



7th Grade Science

Grade(s):	☐ K ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 6 ☒ 7 ☐ 8	☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ Other _____
Discipline/Course:	Discipline: Science		
Course Title:	Grade 7 Science		
Prerequisite(s):	n/a		
Course Description: <i>Program of Studies</i>	<p>In Grade 7 Science, students explore how matter and energy interact in chemical reactions, living organisms, and ecosystems. They investigate how cells and body systems obtain and use energy, how plants transform sunlight into chemical energy, and how matter cycles through Earth's living and nonliving systems. Students also examine how organisms interact within ecosystems and evaluate the impact of human activities on Earth's resources and the environment. Each unit builds on previous learning, allowing students to connect ideas across physical science, life science, Earth science, and engineering. At the end of the year and in conjunction with the Earth's Resources and Human Impact unit, students explore a local Fairfield ecosystem, the Ash Creek Estuary, to develop an understanding of biodiversity and the interdependence of organisms and their environment. Through investigations and a field study at the estuary, students determine how human activities, including climate change, can impact ecosystem health and the organisms that live there.</p> <p>Throughout the year, students investigate compelling real-world phenomena and use evidence to develop explanations for how and why things happen. Students engage in the work of scientists and engineers by</p>		

	asking questions, planning and carrying out investigations, collecting and analyzing data, reading informational texts, developing and revising models, constructing explanations, engaging in evidence-based argumentation, and designing solutions to problems.	
Course Essential Questions:	<ul style="list-style-type: none"> • How can we make something new that was not there before? • How can we use chemical reactions to design a solution to a problem? • How do things inside our bodies work together to help us survive? • Where does food come from and where does it go next? • How does changing an ecosystem affect what lives there? • How do changes in Earth's systems impact our communities and what can we do about it? 	
Course Enduring Understandings:	<ul style="list-style-type: none"> • Matter is always conserved but continuously transformed through chemical reactions and biological processes. • Energy drives changes in physical, chemical, and biological systems and can be transferred or transformed but not created or destroyed. • Organisms depend on systems of cells and biochemical processes that transform matter and energy. • Ecosystems are dynamic systems in which organisms are dependent upon each other and their environment. • Human activities contribute to changes in Earth's systems over time which, in turn, impact human society. • Biodiversity describes the variety of species in an ecosystem. Biodiverse ecosystems are more resilient, particularly when there is a disruption. • Science and engineering are processes of figuring things out, using evidence, models, investigations, and argumentation to explain phenomena and solve problems. 	
Duration:	☐ Semester	☐ 0.5 Credit (s)

Credit:	☒ Full-Year	☐ 1.0 Credit(s) ☐ 1.5 Credit(s) ☒ N/A
Course Materials/Resources:	<i>OpenSciEd 7.1 Chemical Reactions & Matter</i> <i>OpenSciEd 7.2 Chemical Reactions & Energy</i> <i>OpenSciEd 7.3 Metabolic Reactions</i> <i>OpenSciEd 7.4 Matter Cycling & Photosynthesis</i> <i>OpenSciEd 7.5 Ecosystem Dynamics</i> <i>OpenSciEd 7.6 Earth's Resources & Human Impact</i> <i>Core Knowledge Science Student Readers : Metabolic Reactions and Earth's Resources and Human Impact</i> <i>Inspire Science Course 2 Integrated Middle School Text (McGraw Hill)</i> <u>River Lab Estuary Website</u> <u>Long Island Sound Curricular Guide</u>	
FPS Course Academic Expectation(s):	☒ Exploring and Understanding (EU) ☒ Synthesizing and Evaluating (SE) ☐ Creating and Constructing (CC) ☐ Conveying Ideas (CI) ☐ Collaborating Strategically (CS) ☐ Using Communication Tools (UCT)	
Year at a Glance (Units):	Unit 1 - Chemical Reactions & Matter (~24 classes/6 weeks) Unit 2 - Chemical Reactions & Energy (~24 classes/6 weeks) Unit 3 - Metabolic Reactions (~28 classes/7 weeks) Unit 4 - Matter Cycling & Photosynthesis (~24 classes/6 weeks) Unit 5 - Ecosystem Dynamics (~20 classes/5 weeks) Unit 6 - Earth's Resources & Human Impact (~24 classes/6 weeks)	

Unit Number and Title:	Unit 1 - Chemical Reactions & Matter
Duration:	~ 24 days/6 weeks
Resource(s):	<i>OpenSciEd 7.1 Chemical Reactions & Matter</i> <i>Inspire Science Course 2</i> Integrated Middle School Text (McGraw Hill)
Unit Overview:	<p>In this unit, students develop conceptual understandings of chemical reactions which are essential for learning physical, life, and space science. The unit is anchored by the observation of a store-bought bath bomb added to water. Students observe that the bath bomb immediately begins to bubble (forming a gas), break apart, change the color of the water, and produce a distinct odor. These observations lead to investigations into whether the gas was already trapped inside the solid or if it is a "new" substance created during the process. To explain the phenomenon, students learn about the interactions of atoms and molecules that are far too small to see. They learn about historical models of the atom developed by Dalton and other scientists, and how atoms combine to form molecules and extended structures.</p> <p>Throughout the unit, students conduct investigations to study the chemical and physical properties of substances and to determine if substances have undergone a physical change or a chemical reaction. By the end of the unit, students have a firm grasp on how to model simple molecules, know what to look for to determine if chemical reactions have occurred, and can apply their knowledge to chemical reactions to show how mass is conserved when atoms are rearranged.</p>
Learning Goals	
Standard(s):	<p><i>Next Generation Science Standards:</i></p> <p>Disciplinary Core Ideas (DCIs) PS1.A: Structure and Properties of Matter</p> <ul style="list-style-type: none"> • Substances are made from different types of atoms, which combine with one another in various ways. • Atoms form molecules that range in size from two to thousands of atoms.

- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

PS1.B: Chemical Reactions

- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.
- The total number of each type of atom is conserved, and thus the mass does not change.

LS1.D: Information Processing

- Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.

Science and Engineering Practices (SEPs)

Constructing Explanations and Designing Solutions

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.
- Construct an explanation using models or representations
- Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.

Analyzing and Interpreting Data

- Analyze and interpret data to provide evidence for phenomena.
- Analyze and interpret data to determine similarities and differences in findings.

Engaging in Argument from Evidence

- Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts.
- Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.

