# Audubon Public Schools


## High School Biology

## Curriculum Guide

Developed by:

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# Course Description

## High School Biology

This course includes laboratory work, study of specimens, projects, and a thorough understanding of scientific inquiry. Course content encompasses interrelationships of living things, levels of biological organization, cellular biology, biochemistry, genetics, and evolution. Students should be prepared to conduct projects and write a formal lab report. Instruction centers around inquiry based learning that is incorporated into class activities. Learning activities include teacher-lead instruction, group work, student seatwork, project-based learning, and lab exercises with both student-choice and teacher-choice grouping. Students can expect to start each day with a bell ringer assignment followed by learning activities and/or lecture. At times students will work independently from the teacher in order to achieve student autonomy expected of upper school students. Classes are structured to utilize every minute for learning and assessing understanding. Real world application is a daily objective. Higher-level thinking will be incorporated into each lesson as well as use of technology when applicable to increase student achievement. Students are expected to participate in all activities and actively engage and ask questions during teacher-led lectures. Students are also expected to review and study the content covered in class outside of school daily.

# Overview / Progressions

High School: Biology

| Overview | Earth and Space Sciences | Life Sciences | Physical Sciences |
|---|---|---|---|
| **Unit 1-Biology Basics** | | HS-LS 1-2<br>HS-LS 1-6 | |
| **Unit 2-Cell Biology** | | HS-LS 1-2<br>HS-LS 1-3<br>HS-LS1-4 | |
| **Unit 3-Energy In Living Things** | | HS-LS 1-5<br>HS-LS 1-6<br>HS-LS 1-7 | |
| **Unit 4-Genetics and Heredity** | | HS-LS 1-1<br>HS-LS 1-6<br>HS-LS 3-1 | |
| **Unit 5- Evolution** | | HS-LS 1-1<br>HS-LS1-3<br>HS-LS 4-1<br>HS-LS 4-5 | |
| **Unit 6-Ecology** | | HS-LS 1-1<br>HS-LS1-2<br>HS-LS2-1<br>HS-LS4-6 | |

| **BIOLOGY Unit 1: The Process of Inquiry** (20 Instructional Days) | |
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| **Overarching Essential Questions** | **Overarching Enduring Understandings** |
| ● How are scientific breakthroughs made, i.e. how does the inquiry process lead to discovery?<br>● What skills/tools must a person possess/use in order to solve a scientific problem?<br>● What procedures must be followed in order to set up an experimental environment that will allow a scientist to gain new information?<br>● How can the collection and analysis of data lead to a valid conclusion?<br>● What are the properties of a water molecule and how do its properties make it essential for all living things?<br>● What are the four major organic molecules and why are they necessary in all living things?<br>○ | ● Scientific discovery is a process that begins with an observation followed by a question - this begins the process of inquiry.<br>● Scientific discovery is a collaborative process - scientists all over the world use similar methods to solve problems, which aids in the sharing of experiments, data, and conclusions.<br>● Data can be collected from and experiment in different forms - it can also be displayed in tables, charts, and/or graphs.<br>○<br>● Technology can be used in various ways to help scientists answer their questions.<br>○<br>● A water molecule is formed when two hydrogen atoms and one oxygen atom form a polar covalent bond. This allows water to exhibit the properties of adhesion, cohesions, high specific heat, pH, and solvency (ability to dissolve other substances).<br>● Carbon has the ability to form four covalent bonds. This means carbon is the main component in larger, more complex molecules (macromolecules), which can carry out various functions and are essential for all living things. |
| **Student Learning Objectives** | |
| *What students should be able to do after instruction.* | *Evidence Statements* |
| Follow the steps in an experimental procedure that helps solve a problem or answer a question. This includes making a hypothesis, collecting various types of data, organizing the data, and analyzing the data to come to a conclusion. | **HS-LS 1-1** |

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| Design a valid experiment to answer a question of their own making (related to biology). | **HS-LS-1-2** |
| Revise and edit an experimental design so that it more clearly attempts to answer a scientific question. | **HS-LS-1-3** |
| Use technological resources to assign in the inquiry process - the experimental procedure and/or the analysis and displaying of data. | **HS-LS-1-4** |
| Collaborate with other students to formulate a solution to a real-world problem | **HS-LS-1-2** |
| Illustrate the properties of a water molecule by drawing individual molecules and groups of molecules in the appropriate arrangement. | **HS-LS-1-6** |
| Build complex organic molecules and explain the functionality of both their monomers and polymers. | **HS-LS-1-6** |

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.<br>• Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)<br>**Planning and Carrying Out Investigations**<br>Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.<br>• Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of | **LS1.A: Structure and Function**<br>• Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)<br>• 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, which carry out most of the work of cells. (HS-LS1-1) *(Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)*<br>• 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. (HS-LS1-2)<br>• Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external | **Systems and System Models**<br>• 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. (HS-LS1-2),(HS-LS1-4)<br>**Energy and Matter**<br>• 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. (HS-LS1-5), (HS-LS1-6)<br>**Structure and Function**<br>• Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1)<br>**Stability and Change** |

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| data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3)<br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>● 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 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. (HS-LS1-1)<br>● 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 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. (HS-LS1-6)<br>- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -<br>***Connections to Nature of Science***<br>**Scientific Investigations Use a Variety of Methods**<br>● Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, | conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)<br>**LS1.C: Organization for Matter and Energy Flow in Organisms**<br>● The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their 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 for example to form new cells. (HS-LS1-6)<br>● As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7) | ● Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3) |

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| replicability of results, and honest and ethical reporting of findings. (HS-LS1-3) | | |

| Three-Dimensional Teaching and Learning |
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| The core of this unit lies in the development of problem solving that will span all subject areas, especially the sciences. It will also incorporate the use of technology to help communicate the methods and results of the students' problem solving techniques. By employing these problem solving strategies across several fields, students will master using the techniques instead of memorizing the subject matter they contain. |

| Prior Learning |
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| Before beginning this unit, students should have a basic understanding of atoms and molecules, i.e. elements are made of atoms and those atoms can chemically bond with other atoms to make new substances with new properties (compounds). Students should also be aware of the elements that comprise living things (mainly carbon, oxygen. hydrogen, and nitrogen) and their symbols on the Periodic Table. Students should also be able to differentiate between the size and scale of atoms, molecules, and cells - that cells are microscopic but atoms and molecules cannot be visualized even with the most powerful microscope. Students should also be aware of the concept of cells - that they are the basis of living things, not nonliving things. |

| **Part A: What is involved in the process of inquiry which is the nature of science and the scientific method?** | |
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| **Concepts** | **Formative Assessment** |
| The scientific method is used to find answers to problems of a scientific nature.<br><br>A hypothesis is a possible answer to a question/problem and must be testable. | *Students who understand the concepts are able to:*<br>Pose their own scientific questions and provide a written explanation as to how they would attempt to find a solution or |

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| Data can be collected in both qualitative and quantitative forms and can be organized in various types of graphs, depending on the nature of the data.<br><br>A scientific conclusion is written for the purpose of communicating one's findings from scientific research or an experiment. It attempts to provide a final answer to the problem (citing data), states if the hypothesis was supported by the data, and critiques the experimental design and makes suggestions for improvements.<br><br>Scientific problems can be solved by doing research or by performing experiments. These can be done in a lab or field setting, each having its own pros and cons.<br><br>The independent variable in an experiment is the change that the scientist is making or testing - the dependent variable is the observed change, or what is being measured.<br><br>A control group is often included in an experiment to ensure the validity of the experiment - it shows how the experiment runs under normal conditions and is used to compare to the experimental trials. | answer to those questions (while following the guidelines provided by the scientific method).<br><br>Construct a testable hypothesis and design a procedure that would test that hypothesis.<br><br>Organize quantitative data into a table, then convert it into an appropriate graph.<br><br>Use data collected during an experiment to draw conclusions about a problem and build a well-written conclusion expressing their findings to classmates.<br><br>Design an experiment that will provide an answer to a scientific problem. The experimental design must include several trials, including a control group, and must differentiate between its independent and dependent variable. |

| **Part B: How do atoms bond to form water molecules and how does the structure of those water molecules relate to how water functions in living things?** | |
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| **Concepts** | **Formative Assessment** |
| Water's polarity makes it an excellent solvent, which is key to a cell's and an organism's survival.<br><br>Water will readily form acids and bases when combined with certain substances. The pH environment of a cell is important in the maintenance of homeostasis. | *Students who understand the concepts are able to:*<br>Draw several water molecules interacting and explain how those interactions make it an excellent solvent.<br><br>Predict then determine the pH of several substances, then predict how cells would react to changes in their pH. |

| **Part C: Why are all living things made of the same four types of molecules?** | |
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| **Concepts** | **Formative Assessment** |
| Carbon has the ability to form four bonds, which enables molecules that are carbon-based (organic) to have very complex structures. These complex molecules can then link together to form chains, thus building upon levels of complexity forming the biological structures we can see.<br><br>Proteins known as enzymes play a particularly important role in the functionality of a cell. The structure of each enzyme is unique to its function, but can be altered if homeostasis is not maintained (if the cell's temperature or pH is altered). | *Students who understand the concepts are able to:*<br>Using molecular models, build (organic) molecules using carbon as the basic structure, showing the overall complexity of the molecule.<br><br>Using molecular models, link smaller organic molecules (monomers) together to make larger, more complex molecules (polymers).<br><br>Demonstrate how the shape of an enzyme relates to its function.<br><br>Calculate the ideal temperature and pH conditions for different enzymes and predict what may happen to those enzymes if the ideal conditions are altered. |

| **Embedded English Language Arts/Literacy and Mathematics** |
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| English Language Arts/Literacy<br><br>• RST.11-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS1-1), (HS-LS1-6) •<br><br>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1), (HS-LS1-6) •<br><br>WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS1-6) • |

