Platte County
HOME OF THE PIRATES

SCIENCE CURRICULUM

BIOLOGY

Board Approval Date: pending
May 2024

SCIENCE: INTRO TO BIOLOGY - UNIT 1

<table>
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<tr><td colspan="4">Pacing: 2 weeks</td></tr>
<tr><th>Unit Power Standard(s) Code</th><th colspan="3">Unit Power Standard(s) Description</th></tr>
<tr><td>9-12.LS1.A.2</td><td colspan="3">DEVELOP and USE a <u>model</u> to ILLUSTRATE the hierarchical <u>organization</u> of interacting <u>systems</u> that PROVIDE specific <u>functions</u> within multicellular <u>organisms.</u></td></tr>
<tr><th colspan="2">Below Grade/Course Connected Standard(s)</th><th colspan="2">Above Grade/Course Connected Standard(s)</th></tr>
<tr><td colspan="2">8th grade students were previously engaged with 6-8.LS1.A.2</td><td colspan="2">N/A</td></tr>
<tr><th>Unit Supporting Standards Code</th><th colspan="3">Unit Supporting Standards Description</th></tr>
<tr><td>9-12.LS3.B.1</td><td colspan="3">COMPARE and CONTRAST asexual and sexual reproduction with regard to genetic <u>information</u> and <u>variation</u> in <u>offspring.</u></td></tr>
<tr><th colspan="4">Unpacked Standard(s)</th></tr>
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<tr><td>9-12.LS1.A.2</td><td>DEVELOP and USE a model to ILLUSTRATE the hierarchical organization of interacting systems that PROVIDE specific functions within multicellular organisms.</td><td>3</td><td>SCIENCE AND ENGINEERING PRACTICES
Developing and Using Models ● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
DISCIPLINARY CORE IDEAS
Structure and Function ● Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.
CROSSCUTTING CONCEPTS
System and System Models ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.</td></tr>
<tr><th>DESE Questions Examples:</th><td colspan="3">These examples could be added from any of these three places.
Sample stem is not appropriate for this unit
<u>Alternatives include:</u>
1. Make a Claim about whether you think viruses are a living thing. Use three pieces of evidence to support your claim. Explain your reason as to why your evidence supports your claim.</td></tr>
</table>

	Life 9-12 EOC	
“Unwrapped” Content (<u>nouns</u>) (students need to know)	**“Unwrapped” Skills (VERBS) (students need to be able to do & DOK)**	**“Unwrapped” Understanding (students need to understand)**
• Model • Organization • Systems • Functions • Organisms • Claim • Evidence • Reasoning	• Develop (3) • Use (2) • Illustrate (1) • Provide (1) • Observe (1) • Annotate (2) • Differentiate (2) • Compare and Contrast (2)	• Students will develop an argument using evidence that something is biotic or abiotic. • Students will distinguish between an observation and an inference. • Students will use a concept map to differentiate the similarities and differences between living and nonliving things. • Students will ask questions that arise from observations or results, to clarify and/or seek additional information. • Students will compare and contrast viruses, bacteria and animal cells using a venn diagram to find similarities and differences based on observations they make. • Students will annotate a reading on viruses and use the evidence they found to to create a logical argument using evidence whether something is living or nonliving.

New Academic Vocabulary	Scaffolded (Review) Academic Vocabulary
• Homeostasis • Asexual reproduction • Response • Metabolism • Sexual reproduction • Stimulus • Fertile • prokaryote • Positive feedback • Species • Eukaryote • Negative feedback • Evolution • Differentiation • Somatic	• Biology • Atom • Molecule • Organ • Tissue • Cell • Organ system • Organism • Population • Species • Community • Ecosystem • Biosphere • Abiotic • Biotic • Heterotroph • Unicellular • Multicellular • Autotroph • Hypothesis • Unicellular • Genetic Code (DNA) • Independent variable • Dependent variable • Control • Constant

Assessment

Common Summative Assessment/Demonstration of Understanding

- **Common Unit Assessment to be completed in the 2024-2025 School Year.**

Links to student example of summative assessments/demonstration of understanding

Score 4	Score 3	Score 2	Score 1
Example	**Example**	**Example**	**Example**

Proficiency Scale

4	**Student has mastered understanding of the entire standard(s) and make little to no errors when asked to demonstrate and apply their learning.**
	•
3	**Student consistently shows understanding for most components of the standard(s) with few errors when asked to demonstrate and apply their learning.**
	•
2	**Student can sometimes show understanding for some of the components of the standard(s), yet there are a few aspects that they are still learning and improving upon.**
	•

1	**Student rarely shows understanding for any component of the standard(s) and are still needing significant teaching to apply their learning.**
	•

Additional Information

Professional Resource Suggestions	Instructional Resources
	Pogil Demo a Day
	Other Resources: • Interactive notebook • Intro to life video • Biotic and abiotic reading • Are viruses Alive Reading / CER

Curriculum Designer Notes:	The intent of this unit should be: • To build foundational vocabulary and science skills. • Skills to focus on include Observation / Inference, compare and contrast • Reading: Annotating and Note Taking • Writing Claim, Evidence and Reasoning This seems like an insignificant unit but the groundwork laid here is an important step that students need so we can build on it. This curriculum is designed to learn in small steps and continuous scrolling back to past learned information. State Assessment Content Limits/Boundaries Do : Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to stimuli. Similar cells work together to form tissues. Tissues work together to form organs. Organs work together to form organ systems. Organ systems interact to form an organism. Do Not : • Tasks should not include interactions or functions at the molecular or chemical reaction level. Any descriptions of relationships should be at the systems level. • Tasks should not include the individual structure and function of parts of the systems

Science: Unit 2 -Chemistry of Life

Overview	
Quarter(s): 1	
Pacing: 3 weeks	
Unit Power Standard(s) Code	**Unit Power Standard(s) Description**
9-12.LS1.C.3	CONSTRUCT and REVISE an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms MAY COMBINE with nitrogen, sulfur and phosphorus to FORM large carbon-based molecules.
9-12.LS1.A.1	CONSTRUCT a model of how the structure of DNA DETERMINES the structure of proteins which CARRY OUT the essential functions of life through systems of specialized cells.
Below Grade/Course Connected Standard(s)	**Above Grade/Course Connected Standard(s)**
8th grade students were previously engaged with 6-8.PS1.A.1, 6-8.PS1.B.1	N/A
Unit Supporting Standards Code	**Unit Supporting Standards Description**
9-12.LS1.A.2	DEVELOP and USE a model to ILLUSTRATE the hierarchical organization of interacting systems that PROVIDE specific functions within multicellular organisms.

Unpacked Standard(s)

Power Standard(s) Code	Power Standard(s) Description	DOK(s)	DESE Expectation(s) Unwrapped
9-12.LS1.C.3	CONSTRUCT and REVISE an explanation based on evidence that organic macromolecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may COMBINE with nitrogen, sulfur and phosphorus to FORM large	3	SCIENCE AND ENGINEERING PRACTICES Constructing Explanations and Designing Solution • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and on the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future DISCIPLINARY CORE IDEAS Organization for Matter and Energy Flow in Organisms • The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their

	carbon-based molecules.		hydrocarbon backbones are used to make amino ● acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used to form ● new cells. ● As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in ● different ways to form different products CROSSCUTTING CONCEPTS Energy and Matter ●Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system
9-12.LS1.A.1	CONSTRUCT a model of how the STRUCTURE of DNA determines the STRUCTURE of PROTEINS which carry out the essential FUNCTIONS of LIFE through SYSTEMS of SPECIALIZED CELLS	3	SCIENCE AND ENGINEERING PRACTICES Using Mathematics and Computational Thinking ●Use mathematical and/or computational representations of phenomena or design solutions to support explanations. DISCIPLINARY CORE IDEAS Interdependent Relationships in Ecosystems ●Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. ●These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. ●Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. ●This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. CROSSCUTTING CONCEPTS Scale, Proportion, and Quantity ●The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs
DESE Questions Examples:	These examples could be added from any of these three places. 1. Item specifications (under "Essential Resources"), bottom right corner it says "sample stems" a. Life 9-12 2. MAP/EOC practice assessments (under "Practice Forms"). The answer document states what standards are connected to that question.		

“Unwrapped” Content (<u>nouns</u>) (students need to know)	“Unwrapped” Skills (VERBS) (students need to be able to do & DOK)	“Unwrapped” Understanding (students need to understand)
• Organic • Macromolecules • Atoms • Carbon • Hydrogen • Oxygen • Nitrogen • Sulphur • Phosphorus • Model	• Construct an Explanation (3) • Revise an Explanation(3) • Classify (1) • Describe(1) • Explain(3) • Construct a model (3) • Develop a model (3) • Use a model (3) • Develop a logical argument (3)	• Students can differentiate and classify the four basic organic molecules that build living organisms based on what they are made out of. • Students can identify macromolecules using various chemical tests and support the identification using evidence. • Students can find evidence to identify types of macromolecules in digested food to develop a logical argument for a claim • Students explain how monomers are synthesized into polymers and how organisms break them down and reuse them. • Students will explain at least three ways energy is stored and transferred in living things. • Students can construct an explanation for the way in which macromolecules make up the mass of organisms as well as their functions. • Students can describe how the structure of DNA enables its functions

		of storing and transferring genetic information from one generation to the next. • Students explain how an enzyme affects the energy and speed of chemical reactions.

New Academic Vocabulary	Scaffolded (Review) Academic Vocabulary
• Covalent bond • Hydrogen bond • Macromolecule • Organic • Carbohydrate • Monomer • Polymer • Monosaccharide • Disaccharide • Glucose • Polysaccharide • Lipid • Protein • Amino acid • Enzyme • Catalyst • Active site • Product • Reactant • Substrate • Activation energy • ADP • ATP • Double helix • Nucleotide • Nucleic acid • Deoxyribose • Ribose	• Chemical reaction • Energy • Kinetic energy • Chemical energy • Potential energy • Adenine • Guanine • Cytosine • Thymine • Uracil

Assessment

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Proficiency Scale

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1	**Student rarely shows understanding for any component of the standard(s) and are still needing significant teaching to apply their learning.**
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Additional Information

Professional Resource Suggestions	Instructional Resources
• Gizmos Case Study 1. Enzymes	Pogil Demo a Day
	Other Resources

Curriculum Designer Notes:	Students come from middle school knowing basic atomic structure, simple molecules such as H2O , Co2, bonding and basic concepts of Law of Conservation. The focus here should be 1. Properties of water with emphasis on pH where we will revisit in Ecology with acidification of lakes and oceans and its effects on living things adhesion/cohesion where we will revisit in photosynthesis and ecology units. 2. Knowing the 4 basic Macromolecules They should know elements they are composed of, Monomers that build them polymers and their function. Note, this background will be used in all of the units the rest of this year in some capacity. 3. Special focus should address enzymes (a type of protein), importance in metabolism, how shape determines function, how they speed up reactions (lower activation energy). We will scroll back to this in Photosynthesis, Cell Respiration and Protein Synthesis. 4. Special focus should address DNA replication. We specifically took this away from the central dogma unit because students routinely get replication and protein synthesis mixed up when taught together. It is best practice to teach replication early, and when you get to mitosis you can review replication and apply the knowledge into the context of mitosis and meiosis to help reinforce knowledge. Labs that help reinforce these topics: 1. Properties of water lab / Acid Base Lab - this is background information that they will use in enzyme function, photosynthesis and ecology

2. Enzyme Lab / focus on factors that affect function with an understanding of denaturation. Other concepts learned include Shape fits function, and properties of enzymes such as they are reusable…
3. Macromolecule identification/investigation lab
    a. Lab should focus on developing a logical argument using evidence to support macromolecule identification.

The previous grade expectations and limits

- We expect our students to come to the highschool with a basic background in atomic structure and types of chemical bonding and how to read a chemical equation.
- Science skills that are needed include basic lab skills, identifying constants, controls, independent and dependent variables, finding evidence , using evidence in a n argument.

<u>Possible evidence they understand LS1.C.3</u>

- Students make a claim explaining the phenomena (chemical structure of a macromolecule).
- The relationship between the carbon, hydrogen, and oxygen atoms from sugar molecules formed in or ingested by an organism and those same atoms found in amino acids and other large carbon-based molecules.
- Larger carbon-based molecules and amino acids resulting from chemical reactions between sugar molecules (or their component atoms) and other atoms.
- Students identify and describe the evidence to construct their explanation, including the following:
- All organisms take in matter (allowing growth and maintenance) and rearrange the atoms in chemical reactions.
- Cellular respiration involves chemical reactions between sugar molecules and other molecules in which energy is released that can be used to drive other chemical reactions.
- Sugar molecules are composed of carbon, oxygen, and hydrogen atoms.
- Amino acids and other complex carbon-based molecules are composed largely of carbon, oxygen, and hydrogen atoms.
- Chemical reactions can create products that are more complex than the reactants.
- Chemical reactions involve changes in the energies of the molecules involved in the reaction.
- Students use a variety of valid and reliable sources for the evidence (e.g.,theories,simulations,peer review,students' own investigations).
- Students use reasoning to connect the evidence, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to construct the explanation that atoms from sugar molecules may combine with other elements via chemical reactions to form other large carbon-based molecules. Students describe the following chain of reasoning for their explanation:
- The atoms in sugar molecules can provide most of the atoms that comprise amino acids and other complex carbon-based molecules.
- The energy released in respiration can be used to drive chemical

reactions between sugars and other substances, and the products of those reactions can include amino acids and other complex carbon-based molecules.
- The matter flows in cellular processes are the result of the rearrangement of primarily the atoms in sugar molecules because those are the molecules whose reactions release the energy needed for cell processes.
- Given new evidence or context, students revise or expand their explanation about the relationships between atoms in sugar molecules and atoms in large carbon-based molecules and justify their revision

<u>Possible evidence they understand LS1.A.1</u>

- Students construct an explanation that includes the idea that regions of DNA, called genes, determine the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
- Students use a variety of valid and reliable sources for the evidence (e.g., theories, simulations, peer review, students' own investigations).
- Identify and describe the evidence to construct their explanation, including that:
- All cells contain DNA
- DNA contains regions that are called genes
- The sequence of genes contains instructions that code for proteins
- Groups of specialized cells (tissues) use proteins to carry out functions that are essential to the organism
- Students use reasoning to connect evidence, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to construct the explanation.
- Students describe the following chain of reasoning in their explanation: Because all cells contain DNA, all cells contain genes that can code for the formation of proteins.
- Body tissues are systems of specialized cells with similar structures and functions, each of whose functions are mainly carried out by the proteins they produce.
- Proper function of many proteins is necessary for the proper functioning of the cells.
- Gene sequence affects protein function, which in turn affects the function of body tissues.

<u>Possible evidence they understand LS1.A.2</u>

- Students construct an explanation that includes the idea that regions of DNA,called genes, determine the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
- Identify and describe the evidence to construct their explanation, including that:
- All cells contain DNA
- DNA contains regions that are called genes
- The sequence of genes contains instructions that code for proteins
- Groups of specialized cells (tissues) use proteins to carry out functions that are essential to the organism

	<u>Limits LS1.C.3</u> ● Tasks should include all necessary models. ● Tasks should not require students to identify macromolecules based on chemical structure. ● Tasks should not include the details of specific chemical reactions or bonding. <u>Limits LS1.A.1</u> ● Tasks should not require students to distinguish between credible and non-credible sources. ● Tasks requiring students to transcribe or translate a DNA sequence must also include a codon chart/wheel. ● Tasks should not assess the functions of tRNA or rRNA. ● Tasks should not require students to identify cell or tissue types, whole body systems, specific protein structures (folding) and functions, or the biochemistry of protein synthesis (i.e., enzymes).