	<ul style="list-style-type: none"> Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. <p>Developing and Using Models</p> <ul style="list-style-type: none"> Develop and/or use a model to predict and/or describe phenomena. Develop a model to describe unobservable mechanisms. <p>Planning and Carrying Out Investigations</p> <ul style="list-style-type: none"> Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. <p>Crosscutting Concepts (CCCs)</p> <p>Scale, Proportion, and Quantity</p> <ul style="list-style-type: none"> Proportional relationships (e.g., density) provide information about the properties of substances. Scientific relationships can be represented through the use of algebraic expressions and equations. <p>Patterns</p> <ul style="list-style-type: none"> Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs, charts, and images can be used to identify patterns in data <p>Energy and Matter</p> <ul style="list-style-type: none"> Matter is conserved because atoms are conserved in physical and chemical processes. <p><i>Common Core State Standards for Mathematics</i> CCSS.MATH.CONTENT.7.RP.A.2.A Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.</p>
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	<p>CCSS.MATH.CONTENT.7.RP.A.2.B Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.</p> <p><i>Common Core State Standards for English Language Arts</i></p> <p>CCSS.ELA-LITERACY.W.7.1.A-E Write arguments to support claims with clear reasons and relevant evidence.</p> <p>CCSS.ELA-LITERACY.W.7.2.C Use appropriate transitions to create cohesion and clarify the relationships among ideas and concepts.</p> <p>CCSS.ELA-LITERACY.W.7.2.D Use precise language and domain-specific vocabulary to inform about or explain the topic.</p> <p>CCSS.ELA-LITERACY.SL.7.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.</p> <p>CCSS.ELA-LITERACY.SL.7.1.C Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.</p>
Essential Question(s):	How can we make something new that was not there before?
Enduring Understanding(s):	<ul style="list-style-type: none"> • Substances are made from different types of atoms, which combine with one another in various ways. • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. • In a chemical reaction, the total number of each type of atom is conserved. • Sensory receptors respond to different inputs and transmit them as signals that travel along nerve cells to the brain.
Learning Goal(s): *Note all NGSS learning	<p>Three-Dimensional Performance Expectations:</p> <p>MS PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.</p>

**goals are 3-dimensional
integrating a DCI, a SEP,
and a CCC**

- Plan and carry out investigations to determine if a chemical reaction has occurred.
- Analyze data to determine the characteristic properties (density, melting point, boiling point, solubility, flammability) of substances and use these properties to determine the products of a chemical reaction.
- Use mathematical and computational thinking by graphing mass vs. volume data for different substances and finding the ratio of mass to volume for the samples measured to determine the density of different substances.
- Conduct investigations to gather data on the properties of a substance before and after energy is added to the substance and to argue from evidence for whether a chemical reaction has occurred.
- Construct and present a written and oral argument for whether a chemical reaction has occurred supported by citing empirical evidence and scientific reasoning.

MS PS1-1: Develop and use models to describe the atomic composition of simple molecules and extended structures.

- Gather and communicate information from a scientific text to explain the central ideas of atomic theory with regard to the particulate structure of matter that makes up all substances.

MS-PS1-5: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

- Construct an explanation to describe why the total number of atoms does not change in a chemical reaction and thus mass is conserved.
- Construct an explanation to describe possible products in a chemical reaction from a set of known reactants by considering that the type of atoms in the chemical reactions should not change.

MS-LS1-8: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain.

- Read scientific texts adapted for classroom use to determine how the molecular structure of different substances is related to their interaction with different sensory receptors and how they cause a different signal to travel through our nerve cells that leads to the perception of different substances.

Content: (Students will know...)

- a chemical reaction occurs when substances interact and are transformed into new substances

- with different properties.
- in a chemical reaction, the starting substances are reactants and the new substances formed are products.
 - all matter is made of atoms.
 - different types of atoms (elements) have different properties.
 - atoms can combine to form molecules and compounds.
 - models of atoms and molecules are useful for explaining the particulate nature of matter.
 - during a chemical reaction, atoms are rearranged.
 - the total amount of matter is always conserved during a chemical reaction.
 - physical changes due not result in new substances.
 - changes in temperature, gas production, color, or formation of a new substance can be evidence that a chemical reaction has occurred.
 - substances can be identified by their characteristic properties.
 - density
 - melting point
 - boiling point
 - solubility
 - flammability
 - color
 - odor

Skills: (Students will be able to...)

- design and conduct their own investigations to identify unknown substances.
- measure, graph, and calculate density to compare different substances.
- conduct investigations to identify evidence that a chemical reaction has occurred.
- use models to represent atoms and molecules and explain how atoms are rearranged during chemical reactions.
- investigate how changing conditions can affect whether or how a chemical reaction occurs.
- use diagrams, models, data, writing, and discussion to communicate explanations of chemical reactions.

Unit Number and Title:	Unit 2 - Chemical Reactions & Energy
Duration:	~ 24 days/6 weeks
Resource(s):	<i>OpenSciEd 7.2 Chemical Reactions & Energy</i> <i>Inspire Science Course 2</i> Integrated Middle School Text (McGraw Hill)
Unit Overview:	In this unit, students are introduced to the anchoring phenomenon—a flameless heater in a Ready-to-Eat meal (MRE) that provides hot food to people by just adding water. Students explore the inside of an MRE flameless heater, then conduct investigations to collect evidence to support the idea that this heater and another type of flameless heater are undergoing chemical reactions as they get warm. During the unit, students learn to use chemical formulas and equations to model the conservation of matter chemical reactions. Students' investigations help them to develop understandings of the role of energy in chemical reactions and they learn to distinguish between exothermic and endothermic reactions. At the end of the unit, students have an opportunity to engage in the engineering design process, defining stakeholders, and refining the criteria and constraints for the design of a homemade heater that harnesses the energy of a chemical reaction. Students engage in an iterative design cycle that includes peer feedback, consideration of design modification consequences, and analysis of impacts on stakeholders. Finally, students optimize their designs and have another team test their homemade heater instructions.
Learning Goals	
Standard(s):	<i>Next Generation Science Standards:</i> Disciplinary Core Ideas (DCIs) PS1.B: Chemical Reactions <ul style="list-style-type: none"> Some chemical reactions release energy, while others store energy. ETS1.B: Developing Possible Solutions <ul style="list-style-type: none"> Models of all kinds are important for testing solutions. A solution needs to be tested and then modified on the basis of the test results in order to improve it.