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-3) •

WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3) • WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS-1- 1), (HS-LS1-6)

• SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2), (HS-LS1-4), (HS-LS1-5), (HS-LS1-7)

Connections to NJSLS – Mathematics

• MP.4 Model with mathematics. (HS-LS1-4)

• HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-LS1-4)

**Samples of Open Education Resources for this unit:**

- "I [f****ing] Love Science" - www.iflscience.com - Science-centered blog that presents current events in science in an online template that mirrors modern social media-based blogs.
- Khan Academy videos
- Bozeman Science videos
- Argument-Driven Inquiry in Biology (published by NSTA Press) - Provides sample lessons for various biology topics
- http://highered.mheducation.com/sites/0072495855/student_view0/chapter2/animation__how_enzymes_work.html
- http://www.sumanasinc.com/webcontent/animations/content/propertiesofwater/water.html

| Differentiation | | |
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| **504** | ● preferential seating<br>● extended time on tests and assignments<br>● reduced homework or classwork<br>● verbal, visual, or technology aids | ● modified textbooks or audio-video materials<br>● behavior management support<br>● adjusted class schedules or grading<br>● verbal testing |
| **Enrichment** | ● Utilize collaborative media tools<br>● Provide differentiated feedback<br>● Opportunities for reflection | ● Encourage student voice and input<br>● Model close reading<br>● Distinguish long term and short term goals |
| **IEP** | ● Utilize “skeleton notes” where some required information is already filled in for the student<br>● Provide access to a variety of tools for responses<br>● Provide opportunities to build familiarity and to practice with multiple media tools<br>● Graphic organizers | ● Leveled text and activities that adapt as students build skills<br>● Provide multiple means of action and expression<br>● Consider learning styles and interests<br>● Provide differentiated mentors |
| **ELLs** | ● Pre-teach new vocabulary and meaning of symbols<br>● Embed glossaries or definitions<br>● Provide translations<br>● Connect new vocabulary to background knowledge | ● Provide flash cards<br>● Incorporate as many learning senses as possible<br>● Portray structure, relationships, and associations through concept webs<br>● Graphic organizers |

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| **At-risk** | • Purposeful seating<br>• Counselor involvement<br>• Parent involvement | • Contracts<br>• Alternate assessments<br>• Hands-on learning |
| **21st Century Skills** | | |
| • Creativity<br>• Innovation<br>• Critical Thinking | | • Problem Solving<br>• Communication<br>• Collaboration |
| **Integrating Technology** | | |
| • Chromebooks<br>• Internet research<br>• Online programs | | • Virtual collaboration and projects<br>• Presentations using presentation hardware and software |

| **BIOLOGY Unit 2: Cell Biology** (40 Instructional Days) | |
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| **Overarching Essential Questions** | **Overarching Enduring Understandings** |
| ● What is the cell theory?<br>● How do the components of a cell work as a system to enable the cell to perform its function (i.e. how can several components, all performing different functions, lead to a whole, which performs a larger function?)?<br>● How do the components of an organism lead to its functionality?<br>● How do cells regulate their internal and external environments in order to maintain homeostasis?<br>● What is the life cycle of the normal cell? | ● Cells can be prokaryotic or eukaryotic.<br>● A eukaryotic cell is a microscopic system made of several components (organelles) each performing a different function.<br>● An organism is itself a system made of several levels of organization of increasing complexity and specialization.<br>● All organisms must maintain homeostasis, which is primarily controlled by the cell membrane's regulation of materials into and out of the cell.<br>● A cell has a typical life span. Cells go through stages of the cell cycle. Cancer cells have an irregular lifespan. |
| **Student Learning Objectives** | |
| *What students should be able to do after instruction.* | *Evidence Statements* |
| Identify things as living or nonliving using the cell theory as a guide. | HS-LS-1-2 |
| Differentiate between prokaryote and eukaryote given micrographs and descriptions. | HS-LS-1-2 |
| Differentiate between stem cells and differentiated cells. | HS-LS-1-2 |
| Develop a model of a eukaryotic cell that both illustrates its structural components as well as its ability to function as a system. | HS-LS-1-2 |

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| Describe the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. | HS-LS-1-2 |
| Construct models that explain the movement of molecules across membranes with membrane structure and function. | HS-LS-1-3 |
| Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. | HS-LS-1-3 |
| Identify the purpose of cell division and differentiation. | HS LS1-4 |
| Identify the causes of cancer and the structural and functional differences between normal cells and cancer cells | HS LS1-4 |

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| risk, time), and refine the design accordingly. (HS-LS1-3)<br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>● 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 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. (HS-LS1-1)<br>● 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 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. (HS-LS1-6)<br>- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -<br>***Connections to Nature of Science***<br>**Scientific Investigations Use a Variety of Methods**<br>● Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3) | ● The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their 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 for example to form new cells. (HS-LS1-6)<br>● As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7) | |

| **Three-Dimensional Teaching and Learning** |
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| One of the major overarching themes in this unit is the understanding that biology, like many sciences, involves the study of systems. This will be done in many layers - atoms form systems of molecules, which can form larger molecules, which form organelles, etc. Modelling will also be a key skill employed in this unit. |

As many of these concepts are too small to be manipulated, students will be asked to construct models to represent these systems and how they build upon each other to produce a greater function.

| Prior Learning |
| --- |
| Before beginning this unit, students should have a basic understanding of atoms and molecules, i.e. elements are made of atoms and those atoms can chemically bond with other atoms to make new substances with new properties (compounds). Students should also be aware of the elements that comprise living things (mainly carbon, oxygen. hydrogen, and nitrogen) and their symbols on the Periodic Table. Students should also be able to differentiate between the size and scale of atoms, molecules, and cells - that cells are microscopic but atoms and molecules cannot be visualized even with the most powerful microscope. Students should also be aware of the concept of cells - that they are the basis of living things, not nonliving things. |

| Embedded English Language Arts/Literacy and Mathematics |
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***English Language Arts/Literacy –***

*NJSLS.R1. Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.*

*NJSLS.R5. Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.*

*NJSLS.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.*

*NJSLS.R8. Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.*

*NJSLS.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.*

*NJSLS.W2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.*

*NJSLS.W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.*

*NJSLS.W5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.*

*NJSLS.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.*

*Mathematics –*

*NJSLS Math N-Q.A. Reason quantitatively and use units to solve problems.*

*NJSLS Math N-CN.A. Perform arithmetic operations with complex numbers.*

*NJSLS Math S-ID.A. Summarize, represent, and interpret data on a single count or measurement variable*

*NJSLS Math S-ID.B. Summarize, represent, and interpret data on two categorical and quantitative variables*

*Technology --*

*NJSLS Tech 8.1.12.A.4 Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.*

| **Three-Dimensional Teaching and Learning** |
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| **Part A: Cell Theory and Organelles** | |
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| **Concepts** | **Formative Assessment** |
| What are the principles of cell theory?<br>What are the differences between prokaryotic and eukaryotic cells?<br>The eukaryotic cell functions much like a complete multicellular organism - organelles work together to help the cell perform its function in the body.<br>Multicellular organisms have a hierarchy of functionality - cells work together to make tissues, tissues to make organs, etc. | *Students who understand the concepts are able to:*<br>Identify something as cellular or non cellular given description or image.<br>Identify something as prokaryotic, eukaryotic, plant or animal cell given a diagram or description or using a microscope.<br>Identify an organelle based on diagram, description or microscope slide.<br>Predict the consequences of the failure or absence of an organelle.<br>Diagram the complexity of life from unicellular to multicellular organisms |

| **Part B: Cell Transport** | |
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| **Concepts** | **Formative Assessment** |
| What is homeostasis? | *Students who understand the concepts are able to:* |

