to determine the genotypes and resulting phenotypes of four offspring. This is a several day creative art-science project

Concepts:

- An allele is a form of a gene. It can be either dominant or recessive
- Inherited traits are determined by one or more pairs of alleles; each parent contributes one allele of a gene pair
- An offspring can receive any combination of alleles from its parents
- If an organism receives two of the same alleles for a trait, it is considered a "purebred" or homozygous for that trait. If it receives two different alleles for the trait it is considered a hybrid, or heterozygous for that trait
- The genotype is a term that describes the genetic characteristics of an organism
- The phenotype is a term that describes the physical characteristics of an organism
- Meiosis produces sex cells (sperm and egg) with half the number of chromosomes than the parent cells
- A Punnett Square is a tool that can be used to predict the outcome of a particular genetic cross

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 5: "Sexual Reproduction in Flowering Plants" Trimester Three

Objectives and Learning Activities:

- Students examine two or more flowers and develop a comprehension of their structures and functions of each structure
- Students plant F_1 generation seeds of the cabbage plants
- Cross-pollinate the cabbage plants flowers in the growing systems
- Investigate and explain how flowers are pollinated in nature
- Demonstrate an understanding of the differences between cell division and meiosis

- View magnified (electron scanning microscope) images of pollen grain from many different species
- Students observe growth of pollinated ovary and allow seed pod to form
- Students take dried-out seeds and plant them to create a F_2 generation

Concepts:

- The flower is the sexual reproductive organ of a flowering plant
- Perfect flowers contain both male and female reproductive structures
- Imperfect flowers contain either the male of female reproductive structures
- Pollination is the transfer of pollen from the anther of one flower to the stigma of another flower
- Pollen grains from different species of plants are very different in size and shape**,** making them incompatible between species
- Some plants self-pollinate, others rely on cross-pollination
- Pollen can be transported in many ways, such as wind, water, insects, birds, gravity, etc
- Fertilization occurs when a sperm cell nucleus from a pollen grain unites with the egg nucleus of an ovule in an ovary. A seed begins to form when fertilization occurs

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 6: "Leaf Structure and Transpiration" Trimester Three

Objectives and Learning Activities:

- Students determine the change in volume of nutrient solution in the reservoir of the growing system over 24 hours in order to calculate the amount of transpiration
- Determine whether there is a relationship between the volume of nutrient solution that passes through the growing systems in 24 hours and the number of leaves on the plant
- Observe and draw a stomatal unit from the epidermis of a lettuce leaf
- Use a model to demonstrate how guard cells operate to form a stoma
- Explain how the structure of a dicot leaf helps control the water flow in a plant
- Identify the process of photosynthesis, the process by which green plants produce glucose and release oxygen into the air
- Separate the pigments naturally found in plants to form a chromatograph and discuss the physics behind this pigment separation

Concepts:

- Transpiration is the process by which water evaporates from plants. It provides the force to draw water up from the roots to the leaves and stem
- Water escapes from plant leaves through openings called stomata, which are formed between cells called guard cells
- Osmosis is the diffusion of water across a semi-permeable membrane
- Guard cells swell and become turgid when water enters them by osmosis
- Osmosis and diffusion that occurs through cell membranes occurs because of differences of concentration gradients within the cell area

- Substances naturally move from areas of higher concentration to areas of lower concentration
- The number of leaves on a plant determines the rate of transpiration
- The leaf is the major photosynthetic organ in the plant and contains the photosynthetic organelles chloroplasts

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 7: "The Next Generation Part 1" Trimester Three

Objectives and Learning Activities:

- Develop a list of ways that seeds are dispersed
- Recognize the pod as a fruit, and the fruit as a package of nutrients and protection for the seeds
- Plant F_2 generation Wisconsin Fast Plants seeds and predict the number of purple-pigmented offspring.
- Review the relationship between the life cycles of Wisconsin Fast Plants and cabbage white butterflies.
- Investigate how seedless fruit is developed for consumers.

