CURRICULUM

FOR

SCIENCE

GRADE 8

This curriculum is part of the Educational Program of Studies of the Rahway Public Schools.

ACKNOWLEDGMENTS

Dr. Susan Dube, Program Supervisor of Science and Technology Education

The Board acknowledges the following who contributed to the preparation of this curriculum.

Jennifer Villao

Dr. Tiffany A. Beer, Director of Curriculum and Instruction

Subject/Course Title:
Science
Grade 8

Date of Board Adoption:
September 21, 2021

RAHWAY PUBLIC SCHOOLS CURRICULUM

Science: Grade 8

PACING GUIDE

Unit	Title	Pacing
1	Structure and Function	5 weeks
2	Body Systems	5 weeks
3	Evidence of a Common Ancestry	4 weeks
4	Inheritance and Variation of Traits	4 weeks
5	Selection and Adaptation	4 weeks
6	Interaction of Matter	4 weeks
7	Structure and Properties of Matter	5 weeks
8	Chemical Reactions	5 weeks
9	Earth Systems	4 weeks

ACCOMMODATIONS

504 Accommodations:	**IEP Accommodations:**
● Provide scaffolded vocabulary and vocabulary lists. ● Provide extra visual and verbal cues and prompts. ● Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials. ● Provide links to audio files and utilize video clips. ● Provide graphic organizers and/or checklists. ● Provide modified rubrics. ● Provide a copy of teaching notes, especially any key terms, in advance. ● Allow additional time to complete assignments and/or assessments. ● Provide shorter writing assignments. ● Provide sentence starters. ● Utilize small group instruction. ● Utilize Think-Pair-Share structure. ● Check for understanding frequently. ● Have student restate information. ● Support auditory presentations with visuals. ● Weekly home-school communication tools (notebook, daily log, phone calls or email messages). ● Provide study sheets and teacher outlines prior to assessments. ● Quiet corner or room to calm down and relax when anxious. ● Reduction of distractions. ● Permit answers to be dictated. ● Hands-on activities. ● Use of manipulatives. ● Assign preferential seating. ● No penalty for spelling errors or sloppy handwriting. ● Follow a routine/schedule. ● Provide student with rest breaks. ● Use verbal and visual cues regarding directions and staying on task. ● Assist in maintaining agenda book.	● Provide scaffolded vocabulary and vocabulary lists. ● Differentiate reading levels of texts (e.g., Newsela). ● Provide adapted/alternate/excerpted versions of the text and/or modified supplementary materials. ● Provide extra visual and verbal cues and prompts. ● Provide links to audio files and utilize video clips. ● Provide graphic organizers and/or checklists. ● Provide modified rubrics. ● Provide a copy of teaching notes, especially any key terms, in advance. ● Provide students with additional information to supplement notes. ● Modify questioning techniques and provide a reduced number of questions or items on tests. ● Allow additional time to complete assignments and/or assessments. ● Provide shorter writing assignments. ● Provide sentence starters. ● Utilize small group instruction. ● Utilize Think-Pair-Share structure. ● Check for understanding frequently. ● Have student restate information. ● Support auditory presentations with visuals. ● Provide study sheets and teacher outlines prior to assessments. ● Use of manipulatives. ● Have students work with partners or in groups for reading, presentations, assignments, and analyses. ● Assign appropriate roles in collaborative work. ● Assign preferential seating. ● Follow a routine/schedule.
Gifted and Talented Accommodations:	**ELL Accommodations:**
● Differentiate reading levels of texts (e.g., Newsela). ● Offer students additional texts with higher lexile levels. ● Provide more challenging and/or more supplemental readings and/or activities to deepen understanding. ● Allow for independent reading, research, and projects. ● Accelerate or compact the curriculum. ● Offer higher-level thinking questions for deeper analysis. ● Offer more rigorous materials/tasks/prompts. ● Increase number and complexity of sources.	● Provide extended time. ● Assign preferential seating. ● Assign peer buddy who the student can work with. ● Check for understanding frequently. ● Provide language feedback often (such as grammar errors, tenses, subject-verb agreements, etc…). ● Have student repeat directions. ● Make vocabulary words available during classwork and exams. ● Use study guides/checklists to organize information. ● Repeat directions. ● Increase one-on-one conferencing.

● Assign group research and presentations to teach the class. ● Assign/allow for leadership roles during collaborative work and in other learning activities.	● Allow student to listen to an audio version of the text. ● Give directions in small, distinct steps. ● Allow copying from paper/book. ● Give student a copy of the class notes. ● Provide written and oral instructions. ● Differentiate reading levels of texts (e.g., Newsela). ● Shorten assignments. ● Read directions aloud to student. ● Give oral clues or prompts. ● Record or type assignments. ● Adapt worksheets/packets. ● Create alternate assignments. ● Have student enter written assignments in criterion, where they can use the planning maps to help get them started and receive feedback after it is submitted. ● Allow student to resubmit assignments. ● Use small group instruction. ● Simplify language. ● Provide scaffolded vocabulary and vocabulary lists. ● Demonstrate concepts possibly through the use of visuals. ● Use manipulatives. ● Emphasize critical information by highlighting it for the student. ● Use graphic organizers. ● Pre-teach or pre-view vocabulary. ● Provide student with a list of prompts or sentence starters that they can use when completing a written assignment. ● Provide audio versions of the textbooks. ● Highlight textbooks/study guides. ● Use supplementary materials. ● Give assistance in note taking ● Use adapted/modified textbooks. ● Allow use of computer/word processor. ● Allow student to answer orally, give extended time (time-and-a-half). ● Allow tests to be given in a separate location (with the ESL teacher). ● Allow additional time to complete assignments and/or assessments. ● Read question to student to clarify. ● Provide a definition or synonym for words on a test that do not impact the validity of the exam. ● Modify the format of assessments. ● Shorten test length or require only selected test items. ● Create alternative assessments. ● On an exam other than a spelling test, don't take points off for spelling errors.

UNIT OVERVIEW

Content Area: Science

Unit Title: Structure and Function

Target Course/Grade Level: Grade 8

Unit Summary: Students demonstrate age appropriate abilities to plan and carry out investigations to develop evidence that living organisms are made of cells. Students gather information to support explanations of the relationship between structure and function in cells. They are able to communicate an understanding of cell theory and understand that all organisms are made of cells. Students understand that special structures are responsible for particular functions in organisms. They then are able to use their understanding of cell theory to develop and use physical and conceptual models of cells. The crosscutting concepts of scale, proportion, and quantity and structure and function provide a framework for understanding the disciplinary core ideas. Students are expected to demonstrate proficiency in planning and carrying out investigations, analyzing and interpreting data, and developing and using models, Students are also expected to use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

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

MS-LS 1-2: Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts

Interdisciplinary Connections and Standards:
Career Readiness, Life Literacies, and Key Skills:

9.4.8.CI.1: Assess data gathered on varying perspectives on causes of climate change (e.g., cross cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions.