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| What impact does the cell membrane play in homeostasis?<br><br>What is the difference between active and passive transport?<br><br>What are the six types of transport?<br><br>What are the differences between hypotonic, isotonic and hypertonic solutions?<br><br>What are the differences between phagocytosis, phagocytosis and exocytosis? | Define homeostasis and explain how it's maintenance is important to living things.<br><br>Using cell membrane models and diagrams diagram the components of the cell membrane and the impact of these components on homeostasis.<br><br>Create a Venn Diagram to compare and contrast passive and active transport.<br><br>Classify a type of cellular transport as active or passive transport based on a diagram or description.<br><br>Classify solutions as hypertonic, isotonic and hypertonic based on a diagram or a description. |

| • **Part C: Cell Cycle and Cancer** | |
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| **Concepts** | **Formative Assessment** |
| Multicellular organisms have a hierarchy of functionality - cells work together to make tissues, tissues to make organisms.<br><br>There are differences between specialized cells and stem cells.<br><br>What is the life cycle of the cell?<br><br>What are the controls on this life cycle (both internal and external)?<br><br>How is cancer related to the cell cycle? | *Students who understand the concepts are able to:*<br>Construct a model of a eukaryotic cell and use it as a basis for explaining how the levels of organization in a multicellular organism build upon each other to bring about the ultimate functionality of a complete organism.<br><br>Compare and contrast specialized cells and stem cells.<br><br>Summarize the differences between adult and embryonic stem cells.<br><br>List the two main purposes for cell division.<br><br>Describe and identify from diagram the stages of mitosis.<br><br>Predict consequences of a failure during a given phase of the cell cycle or mitosis?<br><br>Define cancer, causes of cancer, and the types of tumors that may result. |

| **Embedded English Language Arts/Literacy and Mathematics** |
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| ***English Language Arts/Literacy-***<br><br>*RST.11-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS1-1), (HS-LS1-6)*<br><br>*WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1), (HS-LS1-6)*<br><br>*WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS1-6)*<br><br>*WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-3)*<br><br>*WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3)*<br><br>*WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS-1- 1), (HS-LS1-6)*<br><br>*SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2), (HS-LS1-4), (HS-LS1-5), (HS-LS1-7)*<br><br>***Connections to NJSLS – Mathematics***<br><br>*MP.4 Model with mathematics. (HS-LS1-4)*<br><br>*HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (HS-LS1-4)* • |

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| *HSF-BF.A.1 Write a function that describes a relationship between two quantities. (HS-LS1-4)* |

| **Samples of Open Education Resources for this unit:** |
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| ● *Argument-Driven Inquiry in Biology (published by NSTA Press) - Provides sample lessons for various biology topics*<br>● Cell Information - http://www.scsc.k12.in.us/sms/Teachers/Martin/website.htm<br>● "Diffusion, Osmosis, and Active Transport" - https://concord.org/stem-resources/diffusion-osmosis-and-active-transport<br>● "Cellular Transport" - http://www.wiley.com/college/boyer/0470003790/animations/membrane_transport/membrane_transport.htm<br>● "Tonicity Animations" - http://www.biologyjunction.com/tonicity%20animations.htm<br>● "Membrane Transport" - http://www.mhhe.com/biosci/bio_animations/05_MH_MembraneTransport_Web/index.html |

| **Differentiation** | | |
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| **504** | ● preferential seating<br>● extended time on tests and assignments<br>● reduced homework or classwork<br>● verbal, visual, or technology aids | ● modified textbooks or audio-video materials<br>● behavior management support<br>● adjusted class schedules or grading<br>● verbal testing |
| **Enrichment** | ● Utilize collaborative media tools<br>● Provide differentiated feedback<br>● Opportunities for reflection | ● Encourage student voice and input<br>● Model close reading<br>● Distinguish long term and short term goals |
| **IEP** | ● Utilize "skeleton notes" where some required information is already filled in for the student<br>● Provide access to a variety of tools for responses<br>● Provide opportunities to build familiarity and to practice with multiple media tools<br>● Graphic organizers | ● Leveled text and activities that adapt as students build skills<br>● Provide multiple means of action and expression<br>● Consider learning styles and interests<br>● Provide differentiated mentors |

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| **ELLs** | • Pre-teach new vocabulary and meaning of symbols<br>• Embed glossaries or definitions<br>• Provide translations<br>• Connect new vocabulary to background knowledge | • Provide flash cards<br>• Incorporate as many learning senses as possible<br>• Portray structure, relationships, and associations through concept webs<br>• Graphic organizers |
| **At-risk** | • Purposeful seating<br>• Counselor involvement<br>• Parent involvement | • Contracts<br>• Alternate assessments<br>• Hands-on learning |
| **21st Century Skills** | | |
| • Creativity<br>• Innovation<br>• Critical Thinking | | • Problem Solving<br>• Communication<br>• Collaboration |
| **Integrating Technology** | | |
| • Chromebooks<br>• Internet research<br>• Online programs | | • Virtual collaboration and projects<br>• Presentations using presentation hardware and software |

| **BIOLOGY INQUIRY Unit 3: Energy in Living Things** (40 Instructional Days) | |
|---|---|
| **Overarching Essential Questions** | **Overarching Enduring Understandings** |
| ● What influence do enzymes have on biochemical reactions?<br>● What is the chemical that provides energy for the cell?<br>● How do the carbohydrates in our food get turned into energy for our cells?<br>● How do autotrophs (mainly plants and algae) build the carbohydrate molecules that we need for our energy?<br>● How does the solar energy harnessed by plants and algae travel throughout the rest of an ecosystem? | ● Enzymes regulate the biochemical reactions of life.<br>● ATP is the energy chemical for the cell<br>● Cellular respiration is an aerobic process that is able to transfer the chemical energy stored in the bonds of carbohydrates into the useable chemical energy stored in a molecule of ATP.<br>● Many organisms are anaerobic and are able to perform this energy transfer without oxygen.<br>● Autotrophs are able to build their own carbohydrate molecules, most through the process of photosynthesis, which is reliant upon solar energy.<br>● The solar energy harnessed by plants during photosynthesis travels into other organisms when the plants are |

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| ● How are plants and animals dependent upon each other with regard to the reactants and products of photosynthesis? How can the presence or absence of certain chemicals affect this relationship? How can other outside influences affect this relationship? | eaten. This process continues until each organism in an ecosystem has been supplied with energy.<br>● Plants and animals are dependent upon each other for the carbon dioxide and oxygen needed for photosynthesis and respiration, respectively. Humans are impact this exchange, which is having an effect on the global ecosystem. |

| **Student Learning Objectives** | |
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| *What students should be able to do after instruction.* | *Evidence Statements* |
| Draw and label an energy diagram. Illustrating the differences that exist between a reaction with and without enzymes. | HS-LS1-6 |
| Diagram an ATP molecule and understand the classification of organic molecule it fits into | HS-LS1-6 |
| Act out the process of cellular respiration, using the reactants and products as "actors" in the play. | HS-LS1-7 |
| Develop an exercise plan as it relates to the process of cellular respiration and lactic acid fermentation. | HS-LS2-1 |
| Act out the process of photosynthesis, using the reactants and products as "actors" in the play. | HS-LS2-1 |
| Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. | HS-LS2-3 |
| Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. | HS-LS2-4 |
| Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. | HS-LS2-5 |

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|
| **Developing and Using Models**<br><br>Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show how relationships among variables between systems and their components in the natural and designed worlds.<br><br>● Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)<br><br>**Using Mathematics and Computational Thinking**<br><br>Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.<br><br>● Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)<br>● Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)<br>● Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4) | **LS2.A: Interdependent Relationships in Ecosystems**<br><br>● 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. (HS-LS2-1), (HS-LS2-2)<br>● **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)<br>● 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 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. (HS-LS2-4)<br>● 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. (HS-LS2-5)<br><br>**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**<br><br>● A complex set of interactions within an ecosystem can keep its 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. (HS-LS2-2), (HS-LS2-6)<br>● Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, | **Cause and Effect**<br><br>● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)<br><br>**Scale, Proportion, and Quantity**<br><br>● The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)<br>● Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)<br><br>**Systems and System Models**<br><br>● 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. (HS-LS2-5)<br><br>**Energy and Matter**<br><br>● Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4)<br>● Energy drives the cycling of matter within and between systems. (HS-LS2-3)<br><br>**Stability and Change**<br><br>● Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7)<br><br>*Connections to Nature of Science*<br><br>**Scientific Knowledge is Open to Revision in Light of New Evidence**<br><br>● Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2), (HS-LS2-3)<br>● 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. (HS-LS2-6), (HS-LS2-8) |