Concepts:

- In nature, seeds are dispersed in a variety of ways that are made possible by how the seed is encased. (Wind, water, insects, birds, bats, etc)
- Many types of seeds are encased in pods, which, when mature, dry and split apart to release the seeds.
- Seeds vary in number per pod depending on how many eggs were fertilized by the sperm (pollen).
- Seeds may germinate under a variety of conditions, but viability varies.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 8: "The Next Generation Part 2" Trimester Three

Objectives and Learning Activities:

- Identify characteristics that offspring inherit from their parents.
- Recognize that inherited characteristics may or may not be visible in every generation.
- Observe the Wisconsin Fast Plants sprouts for clues about inherited traits.
- Demonstrate how genes, through pairings, interact to express dominant or recessive traits.
- Discover, by experimentation, how Gregor Mendel established the fundamentals of heredity and modern genetics.
- Simulate meiosis and fertilization.

Concepts:

- Offspring inherit characteristics, or traits, from their parents and tend to resemble them.
- Pairs of genes determine inherited traits with each parent contributing one gene to the pair.
- Different forms of a gene may be dominant or recessive.
- Inherited gene pairs can be considered homozygous (puerbred), or heterozygous (hybrid).
- The gene combination for a trait is considered its genotype, whereas the phenotype describes the physical appearance of the gene combination.
- Meiosis produces sperm and egg cells (sex cells) with half the number of usual chromosomes.
- A Punnett Square is a simple tool used to determine the likelihood of a particular genetic outcome occurring.

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Lesson 9: "The Amphibian Body" Trimester Three

Objectives and Learning Activities:

- Identify structures on preserved specimens that allow them a better chance of survival
- Careful and deliberate virtual dissections of vertebrates, allow us to view the relationship between our bodies and the bodies of other organisms.

Concepts:

- Kingdom Animalia includes the eukaryotic, multicellular consumers, and includes many diverse invertebrates and vertebrates.
- Kingdom Animalia is divided into many diverse phyla, each with unique characteristics.
- Chordates are the most complex phyla of Kingdom Animalia because of the presence of complex nerve cords and associated nervous system, as well as other body structures.
- Invertebrates and vertebrates are animals with very different body plans and structures
- Invertebrates are animals without backbones
- Vertebrates are animals with backbones
- Animals are very diverse, and include Mollusks, Annelids, Arthropods, Echinoderms, Fishes, Amphibians, Reptiles, Birds, and Mammals

Assessments:

- Laboratory Report, including data tables, charts, diagrams, and graphs, where applicable
- Class Discussion (Pre-lab, Post-lab)
- Reading selection discussion

Standards

NGSS Standard Correlation:

MS-LS1-1: Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. [Clarification Statement: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.]

MS-LS1-2: Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [*Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.*]

MS-LS1-3: Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.] [*Assessment Boundary: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.*]

MS-LS1-4: Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [*Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.*

MS-LS1-6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [*Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.*

MS-LS1-7: Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [*Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.*]

MS-LS1-8: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. [*Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.*]

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]

MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.[Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]

MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [*Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.*]

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

MS-LS3-1: Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.[Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [*Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.*]

MS-LS3-2: Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]

MS-LS4-2: Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.]

MS-LS4-3: Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]

MS-LS4-4: Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. [Clarification Statement: Emphasis is on using simple probability statements and proportional

reasoning to construct explanations.]

MS-LS4-5: Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]

MS-LS4-6: Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [*Assessment Boundary: Assessment does not include Hardy Weinberg calculations.*]

Resources

Bibliography

National Academy of Sciences, and Smithsonian Institute 2nd ed. 2013. "*Studying the Development and Reproduction of Organisms"*. Carolina Biological Publisher, Burlington, NC.

Pearson 2011. Interactive Science: *Cells and Heredity*. Upper Saddle River, NJ

Pearson 2011. Interactive Science: *The Diversity of Life.* Upper Saddle River, NJ

Pearson 2011. Interactive Science: *Ecology and the Environment.* Upper Saddle River, NJ