9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).

9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option.

9.4.8.GCA.2: Demonstrate openness to diverse ideas and perspectives through active discussions to achieve a group goal.

9.4.8.IML.1: Critically curate multiple resources to assess the credibility of sources when searching for information.

9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.

9.4.8.IML.4: Ask insightful questions to organize different types of data and create meaningful visualizations.

9.4.8.IML.12: Use relevant tools to produce, publish, and deliver information supported with evidence for an authentic audience.

9.4.8.TL.1: Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.

9.4.8.TL.2: Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).

9.4.8.TL.3: Select appropriate tools to organize and present information digitally.

9.4.8.TL.4: Synthesize and publish information about a local or global issue or event.

Mathematics:

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. (MS-LS1-1),(MS-LS1-2)

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

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

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.

RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

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).

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

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

NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.

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

A. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.

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.

C. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.

D. Establish and maintain a formal/academic style, approach, and form.

E. Provide a concluding statement or section that follows from and supports the argument presented.

Unit Understandings:

Students will understand that…

- there is a difference between living and nonliving things
- living things are made out of cells
- living things may be made of one cell or many and varied cells.
- the cell functions as a whole system based on the individual parts of the cell and their functions

Unit Essential Questions:

- How do cells contribute to the functioning of an organism?

Knowledge and Skills:

Students will know...

- Differences between living and nonliving things.
- Cells are the smallest unit of life that can be said to be alive.
- All living things are made up of cells, either one cell or many different numbers and types of cells.
- Organisms may consist of one single cell (unicellular).
- Nonliving things can be composed of cells.
- Organisms may consist of many different numbers and types of cells (multicellular).
- Cells that can be observed at one scale may not be observable at another scale.
- Engineering advances have led to important discoveries in the field of cell biology, and scientific discoveries have led to the development of entire industries and engineered systems.

Students will be able to...

- Identify and describe the phenomenon under investigation, which includes the idea that living things are made up of cells.
- Students identify and describe the purpose of the investigation, which includes providing evidence for the following ideas: that all living things are made of cells (either one cell or many different numbers and types of cells) and that the cell is the smallest unit that can be said to be alive.

- Describe the data that will be collected and the evidence to be derived from the data, including:
    - The presence or absence of cells in living and nonliving things.
    - The presence or absence of any part of a living thing that is not made up of cells.
    - The presence or absence of cells in a variety of organisms, including unicellular and multicellular organisms. iv. Different types of cells within one multicellular organism.
- Describe how the evidence collected will be relevant to the purpose of the investigation.
- Describe how the tools and methods included in the experimental design will provide the evidence necessary to address the purpose of the investigation, including that due to their small-scale size, cells are unable to be seen with the unaided eye and require engineered magnification devices to be seen.
- Describe how the tools used in the investigation are an example of how science depends on engineering advances.
- Collect and record data on the cellular composition of living organisms.
- Develop a model in which they identify the parts (i.e., components; e.g., nucleus, chloroplasts, cell wall, mitochondria, cell membrane, the function of a cell as a whole) of cells relevant for the given phenomenon.
- Using a model, describe the relationships between components, including:
    - The particular functions of parts of cells in terms of their contributions to overall cellular functions (e.g., chloroplasts' involvement in photosynthesis and energy production, mitochondria's involvement in cellular respiration).
    - The structure of the cell membrane or cell wall and its relationship to the function of the organelles and the whole cell.
- Use the model to describe a causal account for the phenomenon, including how different parts of a cell contribute to how the cell functions as a whole, both separately and together with other structures.
- Include how components, separately and together, contribute to:
    - Maintaining a cell's internal processes, for which it needs energy.
    - Maintaining the structure of the cell and controlling what enters and leaves the cell.
    - Functioning together as parts of a system that determines cellular function.
- Use the model to identify key differences between plant and animal cells based on structure and function, including:
    - Plant cells have a cell wall in addition to a cell membrane, whereas animal cells have only a cell membrane. Plants use cell walls to provide structure to the plant.
    - Plant cells contain organelles called chloroplasts, while animal cells do not. Chloroplasts allow plants to make the food they need to live using photosynthesis

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?

End of Unit Assessment: Students will …

- Develop and use models to describe the relationship between the structure and function of the cell wall and cell membrane.
- Conduct an investigation to produce data that provides evidence distinguishing between living and nonliving things.
- Conduct an investigation to produce data supporting the concept that living things may be made of one cell or many and varied cells.

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies

RESOURCES

Teacher Resources included but not limited to:

- Let's Talk Science: Seeding Argumentation About Cells and Growth: This is a sequence of lessons that have been developed to help middle school students learn and argue about the core concept of how a plant root grows at the cellular level. The first part of the sequence begins with a corn seed germination activity and the initial phase of teaching the students argumentation. The second part of the sequence consists of a microscope investigation to provide data upon which students will base their arguments explaining growth at the cellular level. In the third part of the sequence, students use their data to publicly make a claim, and provide evidence and reasoning to support their claims. This sequence unfolds over the course of three weeks.

- Movement of Molecules Into or Out of Cells: Movement of Molecules Into and Out of Cells is one of a series of activities from "Scientific Argumentation in Biology: 30 Classroom Activities. Movement of Molecules engages students in planning and carrying out investigations, modeling, engaging in argument from evidence, and communication. After observing a figure of magnified red blood cells, and a figure of magnified red blood cells with sugar water added, students are presented with a question (Why do the red blood cells appear smaller) and three possible explanations. Based on their chosen explanation and a set of available materials, they design an experiment to test their claim. After engaging in an "Argumentation Session", they write an essay to support their explanation. Teachers are encouraged to refer to the preface, introduction, assessment samples, and appendix provided in the full book for important background on the practice of argumentation and resources for classroom implementation. The standards addressed in the lesson are also included in the teacher's notes.
- MosaMack: Interactions of Body Systems: In Mosa Mack's Interaction of Body Systems unit, students are led through a progression of three inquiry lessons that focus on the functions and interactions of the circulatory, muscular, nervous, digestive and respiratory systems. You'll notice that Mosa Mack focuses on the five most commonly discussed body systems. To teach additional units, have students suggest how other body systems might be impacted in the comic mystery.
- MosaMack: Cells: Students solve two cell mysteries, determine the source of "mystery cells" in a lab setting, and engineer a new cell for a function of choice.
- https://www.youtube.com/opensciedaccount
- www.fossweb.com
- https://www.brainpop.com/search/?keyword=cells

Equipment Needed:

- Foss: Diversity of Life kit - Investigation 3
    - Notebook sheets 11 - 24
    - Database: Elodea Cells, Elodea Cytoplasmic Streaming
    - Levels of Complexity: Plant Cells
    - Virtual Microscope
    - Database: Paramecium Collection
    - Levels of Complexity: Paramecium
    - Database: Microorganism
    - Database: Human Cheek Cells
    - Levels of Complexity: Animal Cell

- Foss: Human Body Systems kit - Investigation 1 part 2
    - Teaching Slides
    - Notebook Sheet 1-3
    - Structural level Cards

UNIT OVERVIEW

Content Area: Science

Unit Title: Body Systems

Target Course/Grade Level: Grade 8

Unit Summary:

Students develop and use models to describe how gene mutations and sexual reproduction contribute to genetic variation. Students understand how genetic factors determine the growth of an individual organism. They also demonstrate understanding of the genetic implications of sexual and asexual reproduction. The crosscutting concepts of cause and effect and structure and function provide a framework for understanding how gene structure determines differences in the functioning of organisms. Students are expected to demonstrate proficiency in developing and using models. Students use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation

Interdisciplinary Connections and Standards:
Career Readiness, Life Literacies, and Key Skills:

9.4.8.CI.1: Assess data gathered on varying perspectives on causes of climate change (e.g., cross cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions.

9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely
to be effective (e.g., MS-ETS1-2).

9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option.

9.4.8.GCA.2: Demonstrate openness to diverse ideas and perspectives through active discussions to achieve a group goal.
9.4.8.IML.1: Critically curate multiple resources to assess the credibility of sources when searching for information.
9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.
9.4.8.IML.4: Ask insightful questions to organize different types of data and create meaningful visualizations.
9.4.8.IML.12: Use relevant tools to produce, publish, and deliver information supported with evidence for an authentic audience.
9.4.8.TL.1: Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.
9.4.8.TL.2: Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
9.4.8.TL.3: Select appropriate tools to organize and present information digitally.
9.4.8.TL.4: Synthesize and publish information about a local or global issue or event.

Mathematics:

- Use mathematics to model why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
- Summarize numerical data sets that describe why asexual reproduction
- results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation in relation to their context

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts.
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.
RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
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).
NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
WHST.6-8.1. Write arguments focused on discipline-specific content.

A. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
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.

C. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
D. Establish and maintain a formal/academic style, approach, and form.
E. Provide a concluding statement or section that follows from and supports the argument presented.

Unit Understandings:

Students will understand that…

- In multicellular organisms, the body is a system of multiple, interacting subsystems.
- Subsystems are groups of cells that work together to form tissues.
- Organs are groups of tissues that work together to perform a particular body function.
- Tissues and organs are specialized for particular body functions.
- Systems may interact with other systems.
- Systems may have subsystems and be part of larger complex systems.
- Interactions are limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.
- Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

Unit Essential Questions:

- Why do kids look similar to their parents?
- How do structural changes to genes (mutations) located on chromosomes affect proteins or affect the structure and function of an organism?

Knowledge and Skills:

Students will know...

- 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
- 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.

Students will be able to...

- Make a claim to be supported, related to a given explanation or model of a phenomenon. In the claim, students include the idea that the body is a system of interacting subsystems composed of groups of cells.
- Identify and describe the given evidence that supports the claim (e.g., evidence from data and scientific literature), including evidence that:
    - Specialized groups of cells work together to form tissues (e.g., evidence from data about the kinds of cells found in different tissues, such as nervous, muscular, and epithelial, and their functions).
    - Specialized tissues comprise each organ, enabling the specific organ functions to be carried out (e.g., the heart contains muscle, connective, and epithelial tissues that allow the heart to receive and pump blood).

    - Different organs can work together as subsystems to form organ systems that carry out complex functions (e.g., the heart and blood vessels work together as the circulatory system to transport blood and materials throughout the body).
    - The body contains organs and organ systems that interact with each other to carry out all necessary functions for survival and growth of the organism (e.g., the digestive, respiratory, and circulatory systems are involved in the breakdown and transport of food and the transport of oxygen throughout the body to cells, where the molecules can be used for energy, growth, and repair).
- Evaluate the evidence and identify the strengths and weaknesses of the evidence, including:
    - Types of sources.
    - Sufficiency, including validity and reliability, of the evidence to make and defend the claim.
    - Any alternative interpretations of the evidence and why the evidence supports the student's claim, as opposed to any other claims.
- Use reasoning to connect the appropriate evidence to the claim. Students describe the following chain of reasoning in their argumentation:
    - Every scale (e.g., cells, tissues, organs, organ systems) of body function is composed of systems of interacting components.
    - Organs are composed of interacting tissues. Each tissue is made up of specialized cells. These interactions at the cellular and tissue levels enable the organs to carry out specific functions.
    - A body is a system of specialized organs that interact with each other and their subsystems to carry out the functions necessary for life.
- Use oral or written arguments to support or refute an explanation or model of a phenomenon.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

End of Unit Assessment: which can be a summative assessment created by the teacher themselves or the use of a summative assessment found in respective kits. These assessments will typically be based on classroom experiences, as well as real world examples to identify the level of student understanding.

- Rubrics designed by the teacher for projects or written responses completed by students to show their understanding.
- Assessment Menus: providing different options for students to show their understanding of concepts by either writing, graphing, illustrating, building models, etc.
- Use an oral and written argument supported by evidence to support or refute an explanation or a model of how the body is a system of interacting subsystems composed of groups of cells.

- Gather, read, and synthesize information from multiple appropriate sources about sensory receptors' response to stimuli.
- Assess the credibility, accuracy, and possible bias of each publication and methods used.
- Describe how publications and methods used are supported or not supported by evidence.

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.