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| | overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)<br>• 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. (HS-LS2-2), (HS-LS2-3) 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. (HS-LS2-6), (HS-LS2-8)<br>**LS2.D: Social Interactions and Group Behavior**<br>• Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)<br>**LS4.D: Biodiversity and Humans**<br>• Humans depend on the living world for the resources and other benefits provided by biodiversity.<br>• 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 7)landscapes of recreational or inspirational value. (secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HSLS4-6.)<br>**PS3.D: Energy in Chemical Processes**<br>• The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5)<br>**ETS1.B: Developing Possible Solutions**<br>• 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. (secondary to HS-LS2-7) | |

## Three-Dimensional Teaching and Learning

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| Though this unit also expands on the idea of life as a series of systems, it delves more deeply into the interdependence of all organisms upon one another (within a system - an ecosystem). There is a focus on the effects on a system if one part of that system is changed and allows for student hypotheses and research. This unit also reinforces understanding of matter and energy - that the solar energy from the sun is transferred into the energy in chemical bonds, which can then be transferred into another form of energy (kinetic, heat, sound, etc.). |

| **Prior Learning** |
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| This unit will tie into the previous unit's study of organic molecules - this time focusing mainly on carbohydrates. They should have a background in the basic parts of the digestive system and be aware of the basics of the cardiovascular system, i.e. the purpose of the heart and lungs. Students should also be aware of the basic needs of plants and animals - plants need sunlight, water, soil, and carbon dioxide, while animals need water (not for energy), food, and oxygen. It would also be beneficial if they were exposed to the idea of climate change and that humans are indirectly causing this. |

| • **Part A: Enzymes and Biochemical Reactions** | |
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| **Concepts** | **Formative Assessment** |
| Explain the overall function of enzymes in biochemical reactions, such as photosynthesis and respiration. | *Students who understand the concepts are able to:*<br>Draw and label energy diagrams of biochemical reactions (endothermic and exothermic), including products, reactants, and activation energy.<br>Describe the five factors that affect the rate of a chemical reaction.<br>Draw a lock and key model. Make sure to label the enzyme, substrate, active site and product. |

| **Part B: Adenosine Triphosphate** | |
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| **Concepts** | **Formative Assessment** |
| Explain the purpose of ATP and where most of the energy is stored in the molecule. | *Students who understand the concepts are able to:*<br>Draw the structure and label the parts of the ATP molecule. |

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| | Describe the ATP-ADP cycle. Include what is recycled and what is not recycled.<br><br>Explain what the energy is used for when a phosphate is removed and where that energy initially comes from. |

| **Part C: Energy Flow through Ecosystems** | |
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| **Concepts** | **Formative Assessment** |
| All cells use carbohydrates as the basis for their energy needs. Most autotrophs (plants and algae) build these carbohydrate molecules in the process of photosynthesis, in which they harness the energy from the sun to transform molecules of carbon dioxide and water into carbohydrates (and oxygen, a byproduct).<br><br>Autotrophs form the energy base of all ecosystems. As the autotrophs are eaten, some of their energy is transferred to the next level of, and so on. Every time energy is transferred, however, some energy is lost.<br><br>Explain the differences between how autotrophs and heterotrophs acquire energy.<br><br>There are different types of heterotrophs. | *Students who understand the concepts are able to:*<br><br>Trace the energy source for all organisms back to an autotroph (and, indirectly, the sun).<br><br>Calculate how much energy is transferred and lost as organisms are consumed moving up the trophic levels in an ecosystem.<br><br>Interpret a food chain or food web.<br><br>Identify a trophic level based on description or diagram.<br><br>Classify an organism depending on what type of consumer it is based on diagram or description. |

| **Part D: Photosynthesis** | |
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| **Concepts** | **Formative Assessment** |
| What is this process called photosynthesis?<br><br>Why are plants green?<br><br>Describe the significant events of the light-dependent reactions?<br><br>Describe the significant events of the light-independent reactions?<br><br>What are some alternative pathways some plants take to photosynthesize?<br><br>What are some of the environmental factors that affect photosynthesis? | *Students who understand the concepts are able to:*<br>Write and interpret the chemical formula for photosynthesis. Label the reactants and products of this chemical reaction.<br><br>Discuss the locations of the pigments that give the plant its green color and allow it to photosynthesize.<br><br>Identify the reactants and products of the light-dependent and light independent reactions of photosynthesis. |

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| | Using a diagram students will identify the locations of both the light-dependent and and light-independent reactions.<br><br>Predict how changes in Earth's environment will affect the atmosphere and how those atmospheric changes will impact the organisms on Earth. |

| **Part E: Respiration** | |
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| **Concepts** | **Formative Assessment** |
| What is the goal of respiration?<br><br>Respiration can be aerobic and anaerobic with different results.<br><br>Glycolysis prepares the cell for respiration.<br><br>What is the Krebs Cycle?<br><br>What is the Electron Transport Chain?<br><br>What are the two types of anaerobic respiration? | *Students who understand the concepts are able to:*<br>Identify the organelle of respiration and label the parts of the organelle?<br><br>Write and interpret the chemical formula for respiration. Label the reactants and products of this chemical reaction.<br><br>Describe the differences between aerobic and anaerobic respiration.<br><br>Highlight what will be released as a product of glycolysis and what will move on to the Kreb cycle and the location of glycolysis in the cell.<br><br>Using a diagram, describe the significance of the Kreb cycle, highlighting the products of the cycle and what will move on to the ETC.<br><br>Diagram the ATP totals generated from each of the stages contributing to cellular respiration.<br><br>Write and identify the equation for lactic acid and alcoholic fermentation? |

| **Embedded English Language Arts/Literacy and Mathematics** |
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*English Language Arts/Literacy* –

*RST.9-10.8.*Accurately cite strong and thorough textual evidence, (e.g.,via discussion, written response, etc.) and make relevant connections, to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.

*RST.11-12.7* Analyze various perspectives as presented in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account.

*RI.11-12.2*. Determine two or more central ideas of a text, and analyze their development and how they interact to provide a complex analysis; provide an objective summary of the text.

*RST.11-12.8* Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.( HS-LS2-6), ( HS-LS2-7), ( HS-LS2-8)

*WHST.9-12.2* Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.( HS-LS2-1), ( HS-LS2-2), ( HS-LS2-3)

*WHST.9-12.5* Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant. (HS-LS2-2)

*Mathematics* –

MP.2 Reason abstractly and quantitatively. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-6),(HS-LS2-7)

MP.4 Model with mathematics. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. ( HS-LS2-1),( HS-LS2-2),( HS-LS2-4),( HS-LS2-6)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)

HSS-ID.A.1 Represent data with plots on the real number line. (HS-LS2-6)

HSS-IC.B.6 Evaluate reports based on data. (HS-LS2-6)

| Samples of Open Education Resources for this unit: |
|---|
| ● *Argument-Driven Inquiry in Biology (published by NSTA Press) - Provides sample lessons for various biology topics*<br>● "Science of Cooking" - http://www.exploratorium.edu/cooking/<br>● Digestive System Lesson Plan - https://educators.brainpop.com/lesson-plan/digestive-system-lesson-plan-build-a-body-game/<br>● "Cellular Respiration" - http://www.sumanasinc.com/webcontent/animations/content/cellularrespiration.html<br>● "Illuminating Photosynthesis" - http://www.pbs.org/wgbh/nova/nature/photosynthesis.html#<br>● "Energy Pyramids" - http://www.harcourtschool.com/activity/science_up_close/314/deploy/interface.swf<br>● "None Like it Hot!" - https://www.youtube.com/watch?v=OqVyRa1iuMc - clip from "An Inconvenient Truth" explaining climate change<br>● "As Student's Guide to Global Climate Change" - https://www3.epa.gov/climatechange/kids/ |

| Differentiation | | |
|---|---|---|
| **504** | ● preferential seating<br>● extended time on tests and assignments<br>● reduced homework or classwork<br>● verbal, visual, or technology aids | ● modified textbooks or audio-video materials<br>● behavior management support<br>● adjusted class schedules or grading<br>● verbal testing |
| **Enrichment** | ● Utilize collaborative media tools<br>● Provide differentiated feedback<br>● Opportunities for reflection | ● Encourage student voice and input<br>● Model close reading<br>● Distinguish long term and short term goals |

| | | |
|---|---|---|
| **IEP** | • Utilize “skeleton notes” where some required information is already filled in for the student<br>• Provide access to a variety of tools for responses<br>• Provide opportunities to build familiarity and to practice with multiple media tools<br>• Graphic organizers | • Leveled text and activities that adapt as students build skills<br>• Provide multiple means of action and expression<br>• Consider learning styles and interests<br>• Provide differentiated mentors |
| **ELLs** | • Pre-teach new vocabulary and meaning of symbols<br>• Embed glossaries or definitions<br>• Provide translations<br>• Connect new vocabulary to background knowledge | • Provide flash cards<br>• Incorporate as many learning senses as possible<br>• Portray structure, relationships, and associations through concept webs<br>• Graphic organizers |
| **At-risk** | • Purposeful seating<br>• Counselor involvement<br>• Parent involvement | • Contracts<br>• Alternate assessments<br>• Hands-on learning |
| **21st Century Skills** | | |
| • Creativity<br>• Innovation<br>• Critical Thinking | | • Problem Solving<br>• Communication<br>• Collaboration |
| **Integrating Technology** | | |