	<ul style="list-style-type: none"> • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. <p>ETS1.C: Optimizing the Design Solution</p> <ul style="list-style-type: none"> • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. <p>Science and Engineering Practices (SEPs)</p> <p>Asking Questions and Defining Problems</p> <ul style="list-style-type: none"> • Define a design problem that can be solved through the development of a system that includes multiple criteria and constraints. <p>Planning and Carrying Out Investigations</p> <ul style="list-style-type: none"> • Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meets the goals of the investigation. • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. <p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> • Analyze data to define an optimal operational range for a proposed object, tool, or system that best meets criteria for success. <p>Constructing Explanations and Designing Solutions</p> <ul style="list-style-type: none"> • Apply scientific ideas or principals to design, construct, and/or test a design of an object, tool or process or system. • Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. • Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising and re-testing. <p>Developing and Using Models</p>
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	<ul style="list-style-type: none"> • Develop or modify a model based on evidence to match what happens if a variable or component of a system is changed. • Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. • Develop a model to describe unobservable mechanisms. <p>Engaging in Argument from Evidence</p> <ul style="list-style-type: none"> • Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing to questions that elicit pertinent elaboration and detail. • Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints. • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. <p>Obtaining, Evaluating, and Communicating Scientific Information</p> <ul style="list-style-type: none"> • Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or about the natural and designed world(s). • Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations. <p>Crosscutting Concepts (CCCs)</p> <p>System and System Models</p> <ul style="list-style-type: none"> • Systems may interact with other systems; they may have sub-systems and be part of a larger complex system. • Models can be used to represent systems and their interactions- such as inputs, processes and outputs- and energy, matter, and information flows within systems. <p>Matter and Energy</p> <ul style="list-style-type: none"> • Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. • The transfer of energy can be tracked as energy flows through a designed or natural system.
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Common Core State Standards for Mathematics

CCSS.MATH.CONTENT.6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.

CCSS.MATH.CONTENT.6.RP.A.3.C Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.

CCSS.MATH.CONTENT.6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double-number line diagrams, or equations.

CCSS.MATH.CONTENT.6.RP.A.3.A Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.

CCSS.MATH.CONTENT.6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

CCSS.MATH.CONTENT.6.RP.A.3.D Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

CCSS.MATH.CONTENT.7.G.B.6 Solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

Common Core State Standards for English Language Arts

	<p>CCSS.ELA-LITERACY.SL.7.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.</p> <p>CCSS.ELA-LITERACY.SL.7.1.C: Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.</p> <p>CCSS.ELA-LITERACY.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).</p> <p>CCSS.ELA-LITERACY.RST.6-8.10 By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.</p> <p>CCSS.ELA-LITERACY.SL.7.1.A Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.</p> <p>CCSS.ELA-LITERACY.SL.7.1.B Follow rules for collegial discussions, track progress toward specific goals and deadlines, and define individual roles as needed.</p> <p>CCSS.ELA-LITERACY.SL.7.1.D Acknowledge new information expressed by others and, when warranted, modify their own views.</p>
Essential Question(s):	How can we use chemical reactions to design a solution to a problem?
Enduring Understanding(s):	<ul style="list-style-type: none"> • Chemical reactions involve transfers of energy. • Energy released or absorbed during reactions can be harnessed to solve engineering problems. • Engineers optimize designs by balancing performance, safety, cost, and constraints.
Learning Goal(s): <i>Students will know and will be able to use their learning to:</i>	<p>Three-Dimensional Performance Expectations:</p> <p>MS-PS1-6: Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.</p>

<p>(Content/ Skills)</p> <p>*Note all NGSS learning goals are 3-dimensional integrating a DCI, a SEP, and a CCC</p>	<ul style="list-style-type: none"> Analyze data to determine patterns in the amount of energy that is transferred in the chemical reaction under different conditions. Define the design problem that can be solved through the development of a solution with multiple criteria and constraints and that uses a chemical process to release energy. Conduct an investigation to serve as the basis for evidence to confirm that the devices are undergoing a chemical reaction when the temperature increases as energy is transferred from the substances in the devices to its surroundings (what the thermometer measures). <p>MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.</p> <ul style="list-style-type: none"> Evaluate and use accurate methods of data collection to define an optimal proportion of reactants that result in the greatest temperature change and least amount of reactants left over. Provide and receive critiques about design solutions to evaluate competing designs with respect to how they meet criteria and constraints and consider patterns across multiple designs to determine which design characteristics caused more effective outcomes. Evaluate competing design solutions based on jointly developed and agreed-upon design criteria using systematic processes to consider how small changes in one design characteristic might cause changes in other design characteristics. <p>MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.</p> <ul style="list-style-type: none"> Conduct investigations to test the extent to which different chemical reactions transfer energy to the surroundings. Analyze data to determine an optimal proportion of reactants that result in the greatest temperature change and least amount of reactants left over. Prioritize criteria and consider trade-offs that occur as a result of design changes to decide which changes to incorporate for an optimal design. <p>MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process so that an optimal design can be achieved.</p>
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	<ul style="list-style-type: none"> Develop models of chemical reaction systems to describe and/or explain flow of energy to or from the systems and their surroundings. <p>Content: (Students will know...)</p> <ul style="list-style-type: none"> chemical formulas represent substances made of particular atoms. chemical equations are used to represent chemical reactions. energy transfer in chemical reactions. <ul style="list-style-type: none"> exothermic reactions endothermic reactions how matter and energy are conserved in chemical reactions. examples of exothermic and endothermic reactions. energy is not created or destroyed during a chemical reaction, but it can be transferred or transformed. <p>Skills: (Students will be able to...)</p> <ul style="list-style-type: none"> carry out investigations of chemical reactions, collect temperature data, and use observations as evidence that a chemical reaction has occurred. use and revise models to represent how energy is transferred between and around systems during a chemical reaction. construct, test, and modify a device that releases or absorbs thermal energy through chemical processes. collect and analyze data to compare design solutions. evaluate competing designs to reach a consensus on optimal design.
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Unit Number and Title:	Unit 3 - Metabolic Reactions
Duration:	~28 days/7 weeks
Resource(s):	<i>OpenSciEd 7.3 Metabolic Reactions</i> <i>Core Knowledge Science Student Reader: Metabolic Reactions</i>