BIOLOGY : UNIT 3 HOMEOSTASIS - CELLS, TRANSPORT, AND BODY SYSTEMS

<table>
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<tr><td colspan="4">Quarter(s): 1</td></tr>
<tr><td colspan="4">Pacing: 3 weeks</td></tr>
<tr><th>Unit Power Standard(s) Code</th><th colspan="3">Unit Power Standard(s) Description</th></tr>
<tr><td>9-12.LS1.A.2</td><td colspan="3">DEVELOP and USE a model to ILLUSTRATE the hierarchical organization of INTERACTING systems that PROVIDE specific functions within multicellular organisms.</td></tr>
<tr><td>9-12.LS1.A.3</td><td colspan="3">PLAN and CONDUCT an investigation to PROVIDE evidence that feedback mechanisms MAINTAIN homeostasis.</td></tr>
<tr><th colspan="3">Below Grade/Course Connected Standard(s)</th><th>Above Grade/Course Connected Standard(s)</th></tr>
<tr><td colspan="3">8th grade students were previously engaged with 6-8.LS1.A.2, 6-8.LS1.A.4</td><td>N/A</td></tr>
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Developing and Using Models
● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
DISCIPLINARY CORE IDEAS
Structure and Function
● Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.
CROSSCUTTING CONCEPTS
System and System Models
● Models (e.g., physical, mathematical, computer models) can be used to simulate</td></tr>
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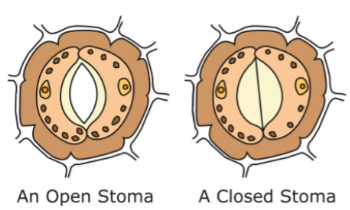
Planning and Carrying Out Investigations
● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence and in the design
o decide on types, quantity, and accuracy of data needed to produce reliable measurements;
o consider limitations on the precision of the data (e.g., number of trials, cost, risk, time);
o refine the design accordingly.
Scientific Investigations Use a Variety of Methods
● Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, reliability of results, and honest and ethical reporting of findings.
<u>DISCIPLINARY CORE IDEAS</u>
Structure and Function
● Multicellular organisms have a hierarchical structural organization in which any one system is made up of numerous parts and is itself a component of the next level.
<u>CROSSCUTTING CONCEPTS</u>
Stability and Change
● Feedback (negative or positive) can stabilize or destabilize a system.</td></tr>
<tr><td>DESE Questions Examples:</td><td colspan="3">

<u>Sample Item Stems</u>

A student uses a light microscope to examine the leaf of a tomato plant. She observes that tiny openings in the plant leaves open and close under different light conditions. These openings are called stomata (singular: stoma).

Figure 1. Stomata



The student decides to design an experiment exploring how stomata open and close in a tomato plant in response to stimuli. The results will allow the student to model the relationship of stomata to homeostasis in the plant overall. The student exposed the plants to different amounts of light and humidity for a period of 30 minutes and then made observations. The students' summary of the experimental results are shown in the table.

</td></tr>
</table>

Table 1. Experimental Results

Experimental Condition		Stomata State
Brightness	**Humidity**	**Results**
Very bright	Humid	Open
Very bright	Dry	Closed
Ordinary brightness	Very humid	Open
Ordinary brightness	Very dry	Closed
No light - dark	Humid	Closed
No light - dark	Dry	Closed

Figure 2. Levels of Organization in the Student's Model

Molecules → Organelles → Cells → Tissues → Organs → Organ Systems → Organism

1. In a plant, when the turgor pressure is low, the stomata close and the leaves wilt. When the turgor pressure is high, the stomata open and the leaves are firm. Based on the data in Table 1, under which conditions would the leaf stay firm?

2. The student is conceptually modeling stomata in terms of their function. Complete the sentence below by selecting one answer choice for each blank (set of parentheses).

   A stoma operates on the flow of (carbohydrates/change/light/water vapor) into and out of the leaf by acting as a (consumer of the matter or energy flowing through it/producer of the matter or energy flowing through it, a one-way valve, a two-way gate).

Life 9-12

MAP/EOC practice assessments (under "Practice Forms"). The answer document states what standards are connected to that question.

"Unwrapped" Content (nouns) (students need to know)	"Unwrapped" Skills (VERBS) (students need to be able to do & DOK)	"Unwrapped" Understanding (students need to understand)
• Model • Organization • Systems • Functions • Organisms	• Develop a model (3) • Use a model (3) • Illustrate the interactions of various systems (1) • Provide evidence of specific functions within multicellular organisms (1) • Plan an investigation (3) • Conduct an investigation (3) • Provide evidence that feedback mechanisms maintain homeostasis (1)	• Students will develop a model that differentiates between prokaryote, eukaryote, animal and plant cells based on the structures they contain. • Students will be able to compare and contrast Prokaryotes and Eukaryotes. • Students can illustrate how molecules interact with the cell membrane • Students will illustrate and model how the cell/ plasma membrane regulates what enters and leaves the cell to

		maintain homeostasis ● Students will conduct an investigation regarding the human body that uses transport to maintain homeostasis (including the levels of cell, tissue, organ and organ systems) ● Students will be able to develop or read a model that represents homeostasis and determine if it is positive or negative feedback in human body examples. ● Students provide evidence that positive and negative feedback systems interact with the levels of biological organization (at the level of individual organisms).

New Academic Vocabulary	Scaffolded (Review) Academic Vocabulary
differentiation vesicles semi-permeable membrane fluid mosaic model concentration gradient diffusion facilitated diffusion osmosis phospholipid membrane protein equilibrium active transport protein channel passive transport endocytosis exocytosis	metabolism homeostasis response stimulus macromolecule carbohydrate (glucose) cell/plasma membrane cell wall central vacuole lysosome nucleus prokaryote eukaryote mitochondria chloroplast ribosome centrioles molecule cell

	issue organ organ system Integumentary System Muscular System Respiratory System Circulatory system Digestive system Excretory system solute solvent solution hydrophobic negative feedback positive feedback

Common Summative Assessment/Demonstration of Understanding

- Common Unit Assessment to be completed in the 2024-2025 School Year.

Links to student example of summative assessments/demonstration of understanding

Score 4	Score 3	Score 2	Score 1
Example	Example	Example	Example

Proficiency Scale

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Additional Information

Professional Resource Suggestions	Instructional Resources
• Gizmo Case Studies : 1. Diffusion 2. Osmosis 3. Homeostasis	Pogil Demo a Day
	Other Resources:

Curriculum Designer Notes:	This unit should focus on homeostasis of cells and organisms. The homeostasis of ecosystems will be in our Ecology unit. ○ Students from middle school are supposed to have a firm grasp of cells and organelles. However, what we see is a mix of students that range between large content knowledge to very little content knowledge. We have enough students without the needed content to directly teach homeostasis and review is needed. Focus here should be Cell Structure and Function = Our first section in this unit reviews cells and organelle function. Specific organelles will be reviewed in other units along the way for deeper understanding. ● Something to add here is a microscope lab to observe and gain microscope skills looking at plant and animal cells, pond water would also be good here. An extension could be to add saltwater to the cells to see the effect. This is a great lead into Transport which is our next segment. There is a stomata lab looking at density of stomata, and discussing the relationship between stomata, Co2 levels and global temperatures. The tricky part with this lab is not having covered global temperatures but a brief intro video would work here. More details on global effects will be discussed in our ecology unit. ● Cell Membranes and Transport This section should focus on the structure of the membrane with emphasis on the macromolecule that builds them. This will lead to a discussion on types of transport. Demos include diffusion of dye, semipermeable membranes using ziplock bags, starch and iodine, and lettuce in distilled water and salt water to demonstrate osmosis. ● A great lab to do here is egg lab. This is where you dissolve the egg with vinegar and monitor changes in the size of the egg when placed in different solutions. This lab can also be discussed in ecology when you talk about ocean acidification. ● Feedback and Body Systems = This section should focus on positive and negative feedback using real life examples. Students should have a pretty good grasp of body systems coming from middle school, however we find reviewing is necessary. This should be a quick review of functions and organs within the system You do not need to spend time modeling these systems. Instead, focus on how they work together to maintain homeostasis. Homeostasis lab works well here / exercise lab is another option <u>LS1.A.2</u> ●Students construct an explanation that includes the idea that regions of DNA, called genes, determine the structure of proteins, which carry out the essential functions of life through systems of specialized cells. ●Students use a variety of valid and reliable sources for the evidence (e.g.,theories,simulations,peer review, students' own investigations). ●Identify and describe the evidence to construct their explanation, including

	that: oAll cells contain DNA oDNA contains regions that are called genes oThe sequence of genes contains instructions that code for proteins oGroups of specialized cells (tissues) use proteins to carry out functions that are essential to the organism ●Students use reasoning to connect evidence, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to construct the explanation. o Studentsdescribe the following chain of reasoning in their explanation: oBecause all cells contain DNA, all cells contain genes that can code for the formation of proteins oBody tissues are systems of specialized cells with similar structures and functions, each of whose functions are mainly carried out by the proteins they produce.oProper function of many proteins is necessary for the proper functioning of the cells.oGene sequence affects protein function, which in turn affects the function of body tissues LS1.A.3 oMake a claim identifying the phenomenon under investigation. oStudents describe the phenomenon under investigation, which includes the following idea: that feedback mechanisms maintain homeostasis. oStudents develop an investigation plan and describe the data that will be collected and the evidence to be derived from the data, including ▪changes within a chosen range in the external environment of a living system and responses of a living system that would stabilize and maintain the system's internal conditions (homeostasis), even though external conditions change, thus establishing the positive or negative feedback mechanism. oStudents describe why the data will provide information relevant to the purpose of the investigation. ●Planning the investigation. oIn the investigation plan, students describe the following: ▪How the change in the external environment is to be measured or identified ▪How the response of the living system will be measured or identified ▪How the stabilization or destabilization of the systems internal conditions will be measured or determined ▪The experimental procedure, the minimum number of different systems (and the factors that affect them) that would allow generalization of results, the evidence derived from the data, and identification of limitations on the precision of data to include types and amounts ▪Whether the investigation will be conducted individually or Collaboratively. ●Students collect and record changes in the external environment and organism responses as a function of time. ●Students evaluate their investigation, including O assessment of the accuracy and precision of the data, as well as limitations (e.g., cost risk, time) of the investigation and suggestions for refinement, and O assessment of the ability of the data to provide the evidence required

	<u>LS1.A.2 Limits</u> ●Tasks should not include interactions or functions at the molecular or chemical reaction level. Any description of relationships should be at the systems level. ●Tasks should not include the individual structure and function of parts of the systems (e.g., arteries, xylem). <u>LS1.A.3 Limits</u> ●Tasks should focus on students recognizing and understanding the feedback mechanisms present in internal environments. ●Tasks should provide students with enough background knowledge—students are not expected to know the physiological processes. ●Tasks should not assess the cellular processes involved in the feedback mechanisms (e.g., cell receptors opening channels). ●Tasks can address all aspects of experimental design and scientific method.

Biology: Unit 4- Photosynthesis and Cellular Respiration

Overview

Quarter(s): 2

Pacing: 1.5 Weeks

Unit Power Standard(s) Code	Unit Power Standard(s) Description
9-12.LS2.B.1	CONSTRUCT and REVISE an explanation based on evidence that the processes of photosynthesis, chemosynthesis, and aerobic and anaerobic respiration are responsible for the CYCLING of matter and FLOW of energy through ecosystem and that environmental conditions RESTRICT which reactions can OCCUR.
9-12.LS2.B.3	USE a model that ILLUSTRATES the roles of photosynthesis, cellular respiration, decomposition, and combustion to EXPLAIN the cycling of carbon in its various forms among the biosphere, atmosphere, and geosphere.

Below Grade/Course Connected Standard(s)	Above Grade/Course Connected Standard(s)
8th grade students were previously engaged with 6-8.LS1.B.1	N/A

Unit Supporting Standards Code	Unit Supporting Standards Description
9-12.ESS2.A.4	USE a model to DESCRIBE how variations in the FLOW of energy into and out of Earth's systems result in changes in climate.
9-12.LS1.C.1	USE a model to DEMONSTRATE how photosynthesis TRANSFORMS light energy into stored chemical energy.
9-12.LS1.C.2	USE a model to DEMONSTRATE that cellular respiration is a chemical process whereby the bonds of molecules are BROKEN and the bonds in new compounds are FORMED resulting in a NET TRANSFER of energy.
9-12.ESS3.D.2	PREDICT how human activity AFFECTS the relationships between Earth systems in both positive and negative ways.
9-12.LS2.B.2	COMMUNICATE the pattern of the CYCLING of matter and the FLOW of energy among trophic levels in an ecosystem.

Unpacked Standard(s)

Power Standard(s) Code	Power Standard(s) Description	DOK(s)	DESE Expectation(s) Unwrapped

9-12.LS2.B.1	CONSTRUCT and REVISE an explanation based on evidence that the processes of photosynthesis, chemosynthesis, and aerobic and anaerobic respiration are responsible for the CYCLING of matter and FLOW of energy through ecosystems and that environmental conditions RESTRICT which reactions can OCCUR	3	SCIENCE AND ENGINEERING PRACTICES Constructing Explanations and Designing Solutions ● Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, and peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Connections to Nature of Science: Scientific Knowledge Is Open to Revision in Light of New Evidence ● Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. DISCIPLINARY CORE IDEAS Cycles of Matter and Energy Transfer in Ecosystems ● Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. CROSSCUTTING CONCEPTS Energy and Matter ● Energy drives the cycling of matter within and between systems.
9-12.LS2.B.3	USE a model that ILLUSTRATES the roles of photosynthesis, cellular respiration, decomposition, and combustion to EXPLAIN the CYCLING of CARBON in its various forms among the biosphere, atmosphere, and geosphere	3	SCIENCE AND ENGINEERING PRACTICES Developing and Using Models ● Develop a model based on evidence to illustrate the relationships between systems or components of a system. DISCIPLINARY CORE IDEAS Cycles of Matter and Energy Transfer in Ecosystems ● Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. Energy in Chemical Processes

			● The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. <u>CROSSCUTTING CONCEPTS</u> Systems and System Models ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

DESE Questions Examples:

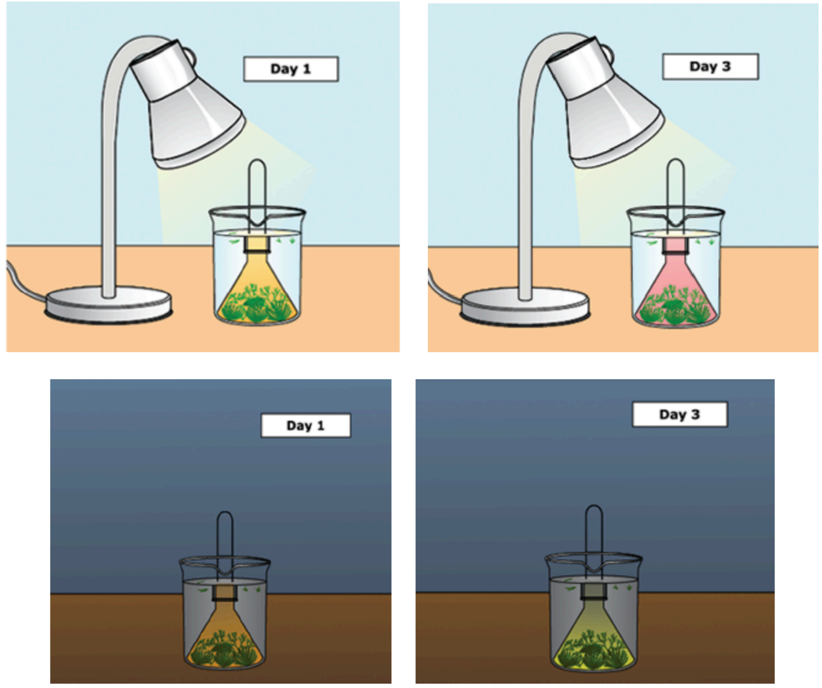
Sample Stems

- Scientists have observed a decrease in dissolved oxygen levels and a decrease in the level of light in the water in a pound. This seems to be happening because the water is cloudy. They conducted two experiments to test the responses of a local species of pondweed (an aquatic plant) to these changing conditions.
- Experiment 1: The first part of the experiment measured the effects of light intensity on carbon dioxide absorption and release in pondweed. Two groups of pondweed were submerged in water. One group was put in light, and the other was kept in darkness. The presence of carbon dioxide in water can be detected with a pH indicator called phenol red. Table 1 shows how the color of phenol red changes due to pH.