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|---|---|
| • Chromebooks<br>• Internet research<br>• Online programs | • Virtual collaboration and projects<br>• Presentations using presentation hardware and software |

| **BIOLOGY INQUIRY Unit 4: Genetics and Heredity** (40 Instructional Days) | |
|---|---|
| **Overarching Essential Questions** | **Overarching Enduring Understandings** |
| • What are the chemicals of inheritance?<br>• What scientists contributed to the understanding of genetics we presently have?<br>• Why does every cell perform a different function (or the same function)?<br>• How and why did you get the traits that you did?<br><br>• Why are all humans so similar yet so different? | • DNA and RNA are the chemicals of inheritance.<br>• Highlight and research the work of genetic scientists through the ages.<br>• Genes are turned on/off during translation to make the different proteins the cells need.<br>• Cells can reproduce asexually. This can lead to a new, complete organism (asexual reproduction) or an identical copy of a cell (mitosis). Different cells will reproduce at different rates. Cells in a multicellular organism will differentiate as an organism develops. |

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| • What is the probability that your children will inherit the same traits that you inherited? | • Organisms that reproduce sexually are the result of the inheritance of DNA, in the form of chromosomes, from two different parent cells.<br>• Organisms vary across species and can also vary within a species - this can be the result of natural genetic variation or random or induced mutations to the DNA.<br>• Since every organism that reproduces sexually has two sets of chromosomes (genes), there is a 50-50 probability that it will pass on either of the genes it inherited from each parent. |

| **Student Learning Objectives** | |
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| *What students should be able to do after instruction.* | *Evidence Statements* |
| Determine the traits of a cell/organism by translating the code in a DNA molecule into its RNA counterpart, then finally into a polypeptide. | HS-LS1-1 |
| Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. | HS-LS1-4 |
| Model the relationship between DNA and chromosomes. | HS-LS3-1 |
| Explain how the process of meiosis results in the passage of traits from parent to offspring, and how that results in increased genetic diversity necessary for evolution. | HS-LS3-1 |
| Trace the inheritance of certain traits through several generations of sexual reproduction and predict the probability of the inheritance for each trait. | HS-LS3-1 |
| Simulate the genetic variation among a population as a result of either natural genetic recombination or mutation. | HS-LS3-1 |

| The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*: | | |
|---|---|---|
| **Science and Engineering Practices** | **Disciplinary Core Ideas** | **Crosscutting Concepts** |

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| **Asking Questions and Defining Problems**<br>Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.<br>● Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)<br>**Analyzing and Interpreting Data**<br>● Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.<br>● 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. (HSLS3-3)<br>**Engaging in Argument from Evidence**<br>Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.<br>● Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2) | **LS1.A: Structure and Function**<br>● 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. (secondary to HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.)<br>**LS3.A: Inheritance of Traits**<br>● 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. (HS-LS3-1)<br>**LS3.B: Variation of Traits**<br>● 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.<br>● Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2) 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. (HS-LS3- 2), (HS-LS3-3) | **Cause and Effect**<br>● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HSLS3-1), (HS-LS3-2)<br>**Scale, Proportion, and Quantity**<br>● 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). (HS-LS3-3)<br>*Connections to Nature of Science*<br>**Science is a Human Endeavor**<br>● Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3- 3)<br>● Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3) |

## Three-Dimensional Teaching and Learning

The key to this unit is its relatability to the students' lives. This is done by modeling DNA structure, but more accurately by applying the principles of genetics to human traits. The students' understanding of genetics will be measured in various problem-solving techniques, many of which involve data analysis and drawing conclusions from that data.

## Prior Learning

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| Students should understand the difference between heritable and non-heritable traits and that humans are a species that inherit traits from two parents. They should also draw from material in Unit 2, in which they were exposed to the concept of monomers linking together to form polymers. |

| **Part A: DNA Structure and Replication** | |
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| **Concepts** | **Formative Assessment** |
| DNA and RNA are both nucleic acids.<br>Explain in detail the structure of a DNA molecule.<br>Describe the difference between purines and pyrimidines to categorize nitrogen bases.<br>Explain the differences between a strand of DNA, genes, and a chromosome.<br>How is DNA replicated?<br>DNA is a molecule made of four different components - the sequence of those four components creates a code that is used to link different amino acids together to make a protein. | *Students who understand the concepts are able to:*<br>Use a Venn diagram to compare and contrast DNA and RNA.<br>Explain the base pairing rules of DNA. Provide an example of a strand of DNA with its complementary pair.<br>Draw the structure of the nucleotide and label its parts<br>Label a diagram correctly identifying a strand of DNA, a gene, and a chromosome.<br>Summarize the process of replication.<br>Describe the difference between a leading and lagging strand in DNA replication using a model.<br>Explain the function of each enzyme in the process of replication. |

| **Part B: Protein Synthesis** | |
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| **Concepts** | **Formative Assessment** |
| Describe the relationship between genes and proteins with the central dogma.<br>Describe the roles of the three types of RNA in protein synthesis. | *Students who understand the concepts are able to:*<br>The Central Dogma was proposed by Francis Crick in the 1950s to explain how DNA in the nucleus is converted into a protein.<br>Sketch each of the RNA types doing their jobs during transcription and translation. |

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| Though cells of the same organism contain the same DNA sequence, not every cell reads the same parts of the code, therefore, two cells in the same organism can perform different functions.<br><br>Mutations are mistakes that can occur in the DNA code and can alter the traits of an organism, or have no effect at all. | Summarize , in detail the steps of transcription and translation including the location of the process and enzymes involved.<br><br>Translate a code in DNA into a sequence of amino acids, or polypeptide (protein).<br><br>Use the translation of DNA code to determine the proteins created and the traits that correspond in the organism's phenotype.<br><br>Predict how mutations of varying size will affect the traits of an organism. |

| **Part C: Meiosis** | |
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| **Concepts** | **Formative Assessment** |
| What is the difference between a haploid cell and a diploid cells?<br><br>Describe the differences between somatic cells and sex cells?<br><br>What are the steps of meiosis?<br><br>How does meiosis contribute to genetic variation of organisms?<br><br>What are some errors that can occur during meiosis? | *Students who understand the concepts are able to:*<br><br>Identify a cell as haploid or diploid based on a description or picture.<br><br>Describe the locations of somatic cells and sex cells and the differences in chromosomes.<br><br>Model the recombination of chromosomes that occurs during the process of meiosis.<br><br>Draw and summarize each step of meiosis.<br><br>Explain what would happen if a mistake is made during meiosis? |

| **Part D: Mendelian Genetics** | |
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| **Concepts** | **Formative Assessment** |
| Explain Mendel's three laws of inheritance. | *Students who understand the concepts are able to:*<br><br>Model meiosis and how this explains the law of segregation. |