Unit Overview:	<p>This unit on metabolic reactions in the human body starts out with students exploring a real case study of a middle-school student who reported some alarming symptoms to her doctor. Students investigate data specific to the patient’s case to learn about how it is affecting the patient’s body. During the unit, students engage in investigations to learn that organisms survive and grow by carrying out chemical reactions that rearrange matter and transfer energy. They also learn that the atoms in food are conserved as they are rearranged into new molecules, while the chemical energy associated with those molecules is transferred and transformed as cells carry out life processes. To explain what is happening to the patient, students explore how the human body obtains and uses the matter and energy it needs to live, grow, and function. Students investigate and learn how the body breaks down food into smaller molecules and how cells use these molecules through chemical reactions. Students develop models and use evidence to understand that the atoms in food are not lost but are rearranged into new substances, while energy is transferred and transformed during these reactions. Through investigations and discussions, students connect the process of cellular respiration to the functioning of the whole organism and develop a deeper understanding of how chemical reactions help living things survive and grow.</p>
Learning Goals	
Standard(s):	<p><i>Next Generation Science Standards:</i></p> <p>Disciplinary Core Ideas (DCIs)</p> <p>LS1.A: Structure and Function</p> <ul style="list-style-type: none"> • In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. <p>LS1.B: Growth and Development of Organisms</p> <ul style="list-style-type: none"> • The growth of an animal is controlled by genetic factors, food intake, and interactions with other organisms, and each species has a typical adult size range. <p>LS1.C: Organization for Matter and Energy Flow in Organisms</p> <ul style="list-style-type: none"> • Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy.

PS3.D: Energy in Processes and Everyday Life

- Cellular respiration in plants and animals involves chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.

Science and Engineering Practices (SEPs)
Developing and Using Models

- Evaluate limitations of a model for a proposed object or tool.
- Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.
- Develop and/or use a model to predict and/or describe phenomena.
- Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.

Analyzing and Interpreting Data

- Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.

Engaging in Argument from Evidence

- Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.
- Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

Crosscutting Concepts (CCCs)
Systems and System Models

- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.
- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

- Models are limited in that they only represent certain aspects of the system under study.

Structure and Function

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.

Common Core State Standards for Mathematics

CCSS.MATH.CONTENT.6.NS.C.8 Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane.

CCSS.MATH.CONTENT.6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship.

CCSS.MATH.CONTENT.7.SP.C.6 Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability.

CCSS.MATH.CONTENT.7.SP.C.8.C Design and use a simulation to generate frequencies for compound events.

CCSS.MATH.CONTENT.6.SP.B.5.C Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.

Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.SL.6-8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6-8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

CCSS.ELA-LITERACY.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-LITERACY.RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

	<p>CCSS.ELA-LITERACY.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.</p> <p>CCSS.ELA-LITERACY.WHST.6-8.1.B Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.</p> <p>CCSS.ELA-LITERACY.W.6.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Essential Question(s):	How do things inside our bodies work together to help us survive?
Enduring Understanding(s):	<ul style="list-style-type: none"> • Body systems work together to obtain, transport, and use nutrients and oxygen. • Food provides matter and energy for cellular processes. • Disruptions to one body system can affect the functioning of many other systems.
<p>Learning Goal(s): <i>Students will know and will be able to use their learning to:</i> (Content/ Skills)</p> <p>*Note all NGSS learning goals are three-dimensional integrating a DCI, a SEP, and a CCC</p>	<p>Three-Dimensional Performance Expectations</p> <p>MS-LS1-3: Use an argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.</p> <ul style="list-style-type: none"> • Analyze and interpret data in order to determine how the organs of the digestive system work together to help the body break down large food molecules. • Using images and data, compare the structures of specific organs in a healthy human and a symptomatic human being to determine how structural differences impact organ function. • Conduct investigations using a microscope to compare and contrast different types of cells and tissues in the human body. • Construct a model of the structure and function of the digestive, respiratory, and circulatory systems. • Ask questions to figure out how problems within one organ system can impact other organ systems, which then affects the human body's ability to produce energy the body needs for growth and function. <p>MS-LS1-5: Construct a scientific explanation based on evidence for how environmental factors</p>

influence the growth of organisms.

- Analyze data to determine the impact of environmental factors on the growth of an organism.

MS-LS1-7: Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

- Plan and conduct an investigation to determine how a chemical reaction in the mouth converts complex carbohydrates (starch) into simpler sugars.
- Explain how food molecules are broken down by a chemical reaction using water in the digestive system that can be absorbed and used by the body.
- Construct an explanation using data and reasoning to explain that a chemical reaction combining glucose and oxygen occurs inside the cells of the human body to release energy, carbon dioxide, and water (cellular respiration).
- Explain that, during digestion, proteins are broken down into amino acids which can then be reused by the body to build body structures.
- Conduct investigations to gather evidence that energy is released when fats are broken down by a chemical reaction into fatty acids.

MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures.

- Compare molecular structures of different biological molecules (carbohydrates, proteins, and fats/lipids) to determine that while molecules may differ from each other in terms of their size and complexity, all molecules are made up of atoms and may have certain atoms in common.
- Explain how proteins, carbohydrates, and fats are built from repeating subunits of amino acids, simple sugars, and fatty acids, respectively.

MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

- Students will plan and carry out an investigation to determine that a chemical reaction happens when a substance is burned because the properties of the substance have changed.

Content: (Students will know...)

- living organisms carry out many chemical reactions that transform matter and energy; these reactions collectively make up metabolism.
- in multicellular organisms, similar specialized cells work together to form tissues, different tissues work together to form organs, and organs work together in organ systems to carry out larger functions of an organism.
- all cells need usable energy to carry out functions such as growth, movement, repair, and maintenance.
- during cellular respiration cells use oxygen to break down glucose to make energy available for cellular activities.
- food contains molecules that provide the matter and chemical energy organisms need to grow, repair, and function.
 - carbohydrates
 - proteins
 - lipids/fats
- large food molecules can be broken down into smaller molecules through chemical reactions.
- the organs of the digestive system work together to chemically break down and absorb food molecules.
- the blood and blood vessels of the circulatory system transport nutrients to cells.
- the bones and muscles of the musculoskeletal system interact to allow movement.
- human body systems, including the musculoskeletal, integumentary, circulatory, and nervous systems, interact to support body functioning.

Skills: (Students will be able to...)

- design and conduct investigations to gather evidence that chemical reactions break down complex molecules into simple molecules, and that the properties of substances change after a chemical reaction.
- use and revise models to represent interactions between organ systems, with a focus on showing the movement of food through the organs of the digestive system and the rearrangement of food molecules in a chemical reaction combining glucose and oxygen to release energy, carbon dioxide, and water.