Table 1. Color of Phenol Red with pH Changes

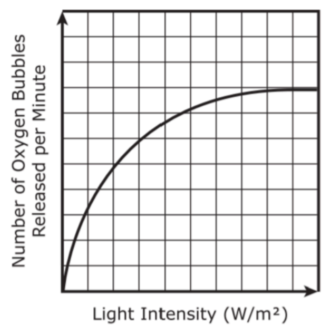
pH	Color of Phenol Red
less than 6.8	yellow
6.8-8.2	organe
greater than 8.2	pink

At the start of the experiment, the water with the phenol red was organe for both groups. After several days, the water of the group in light turned pink and the water of the group in the dark turned yellow.



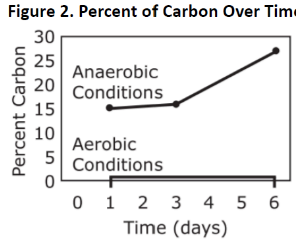
The second part of the experiment tested the effects of light intensity on oxygen released in pondweed. Oxygen release was measured by the formation of bubbles on the surface of the leaves. The results are shown in Figure 1.

Figure 1. Effects of Light Intensity on Oxygen Release



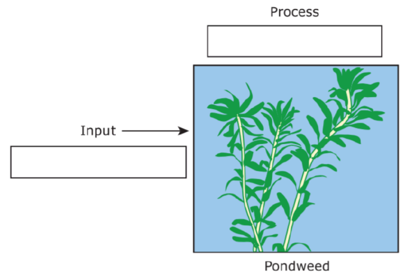
Experiment 2: The scientists had observed that under certain conditions, this species of pondweed can break down sto starch in their stems into ethanol, lactate, and energy. Two groups of pondweed were submerged in water and placed darkness. one group had dissolved oxygen in the environment, and the other did not. For six days, the scientists measu percentage of carbon in the plant tissues that was used to make ethanol. The results of this study are given in Figure 2.

Figure 2. Percent of Carbon Over Time



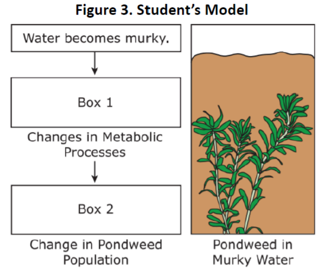
Source: T. Sato, et al., *Journal of Experimental Botany*, 2002

1. A student is working on a model to explain what processes are taking place in the pondweed when the phenol red turns from orange to yellow. The student decides which substance is the input, and what process is occurring. Write the correct answer in each box of the model.



2. Eutrophication most commonly occurs when nutrients from fertilizers enter the pond water by surface runoff. A student reads that under eutrophic conditions, water in a pond becomes murky and oxygen deprived. The student uses the experimental data to model the effects of these conditions on pondweed growing in a pond.

Figure 3. Student's Model



Part A: Write a description about what is happening to photosynthesis in Box 1.
Part B: Explain what is happening with the pondweed population in Box 2 and why.
Part C: Explain how the contents of Boxes 1 and 2 affect carbon cycling in the pond ecosystem.

"Unwrapped" Content (nouns) (students need to know)	"Unwrapped" Skills (VERBS) (students need to be able to do & DOK)	"Unwrapped" Understanding (students need to understand)
Explanations • Evidence • Processes • Photosynthesis • Chemosynthesis • Aerobic Respiration • Anaerobic Respiration • Matter • Energy • Ecosystems • Conditions • Reactions • Model • Photosynthesis • Cell Respiration • Decomposition • Combustion • Biosphere • Atmosphere • Geosphere	• Construct an explanation • Revise an explanation • Model the flow of energy in an ecosystem • Understand environmental conditions • Use a model • Illustrate the biochemical processes • Explain the cycling of carbon	• Students can use models to illustrate the biochemical process of photosynthesis and Cell Respiration and compare and contrast these two processes using these models. • Students can make predictions on the effects of environmental changes on photosynthesis and cell respiration • Students can construct an explanation on how and why environmental conditions affect the flow of energy and cycling of matter in

		ecosystems. (Limitation:using the processes of photosynthesis, chemosynthesis, aerobic and anaerobic respiration)

New Academic Vocabulary	Scaffolded (Review) Academic Vocabulary
ATP (adenosine triphosphate) ADP (adenosine diphosphate) anaerobic fermentation aerobic cristae Combustion carbon oxygen cycle Pigment chlorophyll thylakoid/grana stomata stroma transpiration	chemical bond reactant autotroph carbohydrate electrons product heterotroph chloroplast organelle chemical reaction photosynthesis mitochondria homeostasis chemical energy cellular respiration absorption positive feedback light energy glucose reflection negative feedback guard cells stomata

Assessment

Common Summative Assessment/Demonstration of Understanding

- **Common Unit Assessment to be completed in the 2024-2025 School Year.**

Links to student example of summative assessments/demonstration of understanding

Score 4	Score 3	Score 2	Score 1
Example	Example	Example	Example

Proficiency Scale

4	**Student has mastered understanding of the entire standard(s) and makes little to no errors when asked to demonstrate and apply their learning.** •
3	**Student consistently shows understanding for most components of the standard(s) with few errors when asked to demonstrate and apply their learning.**

	•
2	**Student can sometimes show understanding for some of the components of the standard(s), yet there are a few aspects that they are still learning and improving upon.**
	•
1	**Student rarely shows understanding for any component of the standard(s) and are still needing significant teaching to apply their learning.**
	•

Additional Information

Professional Resource Suggestions	Instructional Resources
• Gizmos Case studies 1.Photosynthesis 2. Respiration	Pogil Demo a Day
	Other Resources:

Curriculum Designer Notes:	Students coming from middle school have surface level knowledge of photosynthesis and respiration. They are aware of structures and chemical reactions. They have difficulty applying knowledge to experimental design and making predictions when factors change. The focus should be: 1. Photosynthesis -Models and application of factors that affect photosynthesis • Discussion should include leaf structure, specifically location and function of chloroplast and their function. A distinction should be made between chloroplast and chlorophyll. (students get them confused) • Include a review of light waves / reflection and absorption. photosynthesis reaction. This is important in applying factors that affect photosynthesis such as colors of light. • They should know the basic structure of a chloroplast and be able to model what goes in and what goes out. • A stomata lab would be good here if it has not been done during the cell unit. The stomata lab also reinforces homeostasis in plants. Which is good since we just finished homeostasis with an emphasis in human body systems. 2. Cellular Respiration - models and application of factors that affect cellular respiration • Discussion should include structure and function of a mitochondria. • Discuss the difference between aerobic and anaerobic respiration. A rootbeer lab (anaerobic respiration) could be done here. The factor we emphasize here is having oxygen or not , and the effects of ATP production. 3. Photosynthesis and Cellular Respiration Compare and Contrast • A model should be created to show the relationship between both processes. . • Pogil has a good activity that walks through both processes and compares and contrasts them both. • An Algal bead lab that studies both photosynthesis and cell respiration in response to different treatments such as light would work well here. You could use a bromothymol blue experiment too.

Note: We will discuss this further in Ecology. They will revisit this and apply it to the cycling of matter in the carbon oxygen cycle and apply effects of both processes in ecosystems

Possible Evidence they understand : 9-12.LS2.B1

- Students make a claim explaining the phenomena (cycling of matter and flow of energy through ecosystems).
  - o Students construct an explanation that includes the following:
    - ▪ Energy from photosynthesis and respiration drives the cycling of matter and flow of energy under aerobic or anaerobic conditions within an ecosystem.
    - ▪ Anaerobic respiration occurs primarily in conditions where oxygen is not available.
- Students identify and describe the evidence to construct the explanation, including the following:
  - o All organisms take in matter and rearrange the atoms in chemical reactions.
  - o Photosynthesis captures energy in sunlight to create chemical products that can be used as food in cellular respiration.
  - o Cellular respiration is the process by which the matter in food (sugars, fats) reacts chemically with other compounds, rearranging the matter to release energy that is used by the cell for essential life processes.
- Students use a variety of valid and reliable sources for the evidence, which may include theories, simulations, peer review, and students' own investigations.
- Students use reasoning to connect evidence, along with the assumption that theories and laws that describe the natural world operates today as they did in the past and will continue to do so in the future, to construct their explanation.
- Students describe the following chain of reasoning used to construct their explanation:
  - o Energy inputs to cells occur either by photosynthesis or by taking in food.
  - o Since all cells engage in cellular respiration, they must all produce products of respiration.
  - o The flow of matter into and out of cells must therefore be driven by the energy captured during photosynthesis or obtained by taking in food and released by respiration.
  - o The flow of matter and energy must occur whether respiration is aerobic or anaerobic.
- Given new data or information, students revise their explanation and justify the revision (e.g., recent discoveries of life surrounding deep sea ocean vents have shown that photosynthesis is not the only driver for cycling matter and energy in ecosystems).

Possible Evidence they understand : 9-12.LS2.B3

- Students use evidence from a given model in which they identify and describe the relevant components, including the following:
  - o The inputs and outputs of photosynthesis
  - o The inputs and outputs of cellular respiration

    - The biosphere, atmosphere, hydrosphere, and geosphere
- Students describe relationships between components of the given model, including the following:
    - The exchange of carbon (through carbon-containing compounds) between organisms and the environment
    - The role of storing carbon in organisms (in the form carbon-containing compounds) as part of the carbon cycle
- Students describe the contribution of photosynthesis and cellular respiration to the exchange of carbon within and among the biosphere, atmosphere, hydrosphere, and geosphere in the given model.
- Students make a distinction between the model's simulation and the actual cycling of carbon via photosynthesis and cellular respiration

Limits: 9-12.LS2.B1

●Tasks should be limited to conceptual understandings, not the specific mechanisms of rearranging atoms.

●Tasks should not include the specific chemical processes of photosynthesis (e.g., light dependent and independent reactions) or the chemosynthesis of either aerobic (e.g., Kreb's Cycle, glycolysis) or anaerobic respiration.

●Tasks should not include the nitrogen cycle, water cycle, or phosphorus cycle.

●Tasks should not require students to distinguish between credible and non-credible sources.

Limits: 9-12.LS2.B3

Tasks should avoid the specific chemical steps of photosynthesis, respiration, decomposition, and combustion.

Biology -Unit 5- Mitosis, Meiosis and DNA Replication

Overview

Quarter(s): 3

Pacing: 3 Weeks

Unit Power Standard(s) Code	Unit Power Standard(s) Description
9-12.LS1.B.1	DEVELOP and USE models to COMMUNICATE the role of mitosis, cellular division, and differentiation in PRODUCING and MAINTAINING complex organisms.
9-12.LS3.A.1	DEVELOP and USE models to CLARIFY relationships about how DNA in the form of chromosomes is PASSED from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.
9-12.LS3.B.3	MAKE and DEFEND a claim that inheritable genetic variations may RESULT from: (1) new genetic combinations through meiosis, (2) mutations OCCURRING during replication, and/or (3) mutations.
9-12.LS3.B.2	DEVELOP and USE models 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.

Below Grade/Course Connected Standard(s)	Above Grade/Course Connected Standard(s)
N/A	N/A

Unit Supporting Standards Code	Unit Supporting Standards Description
9-12.LS3.B.1	COMPARE and CONTRAST asexual and sexual reproduction with regard to genetic information and variation in offspring.

Unpacked Standard(s)

Power Standard(s) Code	Power Standard(s) Description	DOK(s)	DESE Expectation(s) Unwrapped
9-12.LS1.B.1	DEVELOP and USE models to COMMUNICATE the role of mitosis, cellular division, and differentiation in PRODUCING and MAINTAINING complex organisms.	3	SCIENCE AND ENGINEERING PRACTICES Developing and Using Models ● Use a model based on evidence to illustrate the relationships between systems or between components of a system. DISCIPLINARY CORE IDEAS Organization for Matter and Energy Flow in Organisms

			● As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. ● As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. ● Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. ● Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. CROSSCUTTING CONCEPTS Energy and Matter ● Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.
9-12.LS3.A.1	DEVELOP and USE models to CLARIFY relationships about how DNA in the form of chromosomes is PASSED from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.	3	SCIENCE AND ENGINEERING PRACTICES Developing and Using Models ● Develop a model based on evidence to illustrate the relationships between systems or components of a system. DISCIPLINARY CORE IDEAS Structure and Function ● All cells contain genetic

			information in the form of DNA molecules. ● Genes are regions in the DNA that contain the instructions that code for the formation of proteins. Inheritance of Traits ● Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. ● The instructions for forming species' characteristic s are carried in DNA. ● All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. ● Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. <u>CROSSCUTTING CONCEPTS</u> Cause and Effect ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
9-12.LS3.B.3	MAKE and DEFEND a <u>claim</u> that <u>inheritable genetic variations</u> may RESULT from: (1) <u>new genetic combinations</u> through <u>meiosis</u>, (2) <u>mutations</u>	3	<u>SCIENCE AND ENGINEERING PRACTICES</u> Engaging in Argument from Evidence ● Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and

	OCCURRING during replication, and/or (3) mutations.		student-generated evidence. DISCIPLINARY CORE IDEAS Variation of Traits ● In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. ● Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. ● Environmental factors can also cause mutations in genes, and viable mutations are inherited. ● Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. CROSSCUTTING CONCEPTS Cause and Effect ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
9-12.LS3.B.2	DEVELOP and USE models to DESCRIBE why structural changes to genes (mutations) located on chromosomes may AFFECT	3	SCIENCE AND ENGINEERING PRACTICES Developing and Using Models ● Use a model based on evidence to illustrate the

	proteins and may RESULT in harmful, beneficial, or neutral effects to the structure and function of the organism.		relationships between systems or between components of a system. DISCIPLINARY CORE IDEAS Variation of Traits ● In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. ● Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. ● Environmental factors can also cause mutations in genes, and viable mutations are inherited. ● Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. CROSSCUTTING CONCEPTS Cause and Effect ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Stability and Change ● Much of science deals with constructing explanations of how things change and how

			they remain stable. Systems and System Models ● Models (e.g., physical, mathematical, computer) can be used to simulate systems and interactions—including energy, matter and information flows—within and between systems at different scales.
DESE Questions Examples:			

"Unwrapped" Content (<u>nouns</u>) (students need to know)	**"Unwrapped" Skills (VERBS) (students need to be able to do & DOK)**	**"Unwrapped" Understanding (students need to understand)**
● Models ● Mitosis ● Cellular Divisions ● Differentiation ● Organisms ● Relationships ● DNA ● Form ● Chromosomes ● Parents ● Offspring ● Processes ● Meiosis ● Fertilization ● Claim ● Genetics ● Inheritable Genetic Variations ● New Genetic Combinations ● Mutations ● Genes ● Proteins ● Structure ● Function	● Develop models (3) ● Use models (3) ● Communicate roles (3) ● Clarify relationships (3) ● Make an argument (3) ● Defend an argument (2) ● Make a claim (1) ● Defend a claim (2) ● Describe phenomenon (2)	● Students can develop a model of mitosis, cellular division, and differentiation ● Students can use a model of mitosis, cellular divisions, and differentiation ● Students can communicate the roles of mitosis, cellular division, and differentiation ● Students can clarify the relationships between DNA and chromosomes work together to aid in the passing of genetic material to offspring ● Students can make/defend an argument that inheritable genetic variations result from multiple genetic factors ● Students can make/defend a claim that inheritable genetic variations

		results from multiple genetic factors • Students can describe the phenomena of protein structure affecting the traits of an organism.