RESOURCES

Teacher Resources include but are not limited to:

- NOVA body + brain: This link will take you to NOVA's homepage for journal articles, videos, and interactives that can be used to teach the body. (https://www.pbs.org/wgbh/nova/topic/body/)
- Animal Communications: All animal species have some capacity for communication but communication abilities range from very simple to extremely complex, depending upon the species. Communication is influenced by a species' genetic makeup, its environment, and the numerous ways by which animals and humans respond to and adapt to their surroundings. (http://sciencenetlinks.com/esheets/animal-communication/)
- Scholastic: The Human Body - This site allows you to show students short animations and provides activities about the human body. https://www.scholastic.com/teachers/activities/teaching-content/human-body-14-studyjams-interactive-science-activities/
- Brainpop: Search Body Systems for videos and activities on different systems and parts that make up those systems.
- "Could You Eat So Much Your Stomach Explodes?" This video shows students how much food an actual stomach can hold and talks about this myth! Could You Eat So Much That Your Stomach Explodes?
- Mosa Mack:
    - Interaction of Body Systems: In Mosa Mack's Interaction of Body Systems unit, students are led through a progression of three inquiry lessons that focus on the functions and interactions of the circulatory, muscular, nervous, digestive and

respiratory systems. *You'll notice that Mosa Mack focuses on the five most commonly discussed body systems. To teach additional units, have students suggest how other body systems might be impacted in the comic mystery.
    - Nervous System: In Mosa Mack's Nervous System unit, students are led through a progression of three inquiry lessons that focus on how information that organisms receive from the outside world travels through the nervous system and results in different responses.
- Explore Learning:
    - Digestive System: Digestion is a complex process, involving a wide variety of organs and chemicals that work together to break down food, absorb nutrients, and eliminate wastes. But have you ever wondered what would happen if some of those organs were eliminated, or if the sequence was changed? Can the digestive system be improved? Find out by designing your own digestive system with the Digestive System Gizmo.
    - Circulatory System: Trace the path of blood through a beating heart and the network of blood vessels that supplies blood to the body. Take blood samples from different blood vessels to observe blood cells and measure the levels of oxygen, carbon dioxide, sugar, and urea.

Equipment Needed:

- Foss: Human Body Systems kit - "System Connections" Investigation 1 part 2 (Systems Research)
    - Teaching Slides
    - Notebook Sheet 1-3
    - Human Organ System Posters
    - Structural level cards

- Foss: Human Body Systems kit - "Supporting Cells" Investigation 2 part 1 (Food and Oxygen)
    - Teaching Slides
    - Notebook sheets 4 & 5
    - Online Activity: Digestive, Respiratory, Circulatory, and Excretory System Videos
    - Online Activity: Human Cardiovascular System

- Foss: Human Body Systems kit - "Supporting Cells" Investigation 2 part 2 (Aerobic Cellular Respiration)
    - Teaching Slides
    - Notebook sheet 6
    - Online Activity: Digestive and Excretory System Videos

UNIT OVERVIEW

Content Area: Science

Unit Title: Evidence of a Common Ancestry

Target Course/Grade Level: 8th Grade

Unit Summary:

In this unit of study, students analyze graphical displays and gather evidence from multiple sources in order to develop an understanding of how fossil records and anatomical similarities of the relationships among organisms and species describe biological evolution. Students search for patterns in the evidence to support their understanding of the fossil record and how those patterns show relationships between modern organisms and their common ancestors. The crosscutting concepts of cause and effect, patterns, and structure and function are called out as organizing concepts for these disciplinary core ideas. Students use the practices of analyzing graphical displays and gathering, reading, and communicating information. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Approximate Length of Unit: 4 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

MS-LS4-3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

Interdisciplinary Connections and Standards:
Career Readiness, Life Literacies, and Key Skills:

9.4.8.CI.1: Assess data gathered on varying perspectives on causes of climate change (e.g., cross cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions.

9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely
to be effective (e.g., MS-ETS1-2).
9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option.
9.4.8.GCA.2: Demonstrate openness to diverse ideas and perspectives through active discussions to achieve a group goal.
9.4.8.IML.1: Critically curate multiple resources to assess the credibility of sources when searching for information.
9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.
9.4.8.IML.4: Ask insightful questions to organize different types of data and create meaningful visualizations.
9.4.8.IML.12: Use relevant tools to produce, publish, and deliver information supported with evidence for an authentic audience.
9.4.8.TL.1: Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.
9.4.8.TL.2: Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
9.4.8.TL.3: Select appropriate tools to organize and present information digitally.
9.4.8.TL.4: Synthesize and publish information about a local or global issue or event.

Mathematics:
6.EE.B.6: Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-LS4-1),(MS-LS4-2)

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:
RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts.
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.
RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
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).
NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
WHST.6-8.1. Write arguments focused on discipline-specific content.

A. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
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.
C. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
D. Establish and maintain a formal/academic style, approach, and form.
E. Provide a concluding statement or section that follows from and supports the argument presented.

Unit Understandings:

Students will understand that…

- The fossil record documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.
- The collection of fossils and their placement in chronological order as identified through the location of sedimentary layers in which they are found or through radioactive dating is known as the fossil record.
- Relative fossil dating is achieved by examining the fossil's relative position in sedimentary rock layers.
- Objects and events in the fossil record occur in consistent patterns that are understandable through measurement and observation.
- Patterns exist in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in rock layers.
- Patterns can occur within one species of organism or across many species.
- Similarities and differences exist in the gross anatomical structures of modern organisms.
- There are anatomical similarities and differences among modern organisms and between modern organisms and fossil organisms.
- Similarities and differences exist in the gross anatomical structures of modern organisms and their fossil relatives.
- Similarities and differences in the gross anatomical structures of modern organisms enable the reconstruction of evolutionary history and the inference of lines of evolutionary decent.
- Patterns and anatomical similarities in the fossil record can be used to identify cause-and-effect relationships.
- Science assumes that objects and events in evolutionary history occur in consistent patterns that are understandable through measurement and observation.

Unit Essential Questions:

- How do we know when an organism (fossil) was alive?
- How do we know that birds and dinosaurs are related?
- Other than bones and structures being similar, what other evidence is there that birds and dinosaurs are related?

Knowledge and Skills:

Students will know...

- The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.
- Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.
- Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully formed anatomy.

Students will be able to...

- Organize the given data (e.g., using tables, graphs, charts, images), including the appearance of specific types of fossilized organisms in the fossil record as a function of time, as determined by their locations in the sedimentary layers or the ages of rocks.
- Organize the data in a way that allows for the identification, analysis, and interpretation of similarities and differences in the data.
- Identify patterns between any given set of sedimentary layers and the relative ages of those layers.
- Identify the time period(s) during which a given fossil organism is present in the fossil record.
- Identify periods of time for which changes in the presence or absence of large numbers of organisms or specific types of organisms can be observed in the fossil record (e.g., a fossil layer with very few organisms immediately next to a fossil layer with many types of organisms).
- Identify patterns of changes in the level of complexity of anatomical structures in organisms in the fossil record, as a function of time.
- Analyze and interpret the data to determine evidence for the existence, diversity, extinction, and change in life forms throughout the history of Earth, using the assumption that natural laws operate today as they would have in the past.
- Use similarities and differences in the observed patterns to provide evidence for:
    - When mass extinctions occurred.
    - When organisms or types of organisms emerged, went extinct, or evolved.
    - The long-term increase in the diversity and complexity of organisms on Earth.
- Articulate a statement that relates a given phenomenon to scientific ideas, including the following ideas about anatomical similarities and differences among organisms can be used to infer evolutionary relationships, including: 1. Among modern organisms. 2. Between modern and fossil organisms.
- Use evidence and reasoning to construct an explanation for the given phenomenon.
- Students identify and describe evidence (e.g., from students' own investigations, observations, reading material, archived data, simulations) necessary for constructing the explanation, including similarities and differences in anatomical patterns in and between:
    - Modern, living organisms (e.g., skulls of modern crocodiles, skeletons of birds; features of modern whales and elephants).
    - Fossilized organisms (e.g., skulls of fossilized crocodiles, fossilized dinosaurs).
- Students use reasoning to connect the evidence to support an explanation. Students describe the following chain of reasoning for the explanation:

    - Organisms that share a pattern of anatomical features are likely to be more closely related than are organisms that do not share a pattern of anatomical features, due to the cause-and effect relationship between genetic makeup and anatomy (e.g., although birds and insects both have wings, the organisms are structurally very different and not very closely related; the wings of birds and bats are structurally similar, and the organisms are more closely related; the limbs of horses and zebras are structurally very similar, and they are more closely related than are birds and bats or birds and insects).
    - Changes over time in the anatomical features observable in the fossil record can be used to infer lines of evolutionary descent by linking extinct organisms to living organisms through a series of fossilized organisms that share a basic set of anatomical features.
- Organize the given displays of pictorial data of embryos by developmental stage and by organism (e.g., early, middle, just prior to birth) to allow for the identification, analysis, and interpretation of relationships in the data.
- Analyze their organized pictorial displays to identify linear and nonlinear relationships, including:
    - Patterns of similarities in embryos across species (e.g., early mammal embryos and early fish embryos both contain gill slits, whale embryos and the embryos of land animals — even some snakes — have hind limbs).
    - Patterns of changes as embryos develop (e.g., mammal embryos lose their gill slits, but the gill slits develop into gills in fish).
- Use patterns of similarities and changes in embryo development to describe evidence for relatedness among apparently diverse species, including similarities that are not evident in the fully formed anatomy (e.g., mammals and fish are more closely related than they appear to be based on their adult features, whales are related to land animals).

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?
End of Unit Assessment:

- Students will use graphs, charts, and images to identify patterns within the fossil record.
- Students will analyze and interpret data within the fossil record to determine similarities and differences in findings.
- Students will make logical and conceptual connections between evidence in the fossil record and explanations about the existence, diversity, extinction, and change in many life forms throughout the history of life on Earth.

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations with experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

RESOURCES

Teacher Resources include but are not limited to:

- NOVA: Judgment Day: Intelligent Design on Trial: Human Chromosome 2: This video segment from NOVA: "Judgment Day: Intelligent Design on Trial" reveals how genetic evidence helped to confirm an important component of Darwin's theory of evolution by natural selection: the common ancestry of humans and apes. In particular, it explains that humans have one fewer chromosome pair in their cells than apes, due to a mutation found in chromosome number 2 that caused two chromosomes to fuse into one.

- The Day the Mesozoic Died This three-act film tells the story of the detective work that solved the mystery of what caused the disappearance of the dinosaurs at the end of the Cretaceous period. Shot on location in Italy, Spain, Texas, Colorado, and North Dakota, the film traces the uncovering of key clues that led to the discovery that an asteroid struck the Earth 66 million years ago, triggering a mass extinction of animals, plants, and microorganisms.
- MosaMack:
    - Evidence of Evolution: In Mosa Mack's Evolution unit, students are led through a progression of three inquiry lessons that focus on three types of evidence that support the theory of evolution: fossils, anatomical structures, and embryology.
- Explore Learning :
    - Cladogram: Based on the similarities and differences between different organisms, create branching diagrams called cladograms to show how they are related. Use both morphological data (physical traits) and molecular data to create

the simplest and most likely cladograms. Five different sets of organisms are available.
    - Human Evolution: Compare the skulls of a variety of significant human ancestors, or hominids. Use available tools to measure lengths, areas, and angles of important features. Each skull can be viewed from the front, side, or from below. Additional information regarding the age, location, and discoverer of each skull can be displayed.

Equipment Needed:

- Foss: Earth History kit - "Fossils and Past Environments" Investigation 4 all parts
    - Notebook sheets 23-29
    - Limestone, Sandstone, and Shale formation videos
    - Timeline Cards
    - Adding Machine tap
    - Fearless Planet Video & Questions
    - Online Activities on FossWeb:
        - Rock Column Movie Maker
        - Timeliner
        - Time Machine
        - Dating Rock Layers
        - Index Fossil Correlation
- Foss: Heredity and Adaptations kit - "The History of Life" Investigation 1 all parts
    - Readings "Fossil Dating" and "Mass Extinctions"
    - Reading "An Interview With Jennifer Clark" and "Transitions."
    - Teacher Masters
    - Notebook sheets
    - Owl Pellets
    - Forceps
    - Online Activities:
        - Biodiversity Slideshow (fossweb)
        - Fossils Slideshow (fossweb)
        - "Fish with Fingers" video and questions
        - "Great Transitions: The Origin of Tetrapods" video and questions
- Foss: Heredity and Adaptations kit - "Heredity" Investigation 2 part 1 "Lines of Descent"
    - Foss Reading "Tree Thinking"
    - Classification Card Sets
    - Dolphin Cards
    - Notebook Sheets 5-7

UNIT OVERVIEW

Content Area: Science

Unit Title: Inheritance and Variation of Traits

Target Course/Grade Level: Grade 8

Unit Summary:

Students develop and use models to describe how gene mutations and sexual reproduction contribute to genetic variation. Students understand how genetic factors determine the growth of an individual organism. They also demonstrate understanding of the genetic implications of sexual and asexual reproduction. The crosscutting concepts of cause and effect and structure and function provide a framework for understanding how gene structure determines differences in the functioning of organisms. Students are expected to demonstrate proficiency in developing and using models. Students use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

Interdisciplinary Connections and Standards:
Career Readiness, Life Literacies, and Key Skills:

9.4.8.CI.1: Assess data gathered on varying perspectives on causes of climate change (e.g., cross cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions.

9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).

9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option.

9.4.8.GCA.2: Demonstrate openness to diverse ideas and perspectives through active discussions to achieve a group goal.

9.4.8.IML.1: Critically curate multiple resources to assess the credibility of sources when searching for information.
9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.
9.4.8.IML.4: Ask insightful questions to organize different types of data and create meaningful visualizations.
9.4.8.IML.12: Use relevant tools to produce, publish, and deliver information supported with evidence for an authentic audience.
9.4.8.TL.1: Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.
9.4.8.TL.2: Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
9.4.8.TL.3: Select appropriate tools to organize and present information digitally.
9.4.8.TL.4: Synthesize and publish information about a local or global issue or event.