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| Humans are a species that reproduces sexually - in order to reproduce, two parent cells, each containing a half set of DNA (chromosomes), unite, creating offspring that are genetically different from either parent.<br><br>The process of meiosis creates the reproductive cells (gametes) that will unite during sexual reproduction. Each gamete contains a mixture of the parent's two sets of DNA (which were inherited from his/her two parents).<br><br>Much of the human genome (about 99.9%) is the same throughout the species, which means only a small portion of human DNA is unique between individual organisms. | Model the recombination of chromosomes that occurs during the process of meiosis and how this is related to independent assortment.<br><br>Perform monohybrid crosses to demonstrate the understanding of the law of Dominance and recessiveness.<br><br>Given parental phenotypes or genotypes identify all the possible gametes could be produced using Punnett squares and be able to determine the genotypic and phenotypic ratios from your results.<br><br>Be able to use the rules of probability to determine the likelihood of inheriting different combinations of alleles. |

| **Part D: Complex Inheritance Patterns** | |
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| **Concepts** | **Formative Assessment** |
| What is the difference between incomplete dominance and codominance.<br><br>What are multiple alleles and polygenic traits.<br><br>What type(s) of inheritance determines blood type?<br><br>Explain the difference between traits inherited on sex chromosomes and traits on autosomes? | *Students who understand the concepts are able to:*<br><br>Perform crosses, using Punnett Squares for each of the different inheritance patterns.<br><br>Predict the probability of inheritance of certain traits by understanding the various inheritance patterns that genes can follow.<br><br>Identify the type of inheritance pattern based on a description.<br><br>Use a pedigree to determine the inheritance pattern of a trait |

| **Part E: Mutations and Pedigrees** | |
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| **Concepts** | **Formative Assessment** |
| What is a mutation and what causes mutations?<br><br>How are mutations in sex cells and somatic cells different?<br><br>How do gene and chromosomal mutations differ? | *Students who understand the concepts are able to:*<br>Find mutations given DNA strands and identify the type of mutation.<br><br>Study the causes of mutations and how we can prevent them. |

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| | Interpret an inheritance pattern in a family with a pedigree.<br><br>Identify the type of mutation based on a description, picture or pedigree<br><br>Research how mutations in sex cells and somatic cells differ in severity. |

| **Part F: Genetic Engineering** | |
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| **Concepts** | **Formative Assessment** |
| What are some of the different types of genetic engineering?<br><br>How is genetic engineering significant? | *Students who understand the concepts are able to:*<br><br>Research the work presently done in the USA on genetic engineering.<br><br>Be able to identify a suspect using Gel Electrophoresis.<br><br>Genetic engineering has significance to science, technology, and society both positively and negatively. |

| **Embedded English Language Arts/Literacy and Mathematics** |
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| ***English Language Arts/Literacy***<br><br>*RST.11-12.1* Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS3-1), (HSLS3-2)<br><br>*RST.11-12.9* Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-LS3-1)<br><br>*WHST.9-12.1* Write arguments focused on discipline-specific content. (HS-LS3-2) Connections to NJSLS –<br><br>***Mathematics***<br><br>MP.2 Reason abstractly and quantitatively. (HS-LS3-2), (HS-LS3-3) |

| Samples of Open Education Resources for this unit: |
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| ● Argument-Driven Inquiry in Biology (published by NSTA Press) - Provides sample lessons for various biology topics<br>● "Protein Synthesis" - http://highered.mheducation.com/olcweb/cgi/pluginpop.cgi?it=swf::535::535::/sites/dl/free/0072437316/120077/micro06.swf::Protein+Synthesis<br>● "DNA - The Double Helix" - http://www.nobelprize.org/educational/medicine/dna_double_helix/dnahelix.html<br>● "Cancer Protein Structure and Function" - http://www.hhmi.org/biointeractive/bcr-abl-cancer-protein-structure-and-function?utm_source=BioInteractive%20News&utm_campaign=05ac6c5c0d-BioInteractive_News_Vol_3411_11_2014&utm_medium=email&utm_term=0_98b2f5c6ba-05ac6c5c0d-69142477<br>● "How the Cell Cycle Works" - http://highered.mheducation.com/sites/0072495855/student_view0/chapter2/animation__how_the_cell_cycle_works.html<br>● "The Eukaryotic Cell Cycle and Cancer" - http://www.hhmi.org/biointeractive/eukaryotic-cell-cycle-and-cancer<br>● "How Meiosis Works" - https://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter28/animation__how_meiosis_works.html<br>● "Furry Family" - http://vital.cs.ohiou.edu/steamwebsite/downloads/FurryFamily.swf |

| Differentiation | | |
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| **504** | ● preferential seating<br>● extended time on tests and assignments<br>● reduced homework or classwork<br>● verbal, visual, or technology aids | ● modified textbooks or audio-video materials<br>● behavior management support<br>● adjusted class schedules or grading<br>● verbal testing |
| **Enrichment** | ● Utilize collaborative media tools<br>● Provide differentiated feedback<br>● Opportunities for reflection | ● Encourage student voice and input<br>● Model close reading<br>● Distinguish long term and short term goals |

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| **IEP** | • Utilize "skeleton notes" where some required information is already filled in for the student<br>• Provide access to a variety of tools for responses<br>• Provide opportunities to build familiarity and to practice with multiple media tools<br>• Graphic organizers | • Leveled text and activities that adapt as students build skills<br>• Provide multiple means of action and expression<br>• Consider learning styles and interests<br>• Provide differentiated mentors |
| **ELLs** | • Pre-teach new vocabulary and meaning of symbols<br>• Embed glossaries or definitions<br>• Provide translations<br>• Connect new vocabulary to background knowledge | • Provide flash cards<br>• Incorporate as many learning senses as possible<br>• Portray structure, relationships, and associations through concept webs<br>• Graphic organizers |
| **At-risk** | • Purposeful seating<br>• Counselor involvement<br>• Parent involvement | • Contracts<br>• Alternate assessments<br>• Hands-on learning |
| **21st Century Skills** | | |
| • Creativity<br>• Innovation<br>• Critical Thinking | | • Problem Solving<br>• Communication<br>• Collaboration |
| **Integrating Technology** | | |

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| ● Chromebooks<br>● Internet research<br>● Online programs | ● Virtual collaboration and projects<br>● Presentations using presentation hardware and software |

| **BIOLOGY INQUIRY Unit 5: Evolution** (20 Instructional Days) | |
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| **Overarching Essential Questions** | **Overarching Enduring Understandings** |
| ● Why are there so many different species on Earth? Why do some species look and act more similarly than others? | ● There are several categories of evidence that support the theory of evolution, including comparative anatomy, embryology, and molecular biology (DNA). |

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| ● How were the many theories that (attempt to) explain evolution developed?<br><br>● What evidence supports the theory of evolution and natural selection?<br><br>● How can environmental changes impact the survival of a species? How have humans affected these environmental changes?<br><br>● How does evolution occur within a population? | ● Several theories were proposed to explain why there are so many different species on Earth. The most widely accepted is that of Charles Darwin - his theory of evolution by natural selection.<br><br>● The theory of natural selections states that organisms with the heritable traits that best fit their environment (give them the greatest chance of survival and reproduction) will survive and reproduce, thus creating more organisms with those traits.<br><br>● An organism's environment directly affects its survival. If an environment changes, then the fitness levels of certain organisms may change, thus altering the "successful" traits within that ecosystem.<br><br>● Macroevolution explains how all of the different species on Earth came to be. Microevolution explains how traits can become more frequent within one population. |

| **Student Learning Objectives** | |
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| *What students should be able to do after instruction.* | *Evidence Statements* |
| 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. | HS-LS4-2 |
| Calculate the survival rate of different genetic variations within a species. | HS-LS4-3<br>HS-LS3-3 |
| Construct an explanation based on evidence for how natural selection leads to adaptation of populations. | HS-LS4-4 |
| Make an argument either supporting or refuting one of the theories of evolution using empirical evidence. | HS-LS4-1 |

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| Calculate the survival rate of different genetic variations within a species after an environmental change (possibly due to human impact) has occurred. | HS-LS4-5<br>HS-LS4-6<br>HS-LS3-3 |
| Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. | HS-LS2-8 |

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
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| **Analyzing and Interpreting Data**<br>Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.<br>● 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. (HSLS4-3)<br>**Using Mathematics and Computational Thinking**<br>Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.<br>● Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)<br>**Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. | **LS4.A: Evidence of Common Ancestry and Diversity**<br>Genetic information 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. (HS-LS4- 1)<br>**LS4.B: Natural Selection**<br>● 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. (HS-LS4-2), (HS-LS4-3)<br>● The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HSLS4-3)<br>**LS4.C: Adaptation**<br>● 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. (HS-LS4-2)<br>● Natural selection leads to adaptation, that is, to a population anatomically, behaviorally, and physiologically | **Patterns**<br>● 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. (HSLS4-1), (HS-LS4-3)<br>**Cause and Effect**<br>● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HSLS4-2), (HS-LS4-4), (HS-LS4-5), (HS-LS4-6)<br>***Connections to Nature of Science***<br>**Scientific Knowledge Assumes an Order and Consistency in Natural Systems**<br>● Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1), (HS-LS4-4) ***Connections to Nature of Science***<br>**Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**<br>● 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. (HS-LS4-1) |