New Academic Vocabulary	Scaffolded (Review) Academic Vocabulary
• Cloning • Cytokinesis • Haploid • Malignant • Tetrad • Gamete/sex cell • Cell cycle • Diploid • Tumor • XX/XY • Somatic/body cell • Centromere • Homologous Pair • Crossing over • Surface area to volume ratio • Zygote • G1 phase • Karyotype • Independent Assortment • Apoptosis • Binary fission • G2 phase • Cancer • Meiosis • Stem cell • Interphase • S phase • Benign • Mutation • nondisjunction • deletion • duplication • inversion • translocation • trisomy • monosomy • Down Syndrome • Polyploidy • DNA polymerase • helicase	• Asexual reproduction • Cell division • Egg • Chromosome • Differentiation • Sexual reproduction • Fertilization • Sperm • Mitosis • DNA

Assessment

Common Summative Assessment/Demonstration of Understanding

- **Common Unit Assessment to be completed in the 2024-2025 School Year.**

Links to student example of summative assessments/demonstration of understanding

Score 4	Score 3	Score 2	Score 1
Example	Example	Example	Example

Proficiency Scale

4	**Student has mastered understanding of the entire standard(s) and makes little to no errors when asked to demonstrate and apply their learning.**
	•
3	**Student consistently shows understanding for most components of the standard(s) with few errors when asked to demonstrate and apply their learning.**
	•
2	**Student can sometimes show understanding for some of the components of the standard(s), yet there are a few aspects that they are still learning and improving upon.**
	•
1	**Student rarely shows understanding for any component of the standard(s) and are still needing significant teaching to apply their learning.**
	•

Additional Information

Professional Resource Suggestions	Instructional Resources
• Gizmo Meiosis Case Study	Pogil Demo a Day
	Other Resources:

Curriculum Designer Notes:

Students come from middle school having learned about mitosis and meiosis. They will understand the basics but have forgotten quite a bit. Review will be necessary. Students will arrive knowing basic base pairing for DNA replication.

- We recommend teaching mitosis first with a discussion on eros in mitosis (cancer) here.
- Next teach meiosis and again discuss errors in meiosis - nondisjunction and human impact.
- Finally focus on comparing and contrasting mitosis and meiosis. Modeling works well to teach this. Do not focus on the details and steps of these processes. Instead focus on what the processes begin with, what they produce and the reason for each process .
- Focus on where variation comes from but do not have to go in depth with independent assortment and crossing over. Focus on the Law of Segregation . This will be used again when we teach punnett squares to show why we split the alleles.
- Some like to teach replication with Protein Synthesis because it is also part of Central Dogma. However, we find that students confuse the

process when taught all at once. We have found more success by dividing these up. Our rationale for teaching replication here is that it's required for mitosis and meiosis to occur. This gives context to why replication is needed and not just a process to memorize. This will also give you an opportunity to scroll back to macromolecules and reinforce the polymers and monomers required for DNA replication to occur.

- Modeling also works here. There is a nice activity in here that models replication but you end up with a chromosome ready for division
- Errors need to be emphasized here. This will be dealt with in greater depth in genetics with human genetics and evolution when we discuss variations in populations.
- A connection can be made when discussing errors to proteins folding incorrectly and becoming dysfunctional. A great way to scroll and apply content to something they have previously learned.

Labs that help reinforce these topics:
We are currently looking into this . right now modeling is best.

Possible Evidence they understand : 9-12.LS1.B.1

- From a student-generated or given model, students identify and describe the components of the model relevant for illustrating the roles of mitosis, cellular division, and differentiation in producing and maintaining complex organisms.
  - o Genetic material containing two variants of each chromosome pair, one from each parent
  - o Parent and daughter cells (i.e., inputs and outputs of mitosis)
  - o A multicellular organism as a collection of differentiated cells
- Students identify and describe the relationships between components of the given model.
  - o Daughter cells receive identical genetic information from a parent cell or a fertilized egg.
  - o Mitotic cell division produces two genetically identical daughter cells from one parent cell.
  - o Differences between different cell types within a multicellular organism are due to gene expression—not different genetic material within that organism.
- Students use the given model to illustrate that mitotic cell division results in more cells that
  - o allow growth of the organism,
  - o can then differentiate to create different cell types, and
  - o can replace dead cells to maintain a complex organism.
- Students make a distinction between the accuracy of the model and the actual process of cellular division.

Possible Evidence they understand : 9-12.LS3.A.1

- Students develop a model in which they identify and describe the relevant parts of the process (e.g, DNA in the form of chromosomes, gametes, fertilization).
- In the model, students describe the relationships between the components, including the following:
  - o The cause and effect relationship between DNA, the proteins it codes for, and the resulting traits observed in an organism

	o The process of meiosis o The process of fertilization through sexual reproduction ● Students use the model to illustrate the interaction between components of the model and the resulting traits being passed from generation to generation through sexual reproduction. A pedigree is an example of a model that students could use. ● Students make a distinction between the accuracy of the model and actual body processes. <u>Possible Evidence they understand : 9-12.LS3.B.3</u> ● Students make a claim that includes the idea that inheritable genetic variations may result from o new genetic combinations through meiosis, o viable errors occurring during replication, and o mutations caused by environmental factors. ● Students identify and describe evidence that supports the claim, including the following: o Variations in genetic material naturally result during meiosis when corresponding sections of chromosome pairs exchange places. o Genetic mutations can occur due to errors during replication and/or environmental factors. o Genetic material is inheritable. ● Students use scientific knowledge, literature, student-generated data (e.g., may include by not limited to, comparison of RNA strand to DNA, data collected through a technology-enhanced computer simulation), simulations, and/or other sources for evidence. ● Students identify the following strengths and weaknesses of the evidence used to support the claim: o Types and numbers of sources o Sufficiency to make and defend the claim and to distinguish between causal and correlational relationships o Validity and reliability of the evidence ● Students use reasoning to describe links between the evidence and claim, including the following: o Genetic mutations produce genetic variations between cells or organisms. o Genetic variations produced by mutation and meiosis can be inherited. ● Students use reasoning and valid evidence to describe how new combinations of DNA can arise from several sources, including meiosis, errors during replication, and mutations caused by environmental factors. ● Students defend a claim against counterclaims and critique by evaluating counterclaims by describing the connections between the relevant and appropriate evidence and the strongest claim. <u>Possible Evidence they understand : 9-12.LS3.B.2</u> ● Students develop a model in which they identify and describe the following: o Structural changes to DNA

	o The effects of the structural changes to DNA • In the model, students describe the relationships between components, including the relationship between genotype and phenotype. • Students use the model to illustrate the structure and function of the organism and the organism's overall fitness. • Students make a distinction between the accuracy of the model and actual body processes. <u>Limits: 9-12.LS1.B1</u> • Tasks should not include meiosis, specific gene control mechanisms, rote memorization of the steps of mitosis. • Tasks should focus on the nucleus, chromosomes, cell membrane, cell wall, nuclear membrane, and cytoplasm. All other cell parts (e.g. spindle fibers, mitochondria, centrioles) should not be used. <u>Limits: 9-12.LS3.A1</u> • Tasks should focus on the division of DNA to create haploid gametes, as well as the combination of gametes in the process of fertilization to create a diploid cell. • Tasks should avoid rote memorization of the phases of meiosis or the biochemical mechanisms of specific steps in the process. • Tasks should avoid the concepts of independent assortment and crossing over. <u>Limits: 9-12.LS3.B3</u> • Tasks should avoid the phases of meiosis or the biochemical mechanism (e.g., centrioles, spindle fibers) of specific steps in the process. <u>Limits: 9-12.LS3.B2</u> • Tasks should provide students with adequate background information for any given genetic disorder. • Tasks should avoid identifying specific types of mutations (e.g., frameshift, point), specific changes at the molecular level, and the mechanisms for protein synthesis.

Biology: Unit 6 - Protein Synthesis

Overview	
Quarter(s): 2	
Pacing: 2.5 Weeks	

Unit Power Standard(s) Code	Unit Power Standard(s) Description
9-12.LS1.A.1	CONSTRUCT a model of how the structure of DNA DETERMINES the structure of proteins which CARRY OUT the essential functions of life through systems of specialized cells.
9-12.LS3.B.2	DEVELOP and USE models 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.

Below Grade/Course Connected Standard(s)	Above Grade/Course Connected Standard(s)
N/A	*N/A*

Unit Supporting Standards Code	Unit Supporting Standards Description
N/A	N/A

Unpacked Stadard(s)

Power Standard(s) Code	Power Standard(s) Description	DOK(s)	DESE Expectation(s) Unwrapped
9-12.LS1.A.1	CONSTRUCT a model of how the structure of DNA DETERMINES the structure of proteins which carry out the essential functions of life through systems of specialized cells.	3	SCIENCE AND ENGINEERING PRACTICES Using Mathematics and Computational Thinking ●Use mathematical and/or computational representations of phenomena or design solutions to support explanations. DISCIPLINARY CORE IDEAS Interdependent Relationships in Ecosystems ●Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. ●These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. ●Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. ●This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

<table>
<tr><td></td><td></td><td></td><td>CROSSCUTTING CONCEPTS
Scale, Proportion, and Quantity
●The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.</td></tr>
<tr><td>9-12.LS3.B.2</td><td>DEVELOP and USE models 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.</td><td>3</td><td>SCIENCE AND ENGINEERING PRACTICES
Developing and Using Models
● Use a model based on evidence to illustrate the relationships between systems or between components of a system.

DISCIPLINARY CORE IDEAS
Variation of Traits
● In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. ● Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation.
● Environmental factors can also cause mutations in genes, and viable mutations are inherited.
● Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.

CROSSCUTTING CONCEPTS
Cause and Effect
● Empirical evidence is required to differentiate between cause and correlation and make claims</td></tr>
<tr><td>DESE Questions Examples:</td><td colspan="3"></td></tr>
</table>

“Unwrapped” Content (<u>nouns</u>) (students need to know)	“Unwrapped” Skills (VERBS) (students need to be able to do & DOK)	“Unwrapped” Understanding (students need to understand)
• Model • Structure • Functions • Life • Systems • Specialized Cells • Structural changes • Genes • Mutations • Chromosomes • Proteins • Harmful Effects • Beneficial Effects • Organisms	• Construct models (3) • Explain structures (3) • Develop models (3) • Use models (1) • Describe models (1)	• Students can construct models of how DNA structure determines the structure of proteins • Students can explain how the structure of DNA affects the structure of proteins • Students can develop model to describe why structural changes to genes affect proteins • Students can a model which shows how changes to DNA and chromosomes affect the structure of proteins • Students can describe models which influence the creation of harmful, beneficial, or neutral changes to genetic material • Students can explain how changes to the genetic material of organisms affect the structure and functions of an organism.

New Academic Vocabulary	Scaffolded (Review) Academic Vocabulary
• codon • insertion • mRNA • transcription • deletion • rRNA • translation • genetic engineering	• hydrogen bond • covalent bond • ribosome • Genetic code • Amino acid • nucleus • Endoplasmic Reticulum (ER) • mutation

• chromatin • tRNA • gene expression • RNA polymerase • point mutation/ substitution • Central Dogma • frameshift mutation	• polypeptide • chromosome • gene • DNA • RNA • Deoxyribose • ribose • Uracil • Thymine • Cytosine • Adenine • Guanine • Protein • replication

Assessment

Common Summative Assessment/Demonstration of Understanding

- Common Unit Assessment to be completed in the 2024-2025 School Year.

Links to student example of summative assessments/demonstration of understanding

Score 4	Score 3	Score 2	Score 1
Example	Example	Example	Example

Proficiency Scale

4	Student has mastered understanding of the entire standard(s) and makes little to no errors when asked to demonstrate and apply their learning. •
3	Student consistently shows understanding for most components of the standard(s) with few errors when asked to demonstrate and apply their learning. •
2	Student can sometimes show understanding for some of the components of the standard(s), yet there are a few aspects that they are still learning and improving upon. •
1	Student rarely shows understanding for any component of the standard(s) and are still needing significant teaching to apply their learning. •

Additional Information

Professional Resource Suggestions	Instructional Resources
• Gizmo Protein Synthesis Stem Case	Pogil Demo a Day
	Other Resources: •

Curriculum Designer Notes:	Students come from middle school without any understanding of this concept. The focus here should be: ● We think it's best to review chromosome structure here. Students find it hard to differentiate between chromosomes, DNA and genes. ● This will be a good time to reinforce cell parts needed for these processes to occur. ● Students should be able to demonstrate how to transcribe and translate 2 different sections of DNA, compare them, then determine whether or not protein's function has changed. They should be able to defend a claim using evidence from their translation. ● Students should be able to see the connection between changes in DNA leading to changes in proteins which leads to changes in function or a different trait. A great lead into our next unit Genetics. Labs and activities that help reinforce these topics: ● Any activity that has them transcribing, translating and comparing would be great here. Ideally it would be better if the translation led to traits rather than just ending at the translation piece. This helps students make the connection between DNA and the traits we see. ● For a hands on approach: use beads for amino acids and pipe cleaners to string them. Have students transcribe then translate into beads on a pipe cleaner. Students visually see the changes in the amino acid sequence. <u>Possible evidence they understand 9-12.LS1.A.1</u> ● Students construct an explanation that includes the idea that regions of DNA, called genes, determine the structure of proteins, which carry out the essential functions of life through systems of specialized cells. ● Students use a variety of valid and reliable sources for the evidence (e.g., theories, simulations, peer review, students' own investigations). ● Identify and describe the evidence to construct their explanation, including that: o All cells contain DNA o DNA contains regions that are called genes o The sequence of genes contains instructions that code for proteins o Groups of specialized cells (tissues) use proteins to carry out functions that are essential to the organism ● Students use reasoning to connect evidence, along with the assumption that theories and laws that describe the natural the world operates today as they did in the past and will continue to do so in the future, to construct the explanation. Students describe the following chain of reasoning in their explanation: o Because all cells contain DNA, all cells contain genes that can code for the formation of proteins. o Body tissues are systems of specialized cells with similar structures and functions, each of whose functions are mainly carried out by the proteins they produce. o Proper function of many proteins is necessary for the proper functioning of the cells.

	o Gene sequence affects protein function, which in turn affects the function of body tissues <u>Possible evidence they understand 9-12.LS3.B.2</u> ● Students develop a model in which they identify and describe the following: o Structural changes to DNA o The effects of the structural changes to DNA ● In the model, students describe the relationships between components, including the relationship between genotype and phenotype. ● Students use the model to illustrate the structure and function of the organism and the organism's overall fitness. ● Students make a distinction between the accuracy of the model and actual body processes. <u>Limits</u> 9-12.LS1.A.1 ● Tasks should not require students to distinguish between credible and non-credible sources. ● Tasks requiring students to transcribe or translate a DNA sequence must also include a codon chart/wheel. ● Tasks should not assess the functions of tRNA or rRNA. ● Tasks should not require students to identify cell or tissue types, whole body systems, specific protein structures (folding) and functions, or the biochemistry of protein synthesis (i.e., enzymes). <u>Limits</u> 9-12.LS3.B.2 ● Tasks should provide students with adequate background information for any given genetic disorder. ● Tasks should avoid identifying specific types of mutations (e.g., frameshift, point), specific changes at the molecular level, and the mechanisms for protein synthesis.