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:
RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts.
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.
RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
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).
NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
WHST.6-8.1. Write arguments focused on discipline-specific content.

A. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
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.
C. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
D. Establish and maintain a formal/academic style, approach, and form.
E. Provide a concluding statement or section that follows from and supports the argument presented.

Unit Understandings:
Students will understand that…

- Complex and microscopic structures and systems, such as genes located on chromosomes, can be visualized, modeled, and used to describe how their function

depends on the shapes, composition, and relationships among the parts of the system; therefore, complex natural structures/systems can be analyzed to determine how they function.

- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes.
- Each distinct gene chiefly controls the production of specific proteins, which in turn affect the traits of the individual.
- In addition to variations that arise from sexual reproduction, genetic information can be altered due to mutations.
- Some changes to genetic material are beneficial, others harmful, and some neutral to the organism.
- Changes in genetic material may result in the production of different proteins.
- Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.
- Structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism
- Though rare, mutations may result in changes to the structure and function of proteins.
- Organisms reproduce either sexually or asexually and transfer their genetic information to their offspring.
- Asexual reproduction results in offspring with identical genetic information.
- Sexual reproduction results in offspring with genetic variation.
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.
- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. • Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.
- Punnett squares, diagrams, and simulations can be used to describe the cause-and-effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.

Unit Essential Questions:

- How do structural changes to genes (mutations) located on chromosomes affect proteins or affect the structure and function of an organism?
- How do asexual reproduction and sexual reproduction affect the genetic variation of offspring?

Knowledge and Skills:

Students will know...

- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.

- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.
- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.

Students will be able to...

- Develop a model in which they identify the relevant components for making sense of a given phenomenon involving the relationship between mutations and the effects on the organism, including:
    - Genes, located on chromosomes.
    - Proteins.
    - Traits of organisms.
- Describe the relationships between components, including:
    - Every gene has a certain structure, which determines the structure of a specific set of proteins.
    - Protein structure influences protein function (e.g., the structure of some blood proteins allows them to attach to oxygen, the structure of a normal digestive protein allows it to break down particular food molecules).
    - Observable organism traits (e.g., structural, functional, behavioral) result from the activity of proteins.
- Use the model to describe that structural changes to genes (i.e., mutations) may result in observable effects at the level of the organism, including why structural changes to genes:
    - May affect protein structure and function.
    - May affect how proteins contribute to observable structures and functions in organisms.
    - May result in trait changes that are beneficial, harmful, or neutral for the organism.
- Use the model to describe that beneficial, neutral, or harmful changes to protein function can cause beneficial, neutral, or harmful changes in the structure and function of organisms.
- Develop a model (e.g., Punnett squares, diagrams, simulations) for a given phenomenon involving the differences in genetic variation that arise from sexual and asexual reproduction.
- Identify and describe the relevant components, including:
    - Chromosome pairs, including genetic variants, in asexual reproduction: 1. Parents. 2. Offspring.
    - Chromosome pairs, including genetic variants, in sexual reproduction: 1. Parents. 2. Offspring.

- Describe the relationships between components, including:
    - During reproduction (both sexual and asexual), parents transfer genetic information in the form of genes to their offspring.
    - Under normal conditions, offspring have the same number of chromosomes, and therefore genes, as their parents.
    - During asexual reproduction, a single parent's chromosomes (one set) are the source of genetic material in the offspring.
    - During sexual reproduction, two parents (two sets of chromosomes) contribute genetic material to the offspring.
- Describe a causal account for why sexual and asexual reproduction result in different amounts of genetic variation in offspring relative to their parents, including that:
    - In asexual reproduction: 1. Offspring have a single source of genetic information, and their chromosomes are complete copies of each single parent pair of chromosomes. 2. Offspring chromosomes are identical to parent chromosomes.
    - In sexual reproduction: 1. Offspring have two sources of genetic information (i.e., two sets of chromosomes) that contribute to each final pair of chromosomes in the offspring. 2. Because both parents are likely to contribute different genetic information, offspring chromosomes reflect a combination of genetic material from two sources and therefore contain new combinations of genes (genetic variation) that make offspring chromosomes distinct from those of either parent.
- Use cause-and-effect relationships found in the model between the type of reproduction and the resulting genetic variation to predict that more genetic variation occurs in organisms that reproduce sexually compared to organisms that reproduce asexually.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?
End of Unit Assessment:

- Students will develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
- Students will develop and use a model to describe why asexual reproduction results in offspring with identical genetic information.
- Students will develop and use a model to describe why sexual reproduction results in offspring with genetic variation.
- Students will use models such as Punnett squares, diagrams, and simulations to describe the cause-and effect-relationship of gene transmission from parent(s) to offspring and resulting genetic variation.

Learning Activities:
What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations with experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.

RESOURCES

Teacher Resources include but are not limited to:

- Meiosis: How Does the Process of Meiosis Reduce the Number of Chromosomes in Reproductive Cells? This lab activity introduces students to the process of meiosis at the chromosomal level. The guiding question for the investigation is: How does the process of meiosis reduce the number of chromosomes in reproductive cells? Students develop an explanatory model based on their knowledge of mitosis and how cells divide. Students are provided with pictures showing various stages of meiosis. Students sequence the pictures and provide a description of what they think may be going on during each stage. The book provides a link (www.nsta.org/publications/press/extras/argument.aspx) to download images of meiosis (sequencing activity). Students use pop bead chromosomes (provided by the teacher) to create a valid model that explains : what happens to the chromosomes inside a cell as it goes through meiosis, why reproductive cells have half the number of chromosomes of the individuals who produce them, and why there are no pairs of chromosomes in reproductive cells. When students have finished the model, and after they have collected and analyzed the data, they develop an initial argument. They prepare a whiteboard presentation that includes the guiding question, claim, evidence, and justification of evidence and present it to the whole-class using a round-robin format. After collecting feedback, students return to Grade 7 Model Science Unit 6: Inheritance and Variation of Traits (draft 1.25.16) Instructional Days: 20 8 their original small groups for editing and revising before writing a final report. Each lab ends with a list of checkout questions. The book includes an option to extend the lesson by asking students to complete a double-blind peer review of the argument using a rubric provided in the appendix. To provide additional support, four appendixes are included: standards alignment matrixes, options for implementing argument-driven inquiry lab investigations, investigation proposal options, and peer-review guide and instructor scoring rubric. A

detailed step-by-step guide that explains the argument-driven inquiry is included for teachers not familiar with the model.