	<ul style="list-style-type: none"> analyze how organs and body systems function as interacting subsystems, particularly the digestive, circulatory, muscular, respiratory, and excretory systems. use data and scientific reasoning to explain why the mass of a substance burned within a closed system remains constant and how burning food in the presence of oxygen releases energy, carbon dioxide, and water.
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Unit Number and Title:	Unit 4 - Matter Cycling and Photosynthesis
Duration:	~24 days/6 weeks
Resource(s):	<i>OpenSciEd 7.4 Matter Cycling & Photosynthesis</i> <i>Inspire Science Course 2 Integrated Middle School Text (McGraw Hill)</i>
Unit Overview:	<p>This unit is grounded in the exploration of where the food we eat comes from. Students learn how matter moves and changes within ecosystems and how the materials that make up living things are continually recycled. They investigate where organisms get the matter they need to grow and how matter moves between living and nonliving parts of an ecosystem through processes such as photosynthesis, cellular respiration, decomposition, and other chemical reactions. Using models, data, and evidence, students trace elements such as carbon through ecosystems and develop an understanding that matter is not created or destroyed but is continually rearranged and transferred from one form to another. By connecting processes occurring at the cellular, organism, and ecosystem levels, students develop a deeper understanding of how living and nonliving components of Earth's systems are interconnected through the cycling of matter in food chains and food webs. Students figure out that they can trace all food back to plants. By the end of the unit, they understand that all the energy in food originates from the energy of the Sun that is captured during photosynthesis and all the matter in food is constantly recycled between living and nonliving parts of the Earth's systems.</p>

Standard(s):	<p><i>Next Generation Science Standards:</i></p> <p>Disciplinary Core Ideas (DCIs)</p> <p>LS1.C: Organization for Matter and Energy Flow in Organisms</p> <ul style="list-style-type: none"> Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. <p>LS2.B: Cycle of Matter and Energy Transfer in Ecosystems</p> <ul style="list-style-type: none"> Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. <p>PS1.A: Structure and Properties of Matter</p> <ul style="list-style-type: none"> Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. <p>PS1.B: Chemical Reactions</p> <ul style="list-style-type: none"> Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. <p>PS3.D: Energy in Chemical Processes and Everyday Life</p> <ul style="list-style-type: none"> The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. <p>Science & Engineering Practices (SEPs)</p>
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	<p>Developing and Using Models</p> <ul style="list-style-type: none"> • Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. • Develop and/or use a model to predict and/or describe phenomena. <p>Constructing Explanations and Design Solutions</p> <ul style="list-style-type: none"> • Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation of real-world phenomena, examples or events. • Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion. <p>Engaging in Argument from Evidence</p> <ul style="list-style-type: none"> • Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. • Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. • Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or solution to a problem. <p>Obtaining, Evaluating, and Communication Information</p> <ul style="list-style-type: none"> • Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s). • Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings. • Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. • Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations. <p>Crosscutting Concepts (CCCs)</p>
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Systems and System Models

- Systems may interact with other systems; they may have sub-systems and be part of larger complex systems.
- Models can be used to represent systems and their interactions - such as inputs, processes and outputs - and energy, matter, and information flows within systems.

Energy and Matter

- Matter is conserved because atoms are conserved in physical and chemical processes.
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.
- Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).
- The transfer of energy can be tracked as energy flows through a designed or natural system.

Common Core State Standards for Mathematics

CCSS.MATH.CONTENT.6.SP.B.5 Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.

Common Core State Standards for English Language Arts

CCSS.ELA-LITERACY.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-LITERACY.RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

CCSS.ELA-LITERACY.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

CCSS.ELA-LITERACY.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

CCSS.ELA-Literacy.SL.6.1.c: Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.

CCSS.ELA-LITERACY.WHST.6-8.1 Write arguments focused on discipline-specific content.

	CCSS.ELA-LITERACY.WHST.6-8.2.A Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
Essential Question(s):	Where does food come from and where does it go next?
Enduring Understanding(s):	<ul style="list-style-type: none"> ● Plants transform matter from air and water into food using energy from sunlight. ● Matter cycles between living organisms and the environment. ● Photosynthesis and cellular respiration transfer both matter and energy through ecosystems.
Learning Goal(s): <i>Students will know and will be able to use their learning to:</i> (Content/ Skills) *Note all NGSS learning goals are three-dimensional integrating a DCI, a SEP, and a CCC	Three-Dimensional Performance Expectations MS-LS1-6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. <ul style="list-style-type: none"> ● Plan and carry out an investigation to determine what plants need to survive and where plants get food molecules. ● Analyze and interpret data to determine that plants are taking in carbon dioxide and releasing water and oxygen during photosynthesis. ● Develop and use a model to describe the function of chloroplasts in plant cells. ● Plan and carry out an investigation to gather evidence that reducing the inputs of photosynthesis (water, carbon dioxide, light) or the number of chloroplasts decreases the production of sugar and oxygen by a plant. ● Engage in argument to support the claim that plants use sunlight for energy to convert carbon dioxide and water into glucose. ● Understand that glucose is a form of energy that can be used by cells. MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

- Communicate information about the relationship between energy and the cycling of carbon dioxide and oxygen in and out of plants.
- Obtain and evaluate information from scientific texts to understand that plants store sugar for later use in the form of starches. These stored food molecules can be used for energy via cellular respiration or for growth.
- Communicate information about the role of decomposers and how matter and energy is transferred between producers, consumers and decomposers.
- Revise a model based on peer feedback to describe how matter cycles through a system of humans, animals, plants and decomposers as they use food for energy.

MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

- Obtain information from text and video to understand how synthetic materials are designed and constructed.

Content: (Students will know...)

- plants convert light energy into chemical energy stored in glucose.
- the inputs and outputs of photosynthesis.
- the atoms in glucose produced by plants during photosynthesis come from carbon dioxide and water.
- plants store excess glucose in the form of larger carbohydrate molecules such as starch and cellulose.
- the interdependence of photosynthesis and cellular respiration.
- eukaryotic cell structures - mitochondria and chloroplasts.
- carbon is continually recycled and reused as it moves between the living and nonliving parts of the ecosystem.
- energy enters ecosystems through sunlight and then flows through living systems in food chains and food webs.