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| • 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 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. (HS-LS4-2), (HS-LS4- 4)<br><br>**Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.<br><br>• Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)<br><br>**Obtaining, Evaluating, and Communicating Information**<br><br>Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.<br><br>• 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). (HS-LS4-1) | well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3), (HS-LS4-4)<br>• Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)<br>• 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. (HSLS4-5), (HS-LS4-6)<br>• 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. (HS-LS4-5)<br><br>**LS4.D: Biodiversity and Humans**<br><br>• 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. (HS-LS4-6) *(Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.)*<br><br>**ETS1.B: Developing Possible Solutions**<br><br>• 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. (secondary to HS-LS4-6)<br>• 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 | |

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| | client about how a given design will meet his or her needs. *(secondary to HS-LS4-6)* | |

| **Three-Dimensional Teaching and Learning** |
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| Evolution is the most unifying theme in biology - it involves the concepts of genetics and inheritance, biodiversity, cell biology, etc. This unit will also draw from other areas including ELA (making arguments and written explanations) and math (calculating frequencies using algebraic equations). |

| **Prior Learning** |
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| Students should have a basic knowledge about Earth's biodiversity - there are millions of different species on this planet. This unit will expand on that idea, exploring the origins of all of those species and the theories that attempt to explain those origins. Students will also have to draw from the material covered in Unit 4, in which the topics of genetics and inheritance were discussed. Since evolution involves the passing of beneficial traits, an understanding of genetics is necessary to comprehend the mechanisms of microevolution. |

| **Part A: Natural Selection** | |
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| **Concepts** | **Formative Assessment** |
| What is evolution?<br><br>There have been several proposed explanations for evolution, the most widely accepted being Charles Darwin's theory of evolution by natural selection.<br><br>What are the five factors that must be true for evolution to occur?<br><br>Species change over time due to smaller changes in populations over time.<br><br>Beneficial traits are due to genes - the frequency of these genes increases as the survival and reproduction of individuals with these traits increases.<br><br>What is Hardy-Weinberg equilibrium? | *Students who understand the concepts are able to:*<br><br>Make an argument for Darwin's theory of evolution over other theories.<br><br>Explain the four main principles of natural selection.<br><br>Predict the future evolution of a species depending on the genetic characteristics of the species and the environmental conditions.<br><br>Perform calculations of allele and genotype frequencies. |

| **Part B: Patterns of evolution.** | |
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| **Concepts** | **Formative Assessment** |
| What are the patterns of evolution?<br>What are the different types of extinction?<br>Compare evolution of sexual and asexual reproducers. | *Students who understand the concepts are able to:*<br>Describe the patterns of evolution in detail.<br>Explain the difference between a gradual extinction and a mass extinction.<br>Describe the pros and cons of sexual and asexual reproduction from an evolutionary standpoint. |

| **Part C: Evidence of evolution** | |
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| **Concepts** | **Formative Assessment** |
| The theory of evolution is supported by several categories of evidence:<br>Comparing the anatomy of different species, including homologous and vestigial structures<br>Comparing the embryos of different species<br>Comparing the DNA or amino acid sequences from different speciesSpecies change over time due to smaller changes in populations over time.<br>• Beneficial traits are due to genes - the frequency of these genes increases as the survival and reproduction of individuals with these traits increases. | *Students who understand the concepts are able to:*<br>Make an argument for the theory of evolution supported by multiple sources of empirical evidence.<br>Calculate the frequency of alleles within a population and calculate the change in those alleles as environmental conditions change the survival and reproduction rates of certain traits.<br>Describe relationships between organisms based on evidence gathered in various fields of study within biological evolution. |

| **Part D:Phylogeny** | |
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| **Concepts** | **Formative Assessment** |
| What are phylogenetic trees?<br>What are the levels of classification recognized by modern taxonomists? | *Students who understand the concepts are able to:*<br>List the levels of classification and relate them to the phylogenetic tree.<br>Interpret a phylogenetic tree in order to make statements about relationships between organisms.<br>Explain what binomial nomenclature is and who came up with it. |

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| Embedded English Language Arts/Literacy and Mathematics |
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| ***English Language Arts/Literacy***<br><br>RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HSLS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4)<br><br>RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS4-5)<br><br>WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HSLS4-4)<br><br>WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS4-6)<br><br>WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS4-6)<br><br>WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HS-LS4-5)<br><br>SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (HS-LS4-1), (HS-LS4-2)<br><br>**Mathematics**<br><br>MP.2 Reason abstractly and quantitatively. (HS-LS4-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HSLS4-5)<br><br>MP.4 Model with mathematics. (HS-LS4-2) |

| Samples of Open Education Resources for this unit: |
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| ● Argument-Driven Inquiry in Biology (published by NSTA Press) - Provides sample lessons for various biology topics<br>● "Evolution Activities" - http://necsi.edu/projects/evolution/activities/intro./activities_intro.html<br>● "NOVA Evolution" - http://www.pbs.org/wgbh/nova/education/resources/subj_06_03.html#life_29<br>● Cosmos: A Spacetime Odyssey: Episode 2 - "Some Things That Molecules Do" (can be accessed via Netflix) |

- "Peppered Moth Evolution" - http://peppermoths.weebly.com/
- Microevolution Activitiy - http://www.colorado.edu/outreach/BSI/pdfs/microevolution.pdf

| Differentiation | | |
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| **504** | • preferential seating<br>• extended time on tests and assignments<br>• reduced homework or classwork<br>• verbal, visual, or technology aids | • modified textbooks or audio-video materials<br>• behavior management support<br>• adjusted class schedules or grading<br>• verbal testing |
| **Enrichment** | • Utilize collaborative media tools<br>• Provide differentiated feedback<br>• Opportunities for reflection | • Encourage student voice and input<br>• Model close reading<br>• Distinguish long term and short term goals |
| **IEP** | • Utilize "skeleton notes" where some required information is already filled in for the student<br>• Provide access to a variety of tools for responses<br>• Provide opportunities to build familiarity and to practice with multiple media tools<br>• Graphic organizers | • Leveled text and activities that adapt as students build skills<br>• Provide multiple means of action and expression<br>• Consider learning styles and interests<br>• Provide differentiated mentors |

| Differentiation |
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|---|---|---|
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| **ELLs** | ● Pre-teach new vocabulary and meaning of symbols<br>● Embed glossaries or definitions<br>● Provide translations<br>● Connect new vocabulary to background knowledge | ● Provide flash cards<br>● Incorporate as many learning senses as possible<br>● Portray structure, relationships, and associations through concept webs<br>● Graphic organizers |
| **At-risk** | ● Purposeful seating<br>● Counselor involvement<br>● Parent involvement | ● Contracts<br>● Alternate assessments<br>● Hands-on learning |

| 21st Century Skills | |
|---|---|
| ● Creativity<br>● Innovation<br>● Critical Thinking | ● Problem Solving<br>● Communication<br>● Collaboration |
| **Integrating Technology** | |
| ● Chromebooks<br>● Internet research<br>● Online programs | ● Virtual collaboration and projects<br>● Presentations using presentation hardware and software |

## Unit 6: Interactions, Energy and Dynamics

| Overarching Essential Questions | Overarching Enduring Understandings |
|---|---|
| ● Why is an ecosystem studied and what are the interrelated components of an ecosystem and how do we study an ecosystem?<br>● How is the ecosystem provided with the energy and matter that it needs and how do we track the movement of energy and matter through the ecosystem?<br>● How do organisms within an ecosystem interact with each other and how does the availability of resources affect these interactions.<br>● How do we measure populations in an ecosystem and what factors affect population ?<br>● How have human beings impacted the different ecosystems and what can we do to combat our own negative impact on these ecosystems? | ● There are biotic and abiotic factors in an ecosystem. Both of these factors contribute to the stability of the ecosystem. The ecosystem can be studied directly and indirectly.<br>● Producers (organisms that photosynthesize) provide the majority of the energy for the ecosystem whereas matter cycles in and out of an ecosystem. Both are important to the stability of an ecosystem and are illustrated with food chains and webs, cycles and pyramid models.<br>● Each organism has a habitat and a niche and both of these are impacted by available resources.<br>● Population size is measured using population density and dispersion and is impacted by resource availability, immigration, births, emigration and death.<br>● Human beings have impacted both biotic and abiotic factors of the ecosystem. Effective management of resources may help preserve them for the future. Studying or being aware of our impact on the ecosystems will help us maintain the different ecosystems for the future |
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| Student Learning Objectives | |
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| *What students should be able to do after instruction.* | *Evidence Statements* |