- Pedigrees and the Inheritance of Lactose Intolerance: In this activity students analyze a family's pedigrees to make a claim based on evidence about mode of inheritance of a lactose intolerance trait, determine the most likely inheritance pattern of a trait, and analyze variations in DNA to make a claim about which variants are associated with specific traits. This activity serves as a supplement to the film Got Lactose? The Co-evolution of Genes and Culture (http://www.hhmi.org/biointeractive/making-fittest-got-lactase-co-evolution-genes-and-culture). The film shows a scientist as he tracks down the genetic changes associated with the ability to digest lactose as adults. A detailed teacher's guide that includes curriculum connections, teaching tips, time requirements, answer key and a student guide can be downloaded at http://www.hhmi.org/biointeractive/pedigrees-and-inheritance-lactose-intolerance. Six supporting resource and two "click and learn" activities are also found on the link.
- How do Siamese Cats Get Their Color? This resource is an article from the January 2016 issue of The Science Teacher. The unit focuses on an essential question: How do Siamese cats develop their coloration? Students develop explanations by making connections among genes, proteins, and traits. The unit is designed to be implemented over six or seven instructional days. However, each activity can be used as a stand-alone instructional strategy. During the instructional cycle, students develop an initial model to explain how Siamese cats get their coat coloration, learn about enzyme structure and function, use a computer model to see how proteins interact, experiment with Jell-O to see enzymes in action, learn about molecular motor proteins to see how structure relates to function, revise their model of coat coloration, and experiment with precursors of melanin to see how proteins can lead to observable traits. The unit is designed to help teachers extend the central dogma concept beyond the idea that proteins are the final products in the process. The unit provides opportunities for students to develop a conceptual understanding that proteins are important in cellular functions as well as trait-producing mechanisms. The article includes a teacher guide which describes how each activity is aligned to the Next Generation Science Standards. Unit handouts for students and the teacher guide are found on the NSTA website at https://www.nsta.org/online-connections-science-teacher
- ExploreLearning:
    - Meiosis - Explore how sex cells are produced by the process of meiosis. Compare meiosis in male and female germ cells, and use crossovers to increase the number of possible gamete genotypes. Using meiosis and crossovers, create "designer" fruit fly offspring with desired trait combinations.
    - Evolution, Mutation, and Selection - Observe evolution in a fictional population of bugs. Set the background to any color, and see natural selection taking place. Inheritance of color occurs according to Mendel's laws and probability. Mutations occur at random, and probability of capture by predators is determined by the insect's camouflage.
    - Chicken Genetics: Breed "pure" chickens with known genotypes that exhibit specific feather colors, and learn how traits are passed on via co-dominant genes. Chickens can be stored in cages for future breeding, and the statistics of feather

color are reported every time the chickens breed. Punnett squares can be used to predict results.
    - Mouse Genetics (one trait): Breed "pure" mice with known genotypes that exhibit specific fur colors, and learn how traits are passed on via dominant and recessive genes. Mice can be stored in cages for future breeding, and the statistics of fur color are reported every time a pair of mice breed. Punnett squares can be used to predict results.
    - Mouse Genetics (two traits): Breed "pure" mice with known genotypes that exhibit specific fur and eye colors, and learn how traits are passed on via dominant and recessive genes. Mice can be stored in cages for future breeding, and the statistics of fur and eye color are reported every time a pair of mice breed. Punnett squares can be used to predict results.
- MosaMack:
    - Mutations: Students solve a mutations mystery to understand the core ideas behind genes and DNA. In The Make, students randomly select a trait from a bag and compete in survival challenges. Through this activity, they discover that mutations can be beneficial, harmful, or neutral. The unit ends with an engineering challenge in which students use CRISPR to genetically modify a gene to solve a medical problem.
- Legends of learning

Equipment Needed:

- Foss: Heredity and Adaptations kit - "Heredity" Investigation 2 parts - 4("Inheriting Traits," "Modeling Heredity," and "Punnett Squares")
    - Foss Reading "Understanding Heredity" and "A Larkey Yammer"
    - Foss Reading "Mendel and Punnett Squares" and "Mapping the Human Genome"
    - Notebook Sheets 8-11
    - Online Activity: Fossweb:
        - Heredity SlideShow
        - A Model for Predicting Genetic Variation
        - Larkey Impossible Traits

UNIT OVERVIEW

Content Area: Science

Unit Title: Selection and Adaptation

Target Course/Grade Level: 8th Grade

Unit Summary:

Students construct explanations based on evidence to support fundamental understandings of natural selection and evolution. They will use ideas of genetic variation in a population to make sense of how organisms survive and reproduce, thus passing on the traits of the species. The crosscutting concepts of patterns and structure and function are called out as organizing concepts that students use to describe biological evolution. Students use the practices of constructing explanations, obtaining, evaluating, and communicating information, and using mathematical and computational thinking. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment

MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Interdisciplinary Connections and Standards:
Career Readiness, Life Literacies, and Key Skills:

9.4.8.CI.1: Assess data gathered on varying perspectives on causes of climate change (e.g., cross cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions.

9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).

9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option.

9.4.8.GCA.2: Demonstrate openness to diverse ideas and perspectives through active discussions to achieve a group goal.

9.4.8.IML.1: Critically curate multiple resources to assess the credibility of sources when searching for information.
9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.
9.4.8.IML.4: Ask insightful questions to organize different types of data and create meaningful visualizations.
9.4.8.IML.12: Use relevant tools to produce, publish, and deliver information supported with evidence for an authentic audience.
9.4.8.TL.1: Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.
9.4.8.TL.2: Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
9.4.8.TL.3: Select appropriate tools to organize and present information digitally.
9.4.8.TL.4: Synthesize and publish information about a local or global issue or event.

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:
RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts.
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.
RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
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).
NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
WHST.6-8.1. Write arguments focused on discipline-specific content.

A. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
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.
C. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
D. Establish and maintain a formal/academic style, approach, and form.
E. Provide a concluding statement or section that follows from and supports the argument presented.

Unit Understandings:
Students will understand that…

- Genetic variations of traits in a population increase or decrease some individuals' probability of surviving and reproducing in a specific environment.

- Natural selection leads to the predominance of certain traits in a population and the suppression of others.
- Natural selection may have more than one cause, and some cause-and effect relationships within natural selection can only be described using probability
- Natural selection, which over generations leads to adaptations, is one important process through which species change over time in response to changes in environmental conditions.
- The distribution of traits in a population changes.
- Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common.
- Natural selection may have more than one cause, and some cause-and effect relationships in natural selection can only be described using probability.
- Mathematical representations can be used to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.
- In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding.
- In artificial selection, humans choose desirable, genetically determined traits in to pass on to offspring.
- Phenomena, such as genetic outcomes in artificial selection, may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.
- Technologies have changed the way humans influence the inheritance of desired traits in organisms.
- Engineering advances have led to important discoveries in the field of selective breeding.
- Engineering advances in the field of selective breeding have led to the development of entire industries and engineered systems.
- Scientific discoveries have led to the development of entire industries and engineered systems.