	<ul style="list-style-type: none"> food webs are used to model the flow of matter and energy in an ecosystem through producers, consumers, and decomposers . <p>Skills: (Students will be able to...)</p> <ul style="list-style-type: none"> design and conduct their own investigations to produce data as evidence to determine inputs and outputs of a chemical reaction in plants. interpret graphs and data to provide evidence that plants take in carbon dioxide and release oxygen during photosynthesis. apply scientific reasoning to explain that the carbon in food molecules comes from carbon dioxide in the air. use food webs to demonstrate how matter and energy is transferred between producers, consumers, and decomposers.
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Unit Number and Title:	Unit 5 - Ecosystems Dynamics
Duration:	~ 20 days/5 weeks
Resource(s):	<i>OpenSciEd 7.5 Ecosystems Dynamics</i> <i>Inspire Science Course 2</i> Integrated Middle School Text (McGraw Hill)
Unit Overview:	<p>This unit on ecosystem dynamics and biodiversity begins with students reading headlines that claim that the future of orangutans is in peril and that the purchasing of chocolate may be the cause. Students then examine the ingredients in popular chocolate candies and learn that one of these ingredients--palm oil--is grown on farms near the rainforest where orangutans live. Through investigation of this phenomenon, students learn how ecosystems are shaped by the interactions and interdependence among organisms and their environments. They learn how populations can increase or decrease over time as a result of resource availability. They investigate how competition, predation, and symbiotic interactions affect and shape populations and that changes to one population in an ecosystem can impact many other populations in the ecosystem. Throughout the unit, they also learn that human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the</p>

	extinction of other species. Understanding that human activities can have positive and negative effects on natural ecosystems, students then explore improved designs for oil palm farms, which will support both orangutans and farmers.
Learning Goals	
Standard(s):	<p><i>Next Generation Science Standards:</i></p> <p>Disciplinary Core Ideas (DCIs)</p> <p>LS2.A: Interdependent Relationships in Ecosystems</p> <ul style="list-style-type: none"> • Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with non-living factors. • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. • Growth of organisms and population increases are limited by access to resources. • Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and non-living, are shared. <p>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</p> <ul style="list-style-type: none"> • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. • Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. <p>LS4.D: Biodiversity and Humans</p> <ul style="list-style-type: none"> • Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. <p>ESS3.C: Human Impacts on Earth Systems</p>

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.

ETS1.A: Defining and Delimiting Engineering Problems

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.

Science & Engineering Practices (SEPs)

Asking Questions and Defining Problems

- Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
- Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.
- Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.
- Define a design problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

Developing and Using Models

- Evaluate limitations of a model for a proposed object or tool.
- Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.
- Develop and/or use a model to predict and/or describe phenomena.

Planning and Carrying Out Investigations

- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

Mathematics and Computation Thinking

- Use mathematical representations to describe and/or support scientific conclusions and design solutions.

- Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.

Crosscutting Concepts (CCCs)

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

System and System Models

- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.
- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.
- Models are limited in that they only represent certain aspects of the system under study.

Stability and Change

- Small changes in one part of a system might cause large changes in another part.
- Stability might be disturbed either by sudden events or gradual changes that accumulate over time.
- Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.

Common Core State Standards for Mathematics

CCSS.MATH.CONTENT.6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

CCSS.MATH.CONTENT.6.RP.A.3: Use ratio and rate reasoning to solve real-world and mathematical problems, for example, by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

CCSS.Math.Content.7.SP.A.1: Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population.

CCSS.Math.Content.6.SP.A.2: Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

	<p>CCSS.Math.Content.6.SP.B.4: Display numerical data in plots on a number line, including dot plots, histograms, and box plots.</p> <p>CCSS.Math.Content.6.SP.B.5.c: Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.</p> <p><i>Common Core State Standards for English Language Arts</i></p> <p>CCSS.ELA-Literacy.RI.7.2: Determine two or more central ideas in a text and analyze their development over the course of the text; provide an objective summary of the text.</p> <p>CCSS.ELA-Literacy.RST.6-8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.</p> <p>CCSS.ELA-Literacy.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).</p> <p>CCSS.ELA-Literacy.RST.6-8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.</p> <p>CCSS.ELA-Literacy.RST.6-8.10: By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.</p> <p>CCSS.ELA-Literacy.SL.6.1.c: Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.</p> <p>CCSS.ELA-Literacy.SL.7.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.</p> <p>CCSS.ELA-LITERACY.SL.7.1: Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.</p> <p>CCSS.ELA-Literacy.SL.7.3: Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.</p>
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	<p>CCSS.ELA-Literacy.SL.7.4: Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.</p> <p>CCSS.ELA-LITERACY.W.7.1: Write arguments to support claims with clear reasons and relevant evidence.</p> <p>CCSS.ELA-LITERACY.W.7.2.: Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.</p> <p>CCSS.ELA-LITERACY.W.7.2.A.: Introduce a topic; organize ideas, concepts, and information, using strategies, such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.</p> <p>CCSS.ELA-LITERACY.W.7.2.B.: Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples.</p> <p>CCSS.ELA-LITERACY.W.7.2.D.: Use precise language and domain-specific vocabulary to inform about or explain the topic.</p> <p>CCSS.ELA-Literacy.WHST.6-8.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p>
Essential Question(s):	How does changing an ecosystem affect what lives there?
Enduring Understanding(s):	<ul style="list-style-type: none"> • Resource availability impacts populations. • Interactions within and among populations such as competition, predation, and mutualism affect the health and stability of populations. • Ecosystems are dynamic and change over time. • Biodiversity describes the variety of species in an ecosystem. Biodiverse ecosystems are more resilient, particularly when there is a disruption.
Learning Goal(s): <i>Students will know and will be able to use their learning to:</i> (Content/ Skills)	Three-Dimensional Performance Expectations: MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

***Note all NGSS learning goals are three-dimensional integrating a DCI, a SEP, and a CCC**

- Use a computer simulation or model to collect data on what happens when organisms and populations compete for resources under different environmental conditions.
- Construct histograms and line graphs of data collected from an investigation to analyze how populations fluctuate over time based on resource availability.
- Gather information from text, images, and data tables to support claims that a change in one population could affect another population when there is a mutually beneficial relationship.

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem that affects populations.

- Analyze measures of central tendency and range in histograms to make claims about how populations respond to different environmental conditions and the ways in which environmental conditions impact the population.
- Develop an ecosystem model to explain interactions between and changes within predator and prey populations over time.
- Develop and use a model to make predictions and test ideas about how disruptions, or changes, to one part of the system affect populations throughout the system.

MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

- Identify a pattern of design problems for systems that provide food resources that humans need but which also transform the land and the biosphere once occupied by native plants and animals.
- Critically read scientific texts to obtain information about how different ways to grow food can have a positive impact on populations in ecosystems.

MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

- Evaluate competing design solutions and construct an argument to recommend a design solution that will best address the needs of a population in an ecosystem with the competing needs of humans.

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

- Ask questions to develop a model to explain how human activities have altered the biosphere and changed habitats locally and around the world.
- Critically read text to develop ideas about how to support human interaction with ecosystems while also promoting stability in natural systems.

MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

- Define a new criterion for a solution to preserve biodiversity but that also recognizes competing human demands.
- Define a problem that will maintain biodiversity as well as support humans depending on the ecosystem.

Content: (Students will know...)

- organisms depend on resources such as food, water, oxygen, and habitat for survival.
- population size is affected by the availability of resources.
- different types of ecological interactions.
 - competition
 - predation
 - mutualism
- changes in resource availability can result in population fluctuations, and affect long-term stability.
- biodiversity is the variety of species in an ecosystem.
- biodiversity can provide benefits to humans, such as food, medicines, and ecosystem services like water purification
- ecosystems are always changing, but biodiversity helps to support ecosystem resilience.
- human activities, particularly land-use changes and agriculture, can alter habitats and

	<p>populations.</p> <p>Skills: (Students will be able to...)</p> <ul style="list-style-type: none"> • interpret histograms and line graphs to compare and identify patterns and trends to examine the relationship between resource availability and population size. • use evidence to explain changes in population size, biodiversity, and ecosystem dynamics. • construct models of agricultural and natural ecosystems to predict how specific disruptions will impact the system as a whole. • apply engineering principles to optimize land-use systems that attempt to balance population protection with human financial viability. • optimize a design by prioritizing criteria, making trade-offs, and conducting iterative testing.
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Unit Number and Title:	Unit 6 - Natural Resources & Human Impact
Duration:	~ 24 days/6 weeks
Resource(s):	<i>OpenSciEd 7.6 Natural Resources & Human Impact</i> <i>Core Knowledge Science Student Reader: Earth's Resources and Human Impact</i>
Unit Overview:	<p>This unit on Earth's resources and human impact begins with students observing news stories and headlines of drought and flood events across the United States. Students learn that these drought and flood events are not normal and that both kinds of events seem to be related to rising global temperatures. During the unit, students gather evidence for how changes in temperature can affect evaporation, precipitation, and other parts of Earth's water system. They learn that rising global temperatures are caused by an imbalance in Earth's carbon system, resulting in a variety of problems in different communities. Students explore how humans depend on Earth's natural resources and how human activities can affect the availability and quality of those resources and the environment. They investigate how resources such as water, soil, minerals, energy, and other materials are obtained and used, and they examine the environmental impacts associated with their use. Using data, models, and evidence, students consider how human activities can change Earth systems and explore ways that</p>

	<p>individuals and communities can make decisions that balance human needs with the long-term health and sustainability of the environment. Through these investigations, students develop an understanding of the interconnectedness of human societies and Earth’s systems and the importance of considering both environmental impacts and trade-offs when addressing resource-use challenges.</p> <p>This unit includes a case study and field trip to Ash Creek Estuary where students will evaluate the health of the ecosystem and the effects of human impact, including climate change. This culminates with students evaluating different kinds of solutions to these problems and how they are implemented in communities.</p>
Learning Goals	
Standard(s):	<p><i>Next Generation Science Standards:</i></p> <p>Disciplinary Core Ideas (DCIs)</p> <p>ESS3.A: Natural Resources</p> <ul style="list-style-type: none"> • Humans depend on Earth’s land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. <p>ESS3.C: Human Impacts on Earth Systems</p> <ul style="list-style-type: none"> • Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things. • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth, unless the activities and technologies involved are engineered otherwise. <p>ESS3.D: Global Climate Change</p> <ul style="list-style-type: none"> • Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur

	<p>depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding human behavior and applying that knowledge wisely in decisions and activities.</p> <p>ETS1.B: Developing Possible Solutions</p> <ul style="list-style-type: none"> • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. <p>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</p> <ul style="list-style-type: none"> • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. • Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. <p>Science & Engineering Practices (SEPs)</p> <p>Asking Questions and Defining Problems</p> <ul style="list-style-type: none"> • Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. • Ask questions to identify and/or clarify evidence and/or the premise(s) of an argument. • Ask questions that require sufficient and appropriate empirical evidence to answer. • Ask questions that challenge the premise(s) of an argument or the interpretation of a data set. <p>Using Mathematics and Computational Thinking</p> <ul style="list-style-type: none"> • Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends. • Use mathematical representations to describe and/or support scientific conclusions and design solutions. • Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems. <p>Obtaining, Evaluating, and Communicating Information</p> <ul style="list-style-type: none"> • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) 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.
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	<ul style="list-style-type: none"> • Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system. <p>Constructing Explanations and Designing Solutions</p> <ul style="list-style-type: none"> • Construct an explanation that includes qualitative and quantitative relationships between variables that predict(s) and/or describe(s) phenomena. • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) 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. <p>The following practices are also key to the sensemaking in the unit:</p> <ul style="list-style-type: none"> • Developing and Using Models • Analyzing and Interpreting Data • Planning and Carrying Out Investigations • Engaging in Argument from Evidence <p>Crosscutting Concepts (CCCs)</p> <p>Cause and Effect</p> <ul style="list-style-type: none"> • Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. • Cause and effect relationships may be used to predict phenomena in natural or designed systems. <p>Scale, Proportion, and Quantity</p> <ul style="list-style-type: none"> • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. • The observed function of natural and designed systems may change with scale. • Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.
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Stability and Change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.
- Small changes in one part of a system might cause large changes in another part.
- Systems in dynamic equilibrium are stable due to a balance of feedback mechanisms.

The following practices are also key to the sensemaking in the unit:

- Patterns
- Systems and System Models
- Energy and Matter

Common Core State Standards for Mathematics

CCSS.MATH.CONTENT.7.EE.B.4: Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.

CCSS.MATH.CONTENT.6.EE.C.9. Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation.

CCSS.Math.Content.6.RP.A.2: Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship.

CCSS.Math.Content.6.RP.A.3: Use ratio and rate reasoning to solve real-world and mathematical problems.

CCSS.Math.Content.6.RP.A.3.c: Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means $30/100$ times the quantity); solve problems involving finding the whole, given a part and the percent.