Biology: Unit 7 - Genetics

Overview

Quarter(s): 2

Pacing: 3 Weeks

Unit Power Standard(s) Code	Unit Power Standard(s) Description
9-12.LS3.B.4	APPLY concepts of statistics and probability to EXPLAIN the variation and distribution of expressed traits in a population.
9-12.LS3.A.1	DEVELOP and USE models to CLARIFY relationships about how DNA in the form of chromosomes is PASSED from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.
9-12.LS3.B.3	MAKE and DEFEND a claim that inheritable genetic variations may RESULT from: (1) new genetic combinations through meiosis, (2) mutations OCCURRING during replication, and/or (3) mutations.

Below Grade/Course Connected Standard(s)	Above Grade/Course Connected Standard(s)
N/A	N/A

Unit Supporting Standards Code	Unit Supporting Standards Description
N/A	N/A

Unpacked Standard(s)

Power Standard(s) Code	Power Standard(s) Description	DOK(s)	DESE Expectation(s) Unwrapped
9-12.LS3.B.4	APPLY concepts of statistics and probability to EXPLAIN the variation and distribution of expressed traits in a population.	3	**SCIENCE AND ENGINEERING PRACTICES** **Analyzing and Interpreting Data** ● Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. **DISCIPLINARY CORE IDEAS** **Variation of Traits** ● Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus, the variation and distribution of traits observed depends on both genetic and environmental factors.

			CROSSCUTTING CONCEPTS **Scale, Proportion, and Quantity** ● Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). Science Is a Human Endeavor ● Technological advances have influenced the progress of science, and science has influenced advances in technology. ● Science and engineering are influenced by society, and society is influenced by science and engineering.
9-12.LS3.A.1	DEVELOP and USE models to CLARIFY relationships about HOW DNA in the FORM of chromosomes is PASSED from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.	3	**SCIENCE AND ENGINEERING PRACTICE** **Developing and Using Models** ● Develop a model based on evidence to illustrate the relationships between systems or components of a system. **DISCIPLINARY CORE IDEAS** **Structure and Function** ● All cells contain genetic information in the form of DNA molecules. ● Genes are regions in the DNA that contain the instructions that code for the formation of proteins. Inheritance of Traits ● Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. ● The instructions for forming species' characteristics are carried in DNA. ● All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. ● Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. **CROSSCUTTING CONCEPTS** **Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

9-12.LS3.B.3	MAKE and DEFEND a claim that inheritable genetic variations may RESULT from: (1) new genetic combinations through meiosis, (2) mutations OCCURRING during replication, and/or (3) mutations.	3	**SCIENCE AND ENGINEERING PRACTICES** **Engaging in Argument from Evidence** ● Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and student-generated evidence. **DISCIPLINARY CORE IDEAS** **Variation of Traits** ● In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. ● Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. ● Environmental factors can also cause mutations in genes, and viable mutations are inherited. ● Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. **CROSSCUTTING CONCEPTS** **Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

DESE Questions Examples:

It has been observed that the heights of Wisconsin Fast Plants vary within a population. Fast Plants are a specially bred type of Brassica rapa plant which grow very quickly, reaching maturity in 5 weeks instead of 6 months. They reproduce sexually. A student orders Fast Plant seeds to perform a science investigation. The student grows 24 plants, and measures their heights 14 days after planting. The information is summarized in Table 1.

Table 1. Plant Heights After 14 Days (in centimeters)

14	13	31	6	5	15	15	12	16	14	15	15
13	15	12	28	16	30	15	15	14	17	14	15

Height in Fast Plants is determined by the genes EIN and ROS A mutation of one of these genes will produce a plant with an unusual height. Fast Plants expressing the recessive allele EIN grow taller than usual. Fast Plants expressing the recessive allele ROS
Grow shorter than usual.

1. The student crosses plant A, which has a height of 14 cm, with plant B, which has a height of 15 cm. Most of the offspring are normal height and the others are short. The student claims that crossing plant A and plant C, which has a height of 6 cm, can only produce offspring with normal or short phenotypes. Using R as dominant and r as recessive, complete the sentence below.

   Plant A must have the genotype (RR / Rr / rr) and plant C must have the genotype (RR / Rr / rr). During reproduction of
   Plant A and Plant C, the process of (natural selection / environmentally-induced mutation / genetic recombination) can result in offspring with normal or short phenotypes.
2. A group of Fast Plants with the same mix of height genes is grown on a plot of land with abundant soil nutrients, water, and light. The plot of land is exposed to a bird species that preys on tall plants. Explain how the incidence of the detrimental
   trait would change over time.

3. Examining which property of the data set allows identification of individuals who are homozygous for recessive height traits?
4. A student claims that meiosis can result in Fast Plants with the rare gene combination of two copies of the EIN gene. Identify the plant with which height in the table provides evidence supporting this claim.
5. Find the percent of plants in the student's experiment that are homozygous for EIN or ROS Round to the nearest percent.
6. The student crosses plant A, which has a height of 14 cm, with plant B, which has a height of 15 cm. Most of the offspring are normal height and the others are short. The student claims that crossing plant A and plant C, which has a height of 6 cm, can only produce offspring with normal or short phenotypes. Using R as dominant and r as recessive, complete the sentence Below. Plant A must have the genotype (RR / Rr / rr) and plant C must have the genotype (RR / Rr / rr). During reproduction of Plant A and Plant C, the process of (natural selection / environmentally-induced mutation / genetic recombination) can result in offspring with normal or short phenotypes.
7. The student's experiment was designed to isolate causes of plant height. In order to produce this outcome, the plants had t be (genetically identical / identical in phenotype / raised under identical conditions), so that the role of (genetics / mutations / the environment) in causing variations in plant growth would be minimized.
8. A group of Fast Plants with the same mix of height genes is grown on a plot of land with abundant soil nutrients, water, and light. The plot of land is exposed to a bird species that preys on tall plants.

- Part A: Based only on this description of the environment, describe what the survival rate of plants in the first generation would most likely be.

- Part B: Explain why plants with a trait that is detrimental in this environment would continue to appear in offspring of surviving plants.

- Part C: Explain how the incidence of the detrimental trait would change over time.

<table>
<tr><th>“Unwrapped” Content (<u>nouns</u>)
(students need to know)</th><th>“Unwrapped” Skills (VERBS)
(students need to be able to do
& DOK)</th><th>“Unwrapped” Understanding (students need to understand)</th></tr>
<tr><td>
• Statistics
• Probability
• Variation
• Distribution
• Traits
• Population
• Relationships
• DNA
• Chromosomes
• Parents
• Meiosis
• Fertilization
• Sexual Reproduction
• Claim
• Inheritable genetic variations
• New genetic combinations
• Mutations
• Replication
</td><td>
• Apply statistics (1)
• Explain variation of traits (3)
• Explain the distribution of traits (3)
• Develop models (3)
• Use models (3)
• Clarify relationships between DNA and chromosomes (2)
• Make a claim (1)
• Defend a claim (1)
</td><td>
• Students can use basic statistics (punnets) to understand the inheritance and probability of acquiring traits
• Students can explain the reason behind the wide variety of traits amongst organisms
• Students can explain the distribution of traits amongst different organisms
• Students can use models related to genetic probability
• Students can develop a model of how DNA and chromosomes are passed from parents to offspring
• Students can make claims that the diversity of traits/variation result from mechanisms such as meiosis, mutations, and errors during replication (chromosome mutations)
</td></tr>
</table>

New Academic Vocabulary	Scaffolded (Review) Academic Vocabulary
• Mendel • purebred • multiple allele • Incomplete dominance • probability • pedigree • codominance • Polygenic inheritance • monohybrid cross	• Genetics • Allele • Punnett Square • inversion • Homozygous • Dominant • genotype • translocation • Heterozygous

• hybrid • Sex linked gene • carrier	• Recessive • phenotype • trisomy • trait • haploid • diploid • duplication • gene • Homologous pair • autosome • monosomy • karyotype • Sex chromosome • sperm • down syndrome • fertilization • zygote • egg • polyploidy • nondisjunction • deletion

Assessment

Common Summative Assessment/Demonstration of Understanding

- **Common Unit Assessment to be completed in the 2024-2025 School Year.**

Links to student example of summative assessments/demonstration of understanding

Score 4	Score 3	Score 2	Score 1
Example	**Example**	**Example**	**Example**

Proficiency Scale

4	**Student has mastered understanding of the entire standard(s) and makes little to no errors when asked to demonstrate and apply their learning.** •
3	**Student consistently shows understanding for most components of the standard(s) with few errors when asked to demonstrate and apply their learning.** •
2	**Student can sometimes show understanding for some of the components of the standard(s), yet there are a few aspects that they are still learning and improving upon.** •
1	**Student rarely shows understanding for any component of the standard(s) and are still needing significant teaching to apply their learning.** •

Additional Information

Professional Resource Suggestions	Instructional Resources

<table>
<tr><td rowspan="2">• Gizmo Heredity and Traits</td><td>Pogil</td></tr>
<tr><td>Other Resources:</td></tr>
<tr><td>Curriculum Designer Notes:</td><td>Students come from middle school knowing:
• How to do punnett squares with little knowledge as to what it represents. They can do them but do not know what it represents. (Meiosis and fertilization)
The focus here should be:
• How to do basic punnetts. This should also emphasize vocabulary with practice. Emphasis should be placed on what the punnett represents: alleles separating during meiosis, fertilization and probable outcomes.
• A discussion should occur teaching other types of inheritance patterns such as incomplete, complete and sex linked traits.
• Dihybrids are beyond the scope of this course. Keep it to monohybrid crosses, keep them fairly simple with lots of practice.
• USe genetics and to make predictions of mode of inheritance using a pedigree.
Labs that help reinforce these topics:
• We do not have an actual lab for this unit. Mostly modeling genetic problems here and one pedigree assignment with problems to solve.
• An idea would be to run a gel electrophoresis lab, options for tracing genetics are open. Labs could look at PTC trait, sickle cell anemia, and Huntington's disease. We have not done this due to expense but would love to at some point. We have the machines to do this. (Cost consideration $74-$120 per section)
• Wisconsin fast plants would be an option here too.

Possible evidence they understand 9-12.LS3.B.4

• Students organize the given data by the frequency, distribution, and variation of expressed traits in the population. Students may use Punnett squares or pedigrees as models for this standard.
• Students perform and use appropriate statistical analyses of data, including probability measures, to determine the relationship between a trait's occurrence within a population and environmental factors.
• Students analyze and interpret data to explain the distribution of expressed traits, including the following:
o Recognition and use of patterns in the statistical analysis to predict changes in trait distribution within a population if environmental variables change
o Description of the expression of a chosen trait and its variations as causative or correlational to some environmental factor based on reliable evidence

Possible evidence they understand 9-12.LS3.A.1
• Students develop a model in which they identify and describe the relevant parts of the process (e.g, DNA in the form of chromosomes, gametes, fertilization).</td></tr>
</table>

- In the model, students describe the relationships between the components, including the following:
  - o The cause and effect relationship between DNA, the proteins it codes for, and the resulting traits observed in an organism
  - o The process of meiosis
  - o The process of fertilization through sexual reproduction
- Students use the model to illustrate the interaction between components of the model and the resulting traits being passed from generation to generation through sexual reproduction. A pedigree is an example of a model that students could use.
- Students make a distinction between the accuracy of the model and actual body processes.

<u>Possible evidence they understand </u>9-12.LS3.B.3

- Students make a claim that includes the idea that inheritable genetic variations may result from
  - o new genetic combinations through meiosis,
  - o viable errors occurring during replication, and
  - o mutations caused by environmental factors.
- Students identify and describe evidence that supports the claim, including the following:
  - o Variations in genetic material naturally result during meiosis when corresponding sections of chromosome pairs exchange places.
  - o Genetic mutations can occur due to errors during replication and/or environmental factors.
  - o Genetic material is inheritable.
- Students use scientific knowledge, literature, student-generated data (e.g., may include by not limited to, comparison of RNA strand to DNA, data collected through a technology-enhanced computer simulation), simulations, and/or other sources for evidence.
- Students identify the following strengths and weaknesses of the evidence used to support the claim:
  - o Types and numbers of sources
  - o Sufficiency to make and defend the claim and to distinguish between causal and correlational relationships
  - o Validity and reliability of the evidence
- Students use reasoning to describe links between the evidence and claim, including the following:
  - o Genetic mutations produce genetic variations between cells or organisms.
  - o Genetic variations produced by mutation and meiosis can be inherited.
- Students use reasoning and valid evidence to describe how new combinations of DNA can arise from several sources, including meiosis, errors during replication, and mutations caused by environmental factors.
- Students defend a claim against counterclaims and critique by

	evaluating counterclaims and by describing the connections between the relevant and appropriate evidence and the strongest claim. <u>Limits</u> 9-12.LS3.B.4 • Tasks should avoid Hardy-Weinberg calculations and dihybrid crosses. • Tasks should not require students to calculate the probability of polygenic traits. • Tasks should include support or context for any mode of inheritance beyond complete dominance. <u>Limits</u> 9-12.LS3.A.1 • Tasks should focus on the division of DNA to create haploid gametes, as well as the combination of gametes in the process of fertilization to create a diploid cell. • Tasks should avoid rote memorization of the phases of meiosis or the biochemical mechanisms of specific steps in the process. <u>Limits</u> 9-12.LS3.B.3 • Tasks should avoid the phases of meiosis or the biochemical mechanism (e.g., centrioles, spindle fibers) of specific steps in the process.

BIOLOGY: UNIT 8 - NATURAL SELECTION

Overview	
Quarter(s): 3	
Pacing: 4 weeks	
Unit Power Standard(s) Code	**Unit Power Standard(s) Description**
9-12.LS4.A.1	COMMUNICATE scientific information that common ancestry and biological evolution are SUPPORTED by multiple lines of empirical evidence.
9-12.LS4.B.1	CONSTRUCT an explanation based on evidence that the process of evolution primarily RESULTS from four factors: (1) the potential for a species to INCREASE in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to SURVIVE and REPRODUCE in the environment.
9-12.LS4.C.2	EVALUATE the evidence SUPPORTING claims that changes in environmental conditions may RESULT in: (1) INCREASES in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
9-12.LS4.C.3	CREATE or REVISE a model to TEST a solution to MITIGATE adverse impacts of human activity on biodiversity.