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| Given ecosystems compare and contrast the biotic and abiotic factors in order to understand how they are interrelated and how this interrelatedness impacts the ecosystem. | HS-LS2-1 |
| Organize an ecosystem to show the flow of energy through the ecosystem from producers through all consumers showing the decreasing biomass and energy as we move up through the pyramid. | HS-LS2-3<br>HS-LS2-4 |
| Manipulate an ecosystem by removing either a producer, or any level of consumer. Describe the organisms that are more or less successful after this manipulation and the overall effects on the ecosystem. | HS-LS2-2<br>HS-LS2-6 |
| Use sampling techniques to measure the size of populations in an environment and the health of the environment based on the diversity of the ecosystem. | HS-LS2-6 |
| Given an ecosystem, discuss one of the impacts of human beings on that ecosystem and discuss accommodations that humans could make that would lessen their impact. | HS-LS2-7<br>HS-LS 2-8 |

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|
| **Developing and Using Models**<br><br>Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show how relationships among variables between systems and their components in the natural and designed worlds.<br><br>• Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)<br><br>**Using Mathematics and Computational Thinking**<br><br>Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to | **LS2.A: Interdependent Relationships in Ecosystems**<br><br>• 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. (HS-LS2-1), (HS-LS2-2)<br><br>• **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3) | **Cause and Effect**<br><br>• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)<br><br>**Scale, Proportion, and Quantity**<br><br>• The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)<br>• Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)<br><br>**Systems and System Models** |

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| analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.<br>● Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)<br>● Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)<br>● Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4) | ● 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 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. (HS-LS2-4)<br>● 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. (HS-LS2-5)<br>**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**<br>● A complex set of interactions within an ecosystem can keep its 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. (HS-LS2-2), (HS-LS2-6)<br>● Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)<br>● 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. (HS-LS2-2), (HS-LS2-3) 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. (HS-LS2-6), (HS-LS2-8)<br>**LS2.D: Social Interactions and Group Behavior**<br>● Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8) | ● 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. (HS-LS2-5)<br>**Energy and Matter**<br>● Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4)<br>● Energy drives the cycling of matter within and between systems. (HS-LS2-3)<br>**Stability and Change**<br>● Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7)<br>*Connections to Nature of Science*<br>**Scientific Knowledge is Open to Revision in Light of New Evidence**<br>● Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2), (HS-LS2-3)<br>● 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. (HS-LS2-6), (HS-LS2-8) |

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| | **LS4.D: Biodiversity and Humans**<br>● Humans depend on the living world for the resources and other benefits provided by biodiversity.<br>● 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 7)landscapes of recreational or inspirational value. (secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HSLS4-6.)<br>**PS3.D: Energy in Chemical Processes**<br>● The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5)<br>**ETS1.B: Developing Possible Solutions**<br>● 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. (secondary to HS-LS2-7) | |

| **Three-Dimensional Teaching and Learning** |
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| The unit builds upon the previous units topics ( photosynthesis and respiration). It shows the movement of energy through an ecosystem and how this movement maintains the ecosystem. This unit asks us to incorporate the processes going on a cellular level to the level of an ecosystem and how these processes actually control the ecosystem.<br>The DCI's, SEP's and CC's allow us to manipulate an ecosystem and hypothesize the results of the manipulation on the ecosystem. We are also able to historically look at the results of our manipulations over time. |

| **Prior Learning** |
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| • Products, reactants and processes of photosynthesis and respiration. |

- Characteristics of living things.
- The characteristics of the different biomes making up the earth.

| • **Part A: Introduction to Ecology** | |
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| **Concepts** | **Formative Assessment** |
| Demonstrate the complexity and interrelatedness of the components of an ecosystem both biotic and abiotic.<br><br>What are the levels of organization recognized by ecology?<br><br>What are the levels of classification recognized by taxonomy? | *Students will be able to*<br>Construct an energy pyramid showing the producers and different levels of consumers.<br><br>Compare and contrast the components of an ecosystem in order to identify and explain the interrelatedness of all the components from organism to biome.<br><br>Interpret a cladogram in order to make statements about relationships between organisms.<br><br>Classify organisms when given a dichotomous key.<br><br>Measure the diversity of Audubon lake and present the different characteristics (water temperature, clarity, pH) of the lake and surrounding areas in a lab report. Measure the different populations found in an ecosystem? |

| **Part B: Geochemical Cycles** |
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| Concepts | Formative Assessment |
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| What is a geochemical cycle?<br>How does diversity measure the health of the ecosystem and how do we measure this health and demonstrate the interrelatedness of the members of an ecosystem? | *Students who understand the concepts are able to:*<br>Move chemicals like through the ecosystem to show the importance of these chemicals to both biotic and abiotic members of the ecosystem.<br>List where living things play a role in each geochemical cycle. |

| **Part C: Population Growth Patterns** | |
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| **Concepts** | **Formative Assessment** |
| What are the different types of population growth?<br>What are the factors that limit population growth?<br>What is a stable ecosystem?<br>What is a survivorship curve?<br>How have human beings impacted various ecosystems and what steps are we taking presently or can we take to make this a positive impact? | *Students who understand the concepts are able to:*<br>Measure the different populations found in an ecosystem and classify population growth as logistic or exponential using data and or graph.<br>Classify limiting factors as density-dependent, density-independent, biotic,or abiotic.<br>Explain the difference between immigration and emigration.<br>Infer how a population's growth would be affected by a change in availability of any limiting factors. |

| **Part D: Human Impact** | |
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| **Concepts** | **Formative Assessment** |
| What influence do humans have on the geochemical cycles? | *Students who understand the concepts are able to:* |

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| What are resources?<br>What is technology? | Look again at the geochemical cycles and see the influence of humans both positive and negative.<br>Explain the difference between renewable and nonrenewable resources giving examples of each.<br>Describe three types of technology humans use and the pros and cons of each.<br>Interpret a graph that displays information about how humans have influenced the environment.<br>Identify a human created pollutant and describe efforts being made to decrease this pollutant in an ecosystem. |

| **Part E: Ecological Succession** | |
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| **Concepts** | **Formative Assessment** |
| What is the process of ecological succession?<br>How do humans impact the process of ecological succession?<br>What are the roles of the pioneer species and the climax community in ecological succession? | *Students who understand the concepts are able to:*<br>Interpret using a diagram if the succession is primary or secondary.<br>Explain the positive and negative roles humans play in succession. |

| **Part F:Relationships** | |
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| **Concepts** | **Formative Assessment** |

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| How do relationships generate stability in an ecosystem?<br>What are the different ecological relationships? | *Students who understand the concepts are able to:*<br>*Classify a relationship as predation, competition, or symbiosis based on a description or pictures.*<br>*Classify and organism as predator, prey, host, or parasite based on a description or pictures.*<br>Classify symbiotic relationships given descriptions or pictures. |

| **Embedded English Language Arts/Literacy and Mathematics** |
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| ***English Language Arts/Literacy***<br>*RST.9-10.8.*Accurately cite strong and thorough textual evidence, (e.g.,via discussion, written response, etc.) and make relevant connections,<br>to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.<br><br>RST.11-12.7 Analyze various perspectives as presented in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account.<br><br>RI.11-12.2. Determine two or more central ideas of a text, and analyze their development and how they interact to provide a complex analysis; provide an objective summary of the text.<br>*RST.11-12.8* Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.( HS-LS2-6), ( HS-LS2-7), ( HS-LS2-8)<br>*WHST.9-12.2* Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.( HS-LS2-1), ( HS-LS2-2), ( HS-LS2-3)<br>*WHST.9-12.5* Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant. (HS-LS2-2) |

***Mathematics –***

MP.2 Reason abstractly and quantitatively. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-6),(HS-LS2-7)

MP.4 Model with mathematics. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4)

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. ( HS-LS2-1),( HS-LS2-2),( HS-LS2-4),( HS-LS2-6)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-7)

HSS-ID.A.1 Represent data with plots on the real number line. (HS-LS2-6)

HSS-IC.B.6 Evaluate reports based on data. (HS-LS2-6)

| **Samples of Open Education Resources for this unit:** |
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| Holt McDougal ld Videos |
| Online Text |
| Google Classroom |
| Bozeman Videos |

| Differentiation | | |
|---|---|---|
| **504** | ● preferential seating<br>● extended time on tests and assignments<br>● reduced homework or classwork<br>● verbal, visual, or technology aids | ● modified textbooks or audio-video materials<br>● behavior management support<br>● adjusted class schedules or grading<br>● verbal testing |
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