	<p>CCSS.MATH.CONTENT.6.SP.B.4: Display numerical data in plots on a number line, including dot plots, histograms, and box plots.</p> <p>CCSS.MATH.CONTENT.6.SP.B.5: Summarize numerical data sets in relation to their context, such as by:</p> <p>CCSS.MATH.CONTENT.6.SP.B.5.B: Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.</p> <p>CCSS.MATH.CONTENT.6.SP.B.5.C: Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.</p> <p>CCSS.MATH.CONTENT.6.SP.B.5.D: Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.</p> <p>CCSS.Math.Content.7.RP.A.2: Recognize and represent proportional relationships between quantities.</p> <p>CCSS.MATH.CONTENT.6.EE.C.9. Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation.</p> <p><i>Common Core State Standards for English Language Arts</i></p> <p>CCSS.ELA-Literacy.SL.6.1.c: Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion</p> <p>CCSS.ELA-LITERACY.RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.</p> <p>CCSS.ELA-Literacy.RST.6-8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.</p>
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	<p>CCSS.ELA-Literacy.RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).</p> <p>CCSS.ELA-LITERACY. RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS2-1)</p> <p>CCSS.ELA-Literacy.RST.6-8.10: By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.</p> <p>CCSS.ELA-LITERACY.SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.</p> <p>CCSS.ELA-LITERACY.W.7.1: Write arguments to support claims with clear reasons and relevant evidence.</p> <p>CCSS.ELA-LITERACY.W.7.1.A: Introduce claim(s), acknowledge alternate or opposing claims, and organize the reasons and evidence logically.</p> <p>CCSS.ELA-LITERACY.W.7.1.B: Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.</p> <p>CCSS.ELA-LITERACY.W.7.1.C: Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), reasons, and evidence.</p>
Essential Question(s):	How do changes in Earth's system impact our communities and what can we do about it?
Enduring Understanding(s):	<ul style="list-style-type: none"> • Long-term climate variables (temperature and precipitation) are changing in communities. • Human activities have contributed to changes in Earth's carbon cycle which has affected Earth's mean surface temperature (global warming) and Earth's water cycle. • Communities can develop solutions designed to account for stakeholders' needs while also correcting carbon imbalances and adapting to current changes experienced in the community. • Biodiversity is used as a measure of an ecosystem's health. Human actions impact biodiversity which, in turn, affects the resources humans rely on.
Learning Goal(s):	Three-Dimensional Performance Expectations:

Students will know and will be able to use their learning to:
 (Content/ Skills)

***Note all NGSS learning goals are three-dimensional integrating a DCI, a SEP, and a CCC**

MS-ESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

- Develop and use a model to describe the components, interactions, and processes of water distribution and movement on Earth.
- Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal patterns in temperature, total precipitation, and seasonal precipitation in both the local community and at case sites; use this same data to identify patterns in rates of change and numerical relationships to determine similarities and differences between drought and flood sites.

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

- Apply mathematical concepts of percent to understand the proportion and quantity of and stability and/or change in the concentration of greenhouse gases in the atmosphere over time.
- Apply mathematical concepts to calculate an average carbon impact and possible carbon reduction solutions and scale those reductions to see what would happen if more people were to change their behaviors.
- Critically read scientific texts to obtain information on how communities can mitigate the flow of carbon into and out of the atmosphere and/or adapt to changes in the community.
- Apply scientific principles to design a process/system to reduce the vulnerability to climate change impacts (e.g., high heat, changing water resources) in the short-term and contribute to rebalancing carbon in the long-term.
- Construct an argument grounded in evidence and scientific reasoning to recommend a design solution that will prepare a community for predicted changes to temperature and/or precipitation.

MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

- Analyze and interpret data on graphs of historical carbon dioxide levels collected from ice cores to collect evidence of whether the changes in these levels are cyclical in nature and a normal occurrence or are changing at a non-normal rate.
- Integrate qualitative and quantitative scientific information in written text to analyze trends of atmospheric CO₂ levels, energy consumption, and human population over time to determine a correlation between human activities and CO₂ emissions.
- Apply mathematical concepts to compare the rate of combustion and cellular respiration releasing CO₂ into the atmosphere to the rate for photosynthesis removing CO₂ out of the atmosphere and leading to an imbalance in the system.
- Develop a model of Earth's carbon cycle to describe how fossil fuel use causes changes to the climate.
- Develop and use a model to describe how greenhouse gas molecules respond to energy transfer from Earth to the atmosphere and cause atmospheric temperatures to rise.
- Analyze data to provide evidence that increased temperatures cause an increase in evaporation leading to more water vapor entering the atmosphere.
- Integrate scientific information with data to explain how a small change in temperature can affect components of Earth's water system.
- Analyze data to identify changes in the environment that are caused by increasing temperatures.

MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

- Test ideas about different emissions rate scenarios to determine how to reach carbon dioxide equilibrium in the atmosphere.

- Evaluate competing solutions using a systematic process and develop agreed-upon criteria to determine how small changes in behaviors and technologies can add up to larger impacts on reducing CO₂ in the atmosphere.

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

- Students will analyze and interpret data about the interaction between a population and an abiotic factor to make a claim about how the abiotic factor affects population size.
- Students conduct investigations to gather data about the important abiotic components of estuaries (water quality, etc.).
- Students gather information about important abiotic factors that impact estuaries (dissolved oxygen, etc.).

MS-LS2-4: Construct an argument supported by empirical evidence to support the assertion that changes to physical or biological components of an ecosystem affect populations.

- Students will collect and analyze biotic factor data to make a claim about the biodiversity in the ecosystem.
- Students analyze and interpret data to make an evidence-based claim about the overall health of the Ash Creek Estuary.

Content: (Students will know...)

- Earth's global climate system is being affected by rising temperatures.
- changes in global temperature can affect evaporation, precipitation, and water availability.
- changing precipitation patterns can contribute to droughts and floods.
- Earth's carbon system and natural greenhouse effect.
- greenhouse gases (GHGs) - carbon dioxide (CO₂), methane, and water vapor.
- mechanisms of atmospheric warming.
- human population growth and consumption of resources affect Earth's systems.
- how fossil fuels are formed and the impact of their use.

Skills: (Students will be able to...)

- apply mathematical concepts of percentages and averages to make sense of climate data.
- integrate scientific information with quantitative and qualitative data to explain changes in global climate.
- define the problem of climate impact and use systematic processes to evaluate solutions based on criteria and constraints.
- carry out investigations at Ash Creek Estuary in order to collect data on estuary health.
- gather evidence of human impact to evaluate the overall health of the Ash Creek Estuary leading.