Below Grade/Course Connected Standard(s)	Above Grade/Course Connected Standard(s)
8th grade students were previously engaged with 6-8.LS1.C.3	N/A

Unit Supporting Standards Code	Unit Supporting Standards Description
N/A	N/A

Unpacked Standard(s)			
Power Standard(s) Code	**Power Standard(s) Description**	**DOK(s)**	**DESE Expectation(s) Unwrapped**
9-12.LS4.A.1	COMMUNICATE scientific information that common ancestry and biological evolution are SUPPORTED by multiple lines of empirical evidence.	3	SCIENCE AND ENGINEERING PRACTICES Obtaining, Evaluating, and Communicating Information ● Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

			Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena ● A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. ● If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. <u>DISCIPLINARY CORE IDEAS</u> Evidence of Common Ancestry and Diversity ● Genetic information, like the fossil record, provides evidence of evolution. ● DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. ● Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. <u>CROSSCUTTING CONCEPTS</u> Patterns ● Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
9-12.LS4.B.1	CONSTRUCT an <u>explanation</u> based on <u>evidence</u> that the <u>process</u> of <u>evolution</u> primarily RESULTS from four factors: (1) the potential for a <u>species</u> to INCREASE in <u>number</u>, (2) the <u>heritable genetic</u>	3	<u>SCIENCE AND ENGINEERING PRACTICES</u> Constructing Explanations and Designing Solutions ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and

	variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to SURVIVE and REPRODUCE in the environment.		the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. DISCIPLINARY CORE IDEAS Natural Selection • Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. Adaptation • Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. CROSSCUTTING CONCEPTS Cause and Effect • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects
9-12.LS4.C.2	EVALUATE the evidence SUPPORTING claims that changes in environmental conditions may RESULT in: (1) INCREASES in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.	3	SCIENCE AND ENGINEERING PRACTICES Engaging in Argument from Evidence • Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. DISCIPLINARY CORE IDEAS Adaptation • Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and

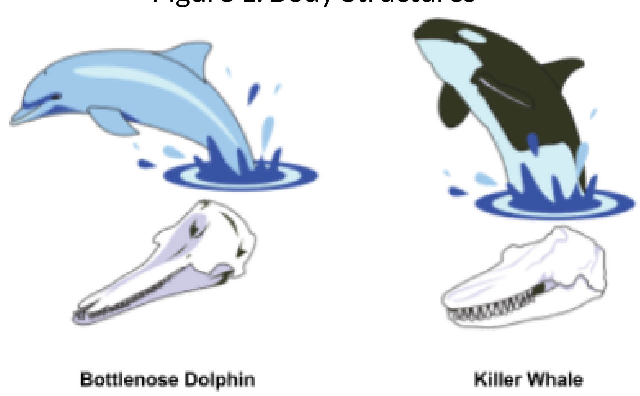
			sometimes the extinction—of some species. ● Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. <u>CROSSCUTTING CONCEPTS</u> Cause and Effect ● Empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects.
9-12.LS4.C.3	CREATE or REVISE a <u>model</u> to TEST a <u>solution</u> to MITIGATE adverse <u>impacts</u> of <u>human activity</u> on <u>biodiversity</u>.	3	<u>SCIENCE AND ENGINEERING PRACTICES</u> Mathematics and Computational Thinking ● Create or revise a simulation of a phenomenon, designed device, process, or system. <u>DISCIPLINARY CORE IDEAS</u> Adaptation ● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. Biodiversity and Humans ● Humans depend on the living world for the resources and other benefits provided by biodiversity. ● But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. ● Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

			Developing Possible Solutions • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. • Both physical models and computers can be used in various ways to aid in the engineering design process. • Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical and in making a persuasive presentation to a client about how a given design will meet his or her needs

DESE Questions Examples:

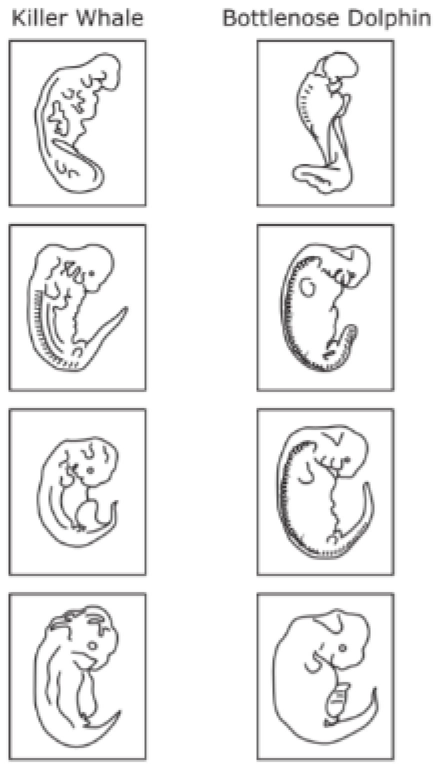
Whales are aquatic mammals. A student studies the odontocetes, a grouping of whales which includes the bottlenose dolphins and killer whales. Unlike other whales, odontocetes have hard teeth. The student compares the body structures of these two species:

Figure 1. Body Structures



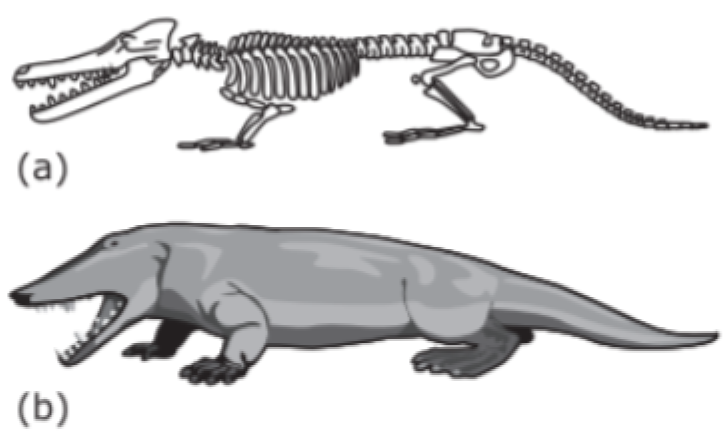
A comparison of embryonic development in the species shows that both start to develop hind legs early in development, but then lose these structures before birth:

Figure 2. Embryonic Development



The student reads about the history of whales. The literature suggests that whales descend from land mammals which adapted gradually to an aquatic environment. Fossils of one very early whale species, Ambulocetus natans, Show legs with hooves. The animal is thought to have spent much of its time swimming in water, while retaining its ability to walk on land.

Figure 3. Evolutionary Ancestor



Ambulocetus Natans

4.Skeletal reconstruction (Thewissen, 2002) and (b) Life restoration (Thewisssen and Williams, 2002)

Further evidence for this history of whales comes from genetic comparisons. Comparison of DNA between the hippopotamus and the humpback whale reveals, for example, the following homologous sequences: ATAGGGAATT (hippopotamus) and ATAGGGACTT (humpback whale).

1. Compare the skeletons shown in Figure 3 and Figure 1. The skeleton in Figure 3 is from a species that appeared earlier on the evolutionary time scale. Based on these Figures, what can be concluded about the teeth in these species?
2. In addition to anatomical evidence, studying patterns in DNA sequence provides what is considered good evidence for common ancestry among hippopotami and humpback whales. What is the percent similarity between the DNA sequence of these two species? Round your answer to the nearest percentage point.
3. A student is constructing an explanation of how the ancestry of the hippopotamus and the humpback whale evolved to become different species. Order the events below into an explanation.
   -New species begin to form
   -Distinct sets of heritable adaptations accumulate
   -Natural selection acts in different patterns on existing genetic material
   -Different resource and threat patterns in distinct environments act on sub-populations.
4. Explanation:Despite high genetic uniformity, genetic variation exists. [Continue with the statements above in the correct order.]

5. The student synthesizes information to make a presentation about the evolutionary history of the odontocetes. The student's presentation will include diagrams drawing links between different organisms. Describe the type of diagrams the student would Include.

6. A student is using the graphic and textual evidence presented to construct an explanation of how Ambulocetus natans evolved over time. The student explains that in the state shown in the diagram, the species was exposed to (one / one land-based and one water-based), set of selection pressures, with (the land environment / the aquatic environment / the amphibious life cycle) ultimately providing the greatest survival opportunities. In response, the species over time (became more adapted to aquatic living / increased in number on land and water / learned aquatic behaviors which became heritable).

"Unwrapped" Content (<u>nouns</u>) (students need to know)	"Unwrapped" Skills (VERBS) (students need to be able to do & DOK)	"Unwrapped" Understanding (students need to understand)
• Scientific Information • Common Ancestry • Evolution • Explanations • Evidence • Processes • Evolution • Species • Heritable Genetic Variation • Individuals	• Communicate scientific information • Support evidence through argument • Construct explanations based on evidence	• Students can communicate scientific information regarding the support for common ancestry • Students can support evidence regarding common ancestry through

• Mutations • Sexual Reproduction • Competition • Resources • Proliferation • Organisms • Environment • Changes • Conditions • Emergence • Extinction • Biodiversity	• Explain the results of multiple lines of evidence • Evaluate evidence supporting claims regarding natural selection • Create models • Revise models • Test solutions	multiple lines of empirical evidence • Students can construct explanations explaining how four major factors are evidence for evolution • Students can explain the multiple lines of evidence supporting claims that environmental conditions result in natural selection • Students can create models supporting the fact that human impact can affect the ecosystem and biodiversity • Students can revise supporting the fact that human impact can affect the ecosystem and biodiversity

New Academic Vocabulary	Scaffolded (Review) Academic Vocabulary
• Natural selection • Adaptation • evolution • Geographic isolation • Founder effect • phylogeny • Adaptive radiation • extinction • Genetic drift • Reproductive isolation • taxonomy • biogeography • fitness • Convergent evolution • Vestigial structure • Clade • Carrying capacity • Bottleneck effect • Survival of the fittest • Behavioral isolation	• Hypothesis • Domain • Class • Genus • Scientific theory • Kingdom • Order • Species • Fossils • Phylum • Family • birth • immigration • Biotic factor • population • death • emigration • Abiotic factor • extinction

• Temporal isolation • Archaea • coevolution • Punctuated equilibrium • Directional selection • Analogous structure • Eukarya • Genetic equilibrium • Disruptive selection • Binomial nomenclature • Bacteria • Divergent evolution • Homologous structures • speciation • cladogram • Speciation • Convergent evolution • Stabilizing selection • Fossil record • Derived characteristic	

Assessment

Common Summative Assessment/Demonstration of Understanding

- Common Unit Assessment to be completed in the 2024-2025 School Year.

Links to student example of summative assessments/demonstration of understanding

Score 4	Score 3	Score 2	Score 1
Example	Example	Example	Example

Proficiency Scale

4	Student has mastered understanding of the entire standard(s) and makes little to no errors when asked to demonstrate and apply their learning. •
3	Student consistently shows understanding for most components of the standard(s) with few errors when asked to demonstrate and apply their learning. •
2	Student can sometimes show understanding for some of the components of the standard(s), yet there are a few aspects that they are still learning and improving upon. •

<table>
<tr><td rowspan="2">1</td><td colspan="2">Student rarely shows understanding for any component of the standard(s) and are still needing significant teaching to apply their learning.</td></tr>
<tr><td colspan="2">•</td></tr>
<tr><td colspan="3">Additional Information</td></tr>
<tr><td colspan="2">Professional Resource Suggestions</td><td>Instructional Resources</td></tr>
<tr><td colspan="2" rowspan="2">• HHMI Elephant Tusklessness
• HHMI has many different natural selection activities to choose from that can demonstrate how this happens.
• Natural Selection Lab</td><td>Pogil</td></tr>
<tr><td>Other Resources:</td></tr>
<tr><td>Curriculum Designer Notes:</td><td colspan="2">Students come from middle school with very little knowledge of this material. The focus here should be:
• How Natural Selection occurs. Discussion should include the major factors that must happen for Natural Selection to occur.
We find that students struggle with differentiating between fitness and adaptation so attention should be paid to this.

• What Evidence do we use to support the idea that species and populations have changed over time.

Labs that help reinforce these topics:
1. For Natural Selection we recommend HMMI Tuskless elephants. This online lab ties gel electrophoresis with Natural selection of Elephants. It also leads to a discussion of Human impact which is important in our Ecology Unit. We will be able to build on this in the next Unit.
• HMMI is a great resource for this unit with many activities to choose from.
2. For Evidence we suggest an activity that breaks down each piece of evidence and has students analyze the evidence for themselves. They should be able to support an argument using the evidence they have discovered. Have students look at Homologous structures, vestigial structures, embryology and DNA.
• When they study the DNA evidence this will lead to building a phylogenetic tree which should reinforce common ancestry.
• HMMI is a great resource for this unit with many activities to choose from.
3. For the evolution of populations and speciation piece focus should be two fold
• For evolution of populations focus on the different types of Natural Selection (directional, stabilizing, disruptive.) Students should be able to identify each graph and explain how it occurs as well as what effect it would have on a population using an example.
• For speciation focus on reproductive isolation and how this results in new species. HMMI has a great interactive online lab using Caribbean anoles from an ongoing research study.

<u>Possible evidence they understand 9-12.LS4.A.1</u>

• Students use at least one format (e.g., oral, graphical, textual, mathematical), to communicate scientific information including that</td></tr>
</table>

	common ancestry and biological evolution are supported by multiple lines of empirical evidence. Students cite the origin of the information as appropriate. ● Students identify and communicate evidence for common ancestry and biological evolution, including the following: o Information derived from DNA sequences, which vary among species but have many similarities between species o Similarities of the patterns of amino acid sequences, even when DNA sequences are slightly different, including the fact that multiple patterns of DNA sequences can code for the same amino acid o Patterns in the fossil record (e.g., presence, location, and inferences possible in lines of evolutionary descent for multiple specimens) o The pattern of anatomical and embryological similarities ● Students identify and communicate connections between each line of evidence and the claim of common ancestry and biological evolution. ● Students communicate that together, the patterns observed at multiple spatial and temporal scales (e.g., DNA sequences,embryological development, fossil records) provide evidence for causal relationships relating to biological evolution and common ancestry. <u>Possible evidence they understand 9-12.LS4.B.1</u> ● Students construct an explanation that includes a description that evolution is caused primarily by one or more of the four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. ● Students identify and describe evidence to construct their explanation, including that o as a species grows in number, competition for limited resources can arise. o individuals in a species have genetic variation (through mutations and sexual reproduction) that is passed on to their offspring. o individuals can have specific traits that give them a competitive advantage relative to other individuals in the species. ● Students use a variety of valid and reliable sources for evidence (e.g., data from investigations, theories, simulations, peer review). ● Students use reasoning to connect the evidence, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to construct the explanation. Students describe the following chain of reasoning for their explanation: o Genetic variation can lead to variation of expressed traits in individuals in a population.

	o Individuals with traits that give competitive advantages can survive and reproduce at higher rates than individuals without the traits because of the competition for limited resources. o Individuals that survive and reproduce at a higher rate will provide their specific genetic variations to a greater proportion of individuals in the next generation. o Over many generations, groups of individuals with particular traits that enable them to survive and reproduce in distinct environments using distinct resources can evolve into a different species. ● Students use the evidence to describe the following in their explanation: o The difference between natural selection and biological evolution (i.e., natural selection is a process, and biological evolution can result from that process) o The cause and effect relationship between genetic variation, the selection of traits that provide comparative advantages, and the evolution of populations that all express the trait <u>Possible evidence they understand 9-12.LS4.C.2</u> ● Students identify the given claims, which include the idea that changes in environmental conditions may result in o increases in the number of individual organisms of some species; o the emergence of new species over time, and o the extinction of other species. ● Students identify and describe additional evidence (in the form of data, information, models, or other appropriate forms) that was not provided but is relevant to the claims and to evaluating the given evidence, including the following: o Data indicating the change over time in ▪ the number of individual organisms in each species, ▪ the number of species in an environment, and ▪ the environmental conditions. o Environmental factors that can determine the ability of individual organisms in a species to survive and reproduce ● Students use their additional evidence to assess the validity, reliability, strengths, and weaknesses of the given evidence, along with its ability to support logical and reasonable arguments about the outcomes of group behavior. ● Students assess the ability of the given evidence to be used to determine causal or correlational effects between environmental changes, the changes in the number of individuals in each species, the number of species in an environment, and/or the emergence or extinction of species ● Students evaluate the degree to which the given empirical evidence can be used to construct logical arguments that identify causal links between environmental changes and changes in the number of

	individual organisms or species based on environmental factors that can determine the ability of individual organisms in a species to survive and reproduce. <u>Possible evidence they understand 9-12.LS4.C.3</u> ● Students create or revise a model that o explains effects of human activity (e.g., overpopulation, overexploitation, adverse habitat alterations, pollution, invasive species, changes in climate) on a threatened or endangered species or to the genetic variation within a species and o provides quantitative information about the effect of the solutions on threatened or endangered species. ● Students describe or identify the components of the model including human activity (e.g., overpopulation, overexploitation, adverse habitat alterations, pollution, invasive species, changes in climate) and the factors that affect biodiversity. ● Students describe the variables that can be changed within the model to evaluate the proposed solutions, trade-offs, or other decisions. ● Students show an understanding of the reliance of ecosystem function and productivity on biodiversity, and that take into account the limitations (constraints) of cost, safety, and reliability as well as cultural, and environmental impacts. ● Students use or identify possible negative consequences of solutions that would outweigh their benefits. ● Students analyze the modeled results to determine whether the model provides sufficient information to evaluate the solution. ● Students identify the model's limitations. ● Students interpret the modeled results, and predict the effects of the specific design solutions on biodiversity based on the interpretation. ● Students revise the model as needed to provide sufficient information to evaluate the solution. <u>Limits 9-12.LS4.A.1</u> ● Tasks should avoid an analysis of phylogenetic trees as a form of empirical evidence. ● Tasks should not require correct citation of information. <u>Limits 9-12.LS4.B.1</u> ● Tasks should avoid other mechanisms of evolution (e.g., genetic drive, gene flow through migration, co-evolution). ● Tasks should not require students to differentiate between credible and non-credible sources. <u>Limits 9-12.LS4.C.2</u> ● Tasks should provide students with a claim and initial evidence for evaluation. ● Tasks should not require students to use group behavior as a source of support.

	• <u>Limits 9-12.LS4.C.3</u> • Tasks should provide students with all necessary background information for a given scenario. Students should not require students to develop their own scenarios. • Tasks do not have to address both the creation and revision of the given model.

Biology Unit 9 Ecology

Overview			
Quarter(s): 3 and 4			
Pacing: 7 Weeks			
Unit Power Standard(s) Code	Unit Power Standard(s) Description		
9-12.LS2.C.1	EVALUATE the claims, evidence, and reasoning that the interactions in ecosystems MAINTAIN relatively consistent populations of species while conditions remain stable, but CHANGING conditions may RESULT in new ecosystem dynamics.		
9-12.LS2.B.2	COMMUNICATE the pattern of the CYCLING of matter and the FLOW of energy among trophic levels in an ecosystem.		
9-12.LS2.B.3	USE a model that ILLUSTRATES the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the CYCLING of carbon in its various forms among the biosphere, atmosphere, and geosphere.		
9-12.LS4.C.3	CREATE or REVISE a model to TEST a solution to MITIGATE adverse impacts of human activity on biodiversity.		
Below Grade/Course Connected Standard(s)		Above Grade/Course Connected Standard(s)	
Students that took 8th grade science were previously engaged with 6-8.LS2.C.1		N/A	
Unit Supporting Standards Code	Unit Supporting Standards Description		
9-12.LS2.A.1	EXPLAIN how various biotic and abiotic factors affect the carrying capacity and biodiversity of an ecosystem using mathematical and/or computational representations.		
9-12.LS2.C.2	DESIGN, EVALUATE, and/or REFINE solutions that positively IMPACT the environment and biodiversity.		
9-12.LS2.B.2	COMMUNICATE the pattern of the CYCLING of matter and the FLOW of ENERGY among trophic levels in an ecosystem.		
9-12.ESS2.A.4	USE a model to DESCRIBE how variations in the FLOW of energy INTO and OUT of Earth's systems result in CHANGES in CLIMATE.		
9-12.LS1.B.1	ANALYZE a major global change to SPECIFY qualitative or quantitative criteria and constraints for solutions that account for societal needs and wants.		
Unpacked Standard(s)			
Power Standard(s) Code	Power Standard(s) Description	DOK(s)	DESE Expectation(s) Unwrapped
9-12.LS2.C.1	EVALUATE the claims, evidence, and reasoning that the interactions in ecosystems MAINTAIN	3	SCIENCE AND ENGINEERING PRACTICES Engaging in Argument from Evidence ● Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

	relatively consistent <u>populations</u> of <u>species</u> while <u>conditions</u> remain stable, but CHANGING <u>conditions</u> may RESULT in new <u>ecosystem dynamics</u>.		Connections to Nature of Science: Scientific Knowledge Is Open to Revision in Light of New Evidence ● Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. <u>DISCIPLINARY CORE IDEAS</u> Ecosystems Dynamics, Functioning, and Resilience ● A complex set of interactions within an ecosystem can keep the ecosystem's numbers and types of organisms relatively constant over long periods of time under stable conditions. ● If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient) as opposed to becoming a very different ecosystem. ● Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. <u>CROSSCUTTING CONCEPTS</u> Stability and Change ● Much of science deals with constructing explanations of how things change and how they remain stable. Refer to Engineering, Technology, and Application of Science 9-12.ETS1.B.1.
9-12.LS2.B.2	COMMUNICATE the <u>pattern</u> of the CYCLING of <u>matter</u> and the FLOW of <u>energy</u> among <u>trophic levels</u> in an <u>ecosystem</u>.	3	<u>SCIENCE AND ENGINEERING PRACTICES</u> Using Mathematical and Computational Thinking ● Use mathematical representations of phenomena or design solutions to support claims. <u>DISCIPLINARY CORE IDEAS</u> Cycles of Matter and Energy Transfer in Ecosystems ● Plants or algae form the lowest level of the food web. ● At each link upward in a food web, only a small fraction of the matter consumed at the

			lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. ● Given this inefficiency, there are generally fewer organisms at higher levels of a food web. ● Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. ● The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. ● At each link in an ecosystem, matter and energy are conserved. CROSSCUTTING CONCEPTS Energy and Matter ● Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.
9-12.LS2.B.3	USE a model that ILLUSTRATES the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the CYCLING of carbon in its various forms among the biosphere, atmosphere, and geosphere.	3	SCIENCE AND ENGINEERING PRACTICES Developing and Using Models ● Develop a model based on evidence to illustrate the relationships between systems or components of a system. DISCIPLINARY CORE IDEAS Cycles of Matter and Energy Transfer in Ecosystems ● Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. Energy in Chemical Processes ● The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. CROSSCUTTING CONCEPTS Systems and System Models ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy,

			matter, and information flows—within and between systems at different scales.
9-12.LS4.C.3	CREATE or REVISE a model to TEST a solution to MITIGATE adverse impacts of human activity on biodiversity.	3	SCIENCE AND ENGINEERING PRACTICES Mathematics and Computational Thinking ● Create or revise a simulation of a phenomenon, designed device, process, or system. DISCIPLINARY CORE IDEAS Adaptation ● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. Biodiversity and Humans ● Humans depend on the living world for the resources and other benefits provided by biodiversity. ● But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. ● Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. Developing Possible Solutions ● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. ● Both physical models and computers can be used in various ways to aid in the engineering design process. ● Computers are useful for a variety of

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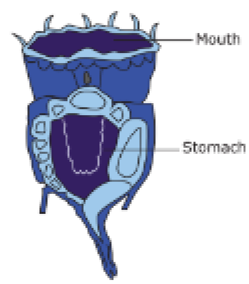
<tr><td>DESE Questions Examples:</td><td colspan="3">

Sample Stem #1

On a field trip, a student collects a sample of lake water and examines it under a microscope. The student sees a microscopic animal with a clearly visible mouth and stomach. Her teacher identifies the organism as a type of zooplankton.

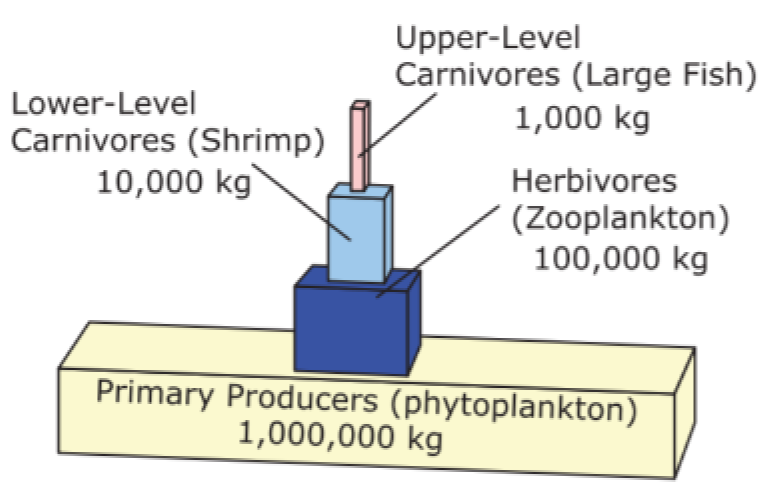
Figure 1. Zooplankton



The zooplankton takes water into its mouth, which it then filters, sending tiny particles of photosynthetic algae (phytoplankton) to its stomach for digestion. The student observes the feeding activity of the zooplankton, although the particles they are consuming are so small they remain invisible under the student's microscope.

The student also observes zooplankton of varying sizes. The student cannot measure absolute size, but observes individuals within a single species ranging from a smallest observed size to three times that size. Her teacher explains that in addition to natural size variation, zooplankton get larger as they mature. The student researches the ecological role of zooplankton and finds a simplified model of biomass at different trophic levels in ecosystems which includes zooplankton:

Figure 2. Aquatic Biomass Pyramid



1. Over a 24-hour time period, the student periodically observes the zooplankton consuming phytoplankton. The student wants to use this

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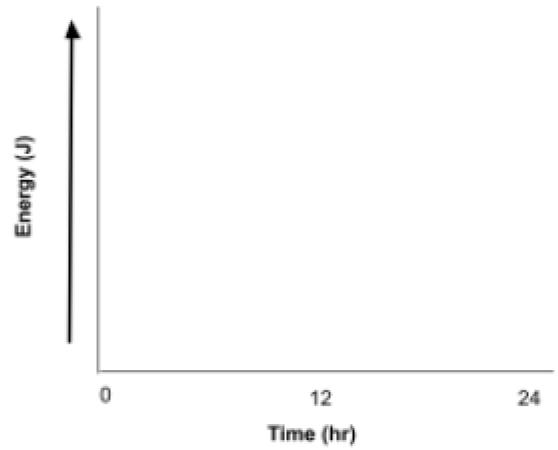
observation to graph the amount of energy taken in by the zooplankton over the time period. Draw the line on the graph below.



2. The student uses the information in Figure 2 to generate an equation representing the mass of living material a trophic level can support in the trophic level above it.

- The term (t) represents the mass of living material in a trophic level.
- The term (t+1) represents the mass of living material in the trophic level above.

Complete the student's equation below. Write the correct answer in the box.3.

$$(t + 1) = \square\,(t)$$

3. The student compares photographs of zooplankton at different stages of maturation, observing that body size increases between the earliest and latest stages. Circle the correct answer from each list to complete the sentences.

The change in body mass through growth largely comes from molecules synthesized by (zooplankton during cell division/phytoplankton during photosynthesis/phytoplankton during ATP production). The synthesized molecules must include additional matter from a variety of sources because this process does not produce (heat energy/carbon dioxide during respiration/all substances needed for growth).

The student takes part in another study of the lake ecosystem. As part of this study, 250 grams of zooplankton are collected from lake water.
Part A: Identify the approximate number of grams of phytoplankton the ecosystem must include in order to support the zooplankton sample.
Part B: Explain your answer to Part A.
Part C: Identify the approximate number of grams of lower-level carnivores the sample can support.

Part D: Explain your answer to Part C.
Part E: Explain the relationships between the masses found in Part A and Part C in terms of the cycling of energy in the ecosystem.

Sample Stem #2

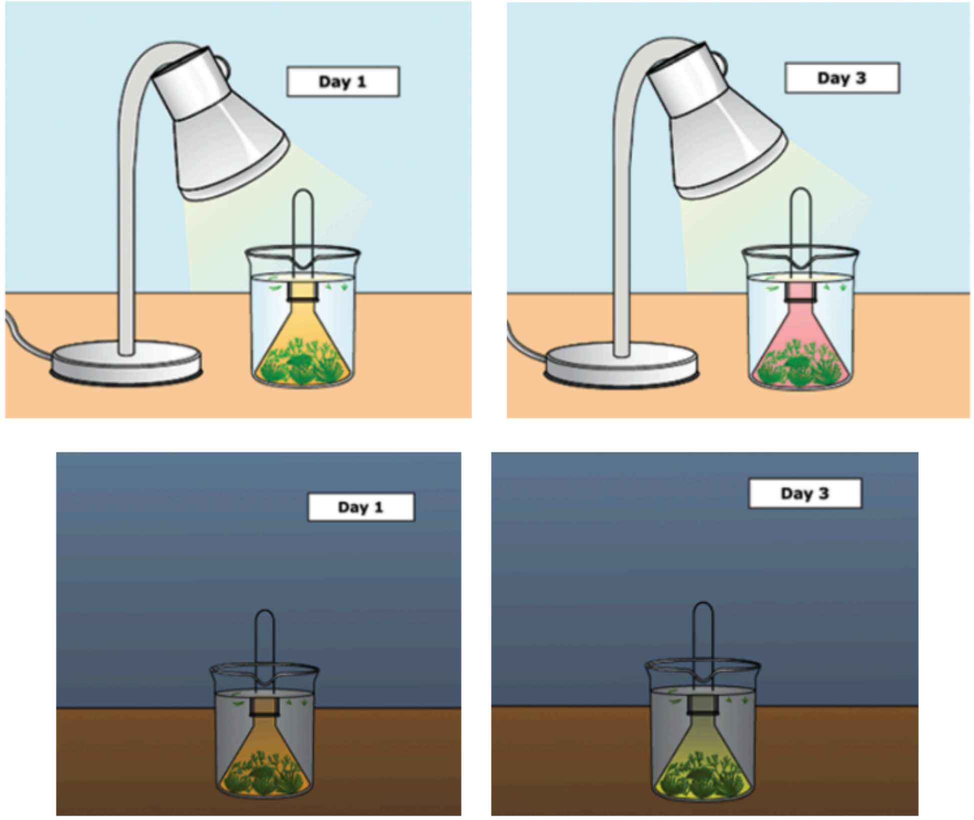
Scientists have observed a decrease in dissolved oxygen levels and a decrease in the level of light in the water in a pound. This seems to be happening because the water is cloudy. They conducted two experiments to test the responses of a local species of pondweed (an aquatic plant) to these changing conditions.

Experiment 1: The first part of the experiment measured the effects of light intensity on carbon dioxide absorption and release in pondweed. Two groups of pondweed were submerged in water. One group was put in light, and the other was kept in
darkness. The presence of carbon dioxide in water can be detected with a pH indicator called phenol red.
Table 1 shows how the color of phenol red changes due to pH

Table 1. Color of Phenol Red with pH Changes

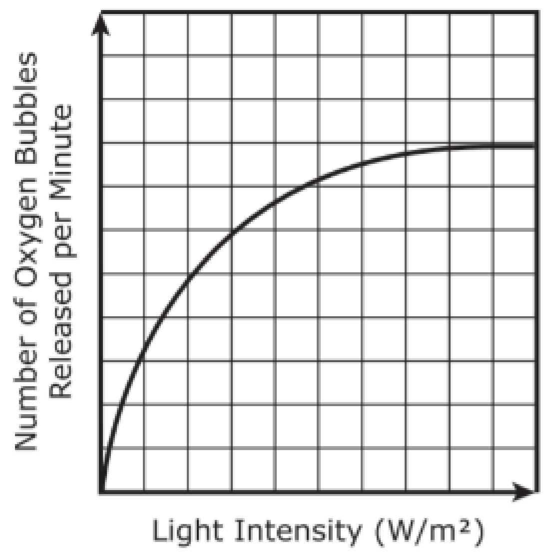
pH	Color of Phenol Red
less than 6.8	yellow
6.8-8.2	organe
greater than 8.2	pink

At the start of the experiment, the water with the phenol red was orange for both groups. After several days, the water of the group in light turned pink and the water of the group in the dark turned yellow.



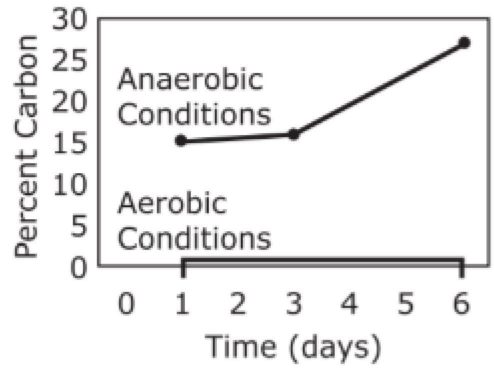
The second part of the experiment tested the effects of light intensity on oxygen released in pondweed. Oxygen release was measured by the formation of bubbles on the surface of the leaves. The results are shown in Figure 1.

Figure 1. Effects of Light Intensity on Oxygen Release

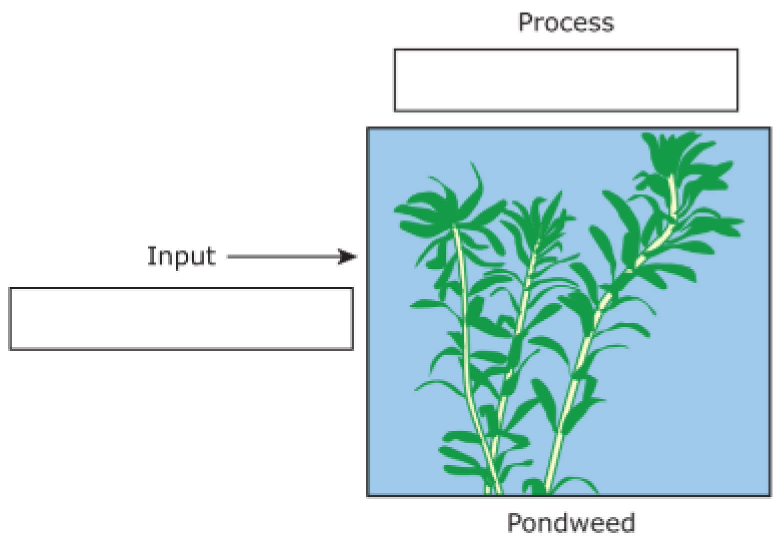


Experiment 2: The scientists had observed that under certain conditions, this species of pondweed can break down stored starch in their stems into ethanol, lactate, and energy. Two groups of pondweed were submerged in water and placed in darkness. one group had dissolved oxygen in the environment, and the other did not. For six days, the scientists measured the percentage of carbon in the plant tissues that was used to make ethanol. The results of this study are given in
Figure 2.

Figure 2. Percent of Carbon Over Time

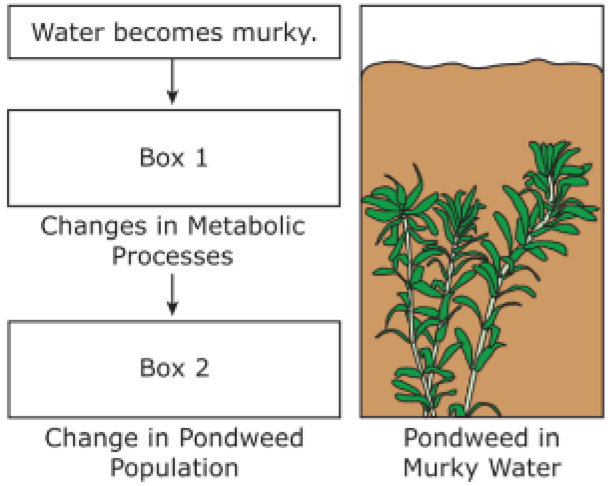


Source: T. Sato, et al., *Journal of Experimental Botany*, 2002



1. A student is working on a model to explain what processes are taking place in the pondweed when the phenol red turns from orange to yellow. The student decides which substance is the input, and what process is occurring. Write the correct answer in each box of the model.
2. Eutrophication most commonly occurs when nutrients from fertilizers enter the pond water by surface runoff. A student reads that under eutrophic conditions, water in a pond becomes murky and oxygen deprived. The student uses the experimental data to model the effects of these conditions on pondweed growing in a pond.

Figure 3. Student's Model



Part A: Write a description about what is happening to photosynthesis in Box 1.
Part B: Explain what is happening with the pondweed population in Box 2 and why.
Part C: Explain how the contents of Boxes 1 and 2 affect carbon cycling in the pond ecosystem.

"Unwrapped" Content (nouns) (students need to know)	"Unwrapped" Skills (VERBS) (students need to be able to do & DOK)	"Unwrapped" Understanding (students need to understand)
• Claims • Evidence • Reasoning • Interactions • Ecosystems • Populations • Species • Conditions • Ecosystems • Dynamics • Pattern • Matter • Energy • Trophic Levels • Photosynthesis • Cellular Respiration • Decomposition • Copmbustion • Carbon • Forms • Biosphere • Atmosphere • Geosphere • Solutions • Impacts	• Evaluate Changes • Evaluate Results • Communicate patterns • Use a model • Illustrate roles • Create a model • Revise a model • Test a solution	• Students will evaluate claims regarding interactions in ecosystems. • Students will evaluate the results of changes in ecosystem dynamics by examining changes in ecosystem conditions. • Students will communicate the patterns related to the cycling of matter throughout the ecosystem. • Students will use ecosystem models to illustrate the roles of biogeochemical processes.

• Human Activity • Biodiversity		• Students will create models of humanities impact on the ecosystem. • Students will revise models of humanities impact on the ecosystem. • Students will test solutions to mitigate human impact on the environment and biodiversity.

New Academic Vocabulary	Scaffolded (Review) Academic Vocabulary
• Ecology • detritivores • Biogeochemical cycle • keystone species • Biotic factor • Trophic level • climate • symbiosis • Abiotic factor • Ecological pyramid • Greenhouse effect • mutualism • Primary producer • biomass • Competitive exclusion principle • parasitism • climate change • global warming • niche • commensalism • decomposers • 10% rule • biological magnification • habitat fragmentation • Density-independent factor • Limiting factor • Invasive species • Density-dependent factor • Exponential growth • Logistic growth • range of tolerance • acid rain • ozone layer • invasive species • sustainable development • desertification • dead zones • endangered	• Positive feedback • community • chemosynthesis • omnivores • resource • Negative feedback • ecosystem • heterotroph • Food chain • carbon-oxygen cycle • biosphere • autotroph • consumer • Food web • species • producer • carnivores • weather • population • photosynthesis • herbivores • habitat • erosion • renewable resources • non-renewable resources • predator-prey relationship • biological magnification

• ocean acidification	

Assessment

Common Summative Assessment/Demonstration of Understanding

- Common Unit Assessment to be completed in the 2024-2025 School Year.

Links to student example of summative assessments/demonstration of understanding

Score 4	Score 3	Score 2	Score 1
Example	Example	Example	Example

Proficiency Scale

4	Student has mastered understanding of the entire standard(s) and makes little to no errors when asked to demonstrate and apply their learning. •
3	Student consistently shows understanding for most components of the standard(s) with few errors when asked to demonstrate and apply their learning. •
2	Student can sometimes show understanding for some of the components of the standard(s), yet there are a few aspects that they are still learning and improving upon. •
1	Student rarely shows understanding for any component of the standard(s) and are still needing significant teaching to apply their learning. •

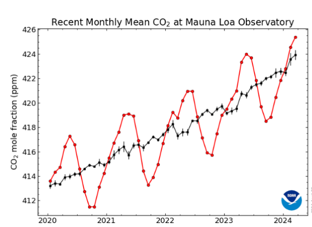
Additional Information

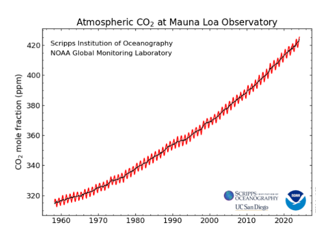
Professional Resource Suggestions	Instructional Resources
• Graph analysis of CO2 changes • Invasive species research project • Sheet Ice analysis • Modeling Food webs and trophic cascades : Wolves of Yellowstone, Sea Otters and Urchins….	Pogil Other Resources:

Curriculum Designer Notes:	Students come from middle school knowing food webs and basic vocabulary such as producers, herbivores, and carnivores. This being said we still found we need to review this vocabulary for the success of the students. The focus here should be: • Just a note: we feel we need to spend more time on this unit than the others. This ties together most of the other units. So they will learn new things but also use the old information and apply it to problem solving in the context of ecological issues. • The theme for the first two sections is nutrients cycle and energy flows. The third section focuses on how populations affect one another. The fourth focuses on human impact. 1. Nutrient Cycles : Discussion of Water cycle, Nitrogen cycle, Carbon oxygen cycle are the focus.

- Review the water cycle , focus is on why water is important for living things. You could reiterate the importance for photosynthesis, digestion of food , and solvent for living things . Also human impact on water quality such as water pollution.
- Review the nitrogen cycle, focus is why we need Nitrogen and how we get it. So tying this into protein and DNA building is important. You could also begin to discuss symbiosis with legumes and bacteria. We will come back to this in #3 below.
- Carbon Oxygen Cycle is the most important - focus should be tying photosynthesis and cellular respiration to this cycle. Following the Carbon between these processes and tying it to macromolecules is important. Factors that impact these two processes and the impact it may have on the environment should be discussed and evaluated.

2. Energy Flows : Food webs and Energy pyramids models should be created and evaluated. Removing an organism from their web is a great idea. Have students evaluate what problems would be created if any and present their claim and evidence to the class.
    - Keystone species should be discussed : examples include Wolves of Yellowstone, Elephants of Africa, Piaster starfish and the otters in the Kelp forest would be good to investigate the impact of keystone species.
3. Relationships in Populations
    - Symbiosis, Competitive Exclusion Principles are the highlights of this section.
      * Coral bleaching and invasive species would be ideal to investigate to support these topics.
    - Primary and secondary succession would be good to discuss - I would hold off for right now until we get more clarification. We are waiting for better sample stems to determine if we should teach this or not.
4. Human Impact : Focus should be discussion and analysis of the impact humans have on our environment. Reading and analyzing graphs is a solid skill needed here.
    - Invasive species research would be good here as well if not used in the section prior.
    - Investigating rise of CO2, impact on ocean (acidification) Gizmos, Phet and other online labs are available. I would look for graphs from Mauna Loa Research station. Using these graphs students should see that photosynthesis and cell respiration that changes yearly if regular but the Co2 levels themselves are rising. This leads to a great discussion into what may have caused this.





Labs that help reinforce these topics:
Any activity you choose (and there are many) should concentrate on

	reading, analyzing graphs, finding evidence to support a claim and argumentative writing using evidence to support the argument. <u>Possible evidence they understand 9-12.LS2.C.1</u> Students identify the given explanation that is supported by the claims, evidence, and reasoning to be evaluated, and which includes the following idea: The complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. o From the given materials, students identify ▪ the claims to be evaluated. ▪ the evidence to be evaluated. ▪ the reasoning to be evaluated. ● Students identify and describe additional evidence (in the form of data, information, or other appropriate forms) that was not provided but is relevant to the explanation and to evaluating the given claims, evidence, and reasoning: o The factors that affect biodiversity o The relationships between species and the physical environment in an ecosystem o Changes in the numbers of species and organisms in an ecosystem that has been subject to a modest or extreme change in ecosystem conditions ● Students describe the strengths and weaknesses of the given claim in accurately explaining a particular response of biodiversity to a changing condition, based on an understanding of the factors that affect biodiversity and the relationships between species and the physical environment in an ecosystem. ● Students use their additional evidence to assess the validity and reliability of the given evidence and its ability to support the argument that resiliency of an ecosystem is subject to the degree of change in the biological and physical environment of an ecosystem. ● Students assess the logic of the reasoning, including the relationship between degree of change and stability in ecosystems,and the utility of the reasoning in supporting the explanation of how o modest biological or physical disturbances in an ecosystem result in maintenance of relatively consistent numbers and types of organisms. o extreme fluctuations in conditions or the size of any population can challenge the functioning of ecosystems in terms of resources and habitat availability and can even result in a new ecosystem. <u>Possible evidence they understand 9-12.LS2.B.2</u> ● Students identify and describe the components in the mathematical representations that are relevant to supporting the claims. The components could include relative quantities related to organisms, matter, energy, and the food web in an ecosystem. (e.g. 10% rule) ● Students identify the claims about the cycling of matter and energy flow among organisms in an ecosystem. ● Students describe how the claims can be expressed as a mathematical relationship in the mathematical representations of the components of an ecosystem.

	• Students use the mathematical representation(s) of the food web to o describe the transfer of matter (as atoms and molecules) and flow of energy upward between organisms and their environment. o identify the transfer of energy and matter between trophic levels. o identify the relative proportion of organisms at each trophic level by correctly identifying producers as the lowest trophic level and as having the greatest biomass and energy and consumers as decreasing in numbers at higher trophic levels. • Students use the mathematical representation(s) to support the claims that include the idea that matter flows between organisms and their environment. • Students use the mathematical representation(s) to support the claims that include the idea that energy flows from one trophic level to another as well as through the environment. • Students analyze and use the mathematical representation(s) to account for the energy not transferred to higher trophic levels, which is instead used for growth, maintenance, or repair, and/or transferred to the environment, and for the inefficiencies in the transfer of matter and energy. <u>Possible evidence they understand 9-12.LS2.B.3</u> • Students use evidence from a given model in which they identify and describe the relevant components, including the following: o The inputs and outputs of photosynthesis o The inputs and outputs of cellular respiration o The biosphere, atmosphere, hydrosphere, and geosphere • Students describe relationships between components of the given model, including the following: o The exchange of carbon (through carbon-containing compounds) between organisms and the environment o The role of storing carbon in organisms (in the form of carbon-containing compounds) as part of the carbon cycle • Students describe the contribution of photosynthesis and cellular respiration to the exchange of carbon within and among the biosphere, atmosphere, hydrosphere, and geosphere in the given model. • Students make a distinction between the model's simulation and the actual cycling of carbon via photosynthesis and cellular respiration. <u>Possible evidence they understand 9-12.LS4.C.3</u>

- Students construct an explanation that identifies the cause and effect relationship between natural selection and adaptation.
- Students identify and describe the evidence to construct their explanation, including the following:
  - o Changes in a population when some feature of the environment changes
  - o Relative survival rates of organisms with different traits in a specific environment
  - o The fact that individual organisms in a species have genetic variation (through mutations and sexual reproduction) that is passed on to their offspring
  - o The fact that individual organisms can have specific traits that give them a competitive advantage relative to other individual organisms in the species
- Students use a variety of valid and reliable sources for the evidence (e.g., theories, simulations, peer review, students' own investigations).
- Students use reasoning to synthesize the valid and reliable evidence to distinguish between cause and correlation to construct the explanation about how natural selection provides a mechanism for species to adapt to changes in their environment, including the following elements:
  - o Biotic and abiotic differences in ecosystems contribute to changes in gene frequency over time through natural selection.
  - o Increasing gene frequency in a population results in an increasing fraction of the population in each successive generation that carries a particular gene and expresses a a particular trait.
  - o Over time, this process leads to a population that is adapted to a particular environment through the widespread expression of a trait that confers a competitive advantage in that environment.

<u>Limits 9-12.LS2.C.1</u>

- Tasks should provide students with a specific claim to evaluate. Students are not required to generate their own claims.
- Tasks should include adequate background information on an ecosystem to draw any necessary conclusions.

<u>Limits 9-12.LS2.B.2</u>

- Tasks should be limited to using proportional reasoning to describe the cycling of matter and the follow of energy.
- Tasks should not require students to develop a claim or generate a mathematical model.

	<u>Limits 9-12.LS2.B.3</u> • Tasks should avoid the specific chemical steps of photosynthesis, respiration, decomposition, and combustion. <u>Limits 9-12.LS4.C.3</u> • Tasks should provide students with data to interpret. • Tasks should not require students to distinguish between credible and non-credible sources. • Tasks should not require students to calculate gene frequency.