Unit Essential Questions:

- Are Genetically Modified Organisms (GMO) safe to eat?
- How can changes to the genetic code increase or decrease an individual's chances of survival?
- How can the environment affect natural selection?

Knowledge and Skills:

Students will know...

- Natural selection leads to the predominance of certain traits in a population, and the suppression of others.
- In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed onto offspring.

Students will be able to...

- Articulate a statement that relates the given phenomenon to scientific ideas about the cause-and-effect relationship between the inheritance of traits increasing the chances of successful reproduction and natural selection.
- Use evidence and reasoning to construct an explanation for the given phenomenon.
- Identify and describe given evidence (e.g., from students' own investigations, observations, reading materials, archived data) necessary for constructing the explanation, including:
    - Individuals in a species have genetic variation that can be passed on to their offspring.
    - The probability of a specific organism surviving and reproducing in a specific environment.
    - The traits (i.e., specific variations of a characteristic) and the cause-and-effect relationships between those traits and the probability of survival and reproduction of a given organism in a specific environment.
    - The particular genetic variations (associated with those traits) that are carried by that organism.
- Use reasoning to connect the evidence and support an explanation that describes the relationship between genetic variation and the success of organisms in a specific environment.
- Describe a chain of reasoning that includes:
    - Any population in a given environment contains a variety of available, inheritable genetic traits.
    - For a specific environment (e.g., different environments may have limited food availability, predators, nesting site availability, light availability), some traits confer advantages that make it more probable that an organism will be able to survive and reproduce there.
    - In a population, there is a cause-and-effect relationship between the variation of traits and the probability that specific organisms will be able to survive and reproduce.
    - Variation of traits is a result of genetic variations occurring in the population.
    - The proportion of individual organisms that have genetic variations and traits that are advantageous in a particular environment will increase from generation to generation due to natural selection because the probability that those individuals will survive and reproduce is greater.
    - Similarly, the proportion of individual organisms that have genetic variations and traits that are disadvantageous in a particular environment will be less likely to survive, and the disadvantageous traits will decrease from generation to generation due to natural selection.
- Gather information about at least two technologies that have changed the way humans influence the inheritance of desired traits in plants and animals through artificial selection by choosing desired parental traits determined by genes, which are then often passed onto offspring. Examples could include gene therapy, genetic modification, and selective breeding of plants and animals.
- Use at least two appropriate and reliable sources of information for investigating each technology.

- Assess the credibility, accuracy, and possible bias of each publication and method used in the information they gather.
- Use their knowledge of artificial selection and additional sources to describe how the information they gather is or is not supported by evidence.
- Synthesize the information from multiple sources to provide examples of how technologies have changed the ways that humans are able to influence the inheritance of desired traits in organisms.
- Use the information to identify and describe how a better understanding of cause-and-effect relationships in how traits occur in organisms has led to advances in technology that provide a higher probability of being able to influence the inheritance of desired traits in organisms.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

End of Unit Assessment: Students will …

- Construct an explanation that includes probability statements regarding variables and proportional reasoning of how genetic variations of traits in a population increase some individuals' probability surviving and reproducing in a specific environment.
- Use probability to describe some cause-and-effect relationships that can be used to explain why some individuals survive and reproduce in a specific environment.
- Explain some causes of natural selection and the effect it has on the increase or decrease of specific traits in populations over time.
- Use mathematical representations to support conclusions about how natural selection may lead to increases and decreases of genetic traits in populations over time.
- Gather, read, and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms (artificial selection) from multiple appropriate sources.
- Describe how information from publications about technologies and methods that have changed the way humans influence the inheritance of desired traits in organisms (artificial selection) used are supported or not supported by evidence.
- Assess the credibility, accuracy, and possible bias of publications and the methods they used when gathering information about technologies that have changed the way humans influence the inheritance of desired traits in organisms (artificial selection).

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- 99.99% Antibacterial Products and Natural Selection: This activity is a hands-on simulation using Skittles and mini-marshmallows to show how natural selection can act as a mechanism to increase the presence of antibacterial resistance in a population.

- An Origin of Species: Pollen peepers: This web simulation allows students to explore adaptive radiation of a fictitious group of birds called Pollen peepers over a period of 5 million years.
- Bug Hunt "Bug Hunt" uses NetLogo software and simulates an insect population that is preyed on by birds. There are six speeds of bugs from slow to fast and the bird tries to catch as many insects as possible in a certain amount of time. Students are able to see the results graphed as the average insect speed over time, the current bug population and the number of insects caught.
- Color Variation over Time in Rock Pocket Mouse Populations: This activity provides an introduction to natural selection and the role of genetic variation by asking students to analyze illustrations of rock pocket mouse populations (dark/light fur) on different color substrates in the Sonoran Desert (light/dark) over time. Based on this evidence, and what they learn about variation and natural selection in the accompanying short film, students use this evidence to explain the change in the rock pocket mouse populations on the lava flow (dark substrate) over time.

- Catch Up on Tomato Technology: This lesson is a tool to demonstrate how various technological advances have changed the tomato and the tomato industry over the years. The technology includes both selective breeding and genetic engineering
- Explore Learning: Natural Selection - You are a bird hunting moths (both dark and light) that live on trees. As you capture the moths most easily visible against the tree surface, the moth populations change, illustrating the effects of natural selection.

RESOURCES

Teacher Resources include but are not limited to:

- 99.99% Antibacterial Products and Natural Selection
- An Origin of Species: Pollenpeepers
- Making Sense of Natural Selection: This article from The Science Teacher magazine describes a unit of study on natural selection. Students begin by trying to explain the phenomenon of the exponential increase in a population of fish.
- Bug Hunt.
- Color Variation over Time in Rock Pocket Mouse Populations
- Catch Up on Tomato Technology.
- Explore Learning: Natural Selection Brainpop: Natural Selection

Equipment Needed:

- Foss: Heredity and Adaptations kit - "Evolution" Investigation 3 all parts ("Adaptation," "Natural Selection," "Genetic Technology," and "Influencing Evolution."
    - Readings "Adaptation," "Natural Selection," "What Makes a Scientific Theory?,"

- Notebook Sheet 12-20
- Video:
  - "The Making of the Fittest: Natural Selection and Adaptation
  - "The Origin of Species: The Beak of the Finch"
- Online Activities:
  - "Walking Sticks: Eat Insects"
  - "Larkey Natural Selecction
  - Slideshow: Biodiversity
  - "Genetic Technology Resources"

UNIT OVERVIEW

Content Area: Science

Unit Title: Interaction of Matter

Target Course/Grade Level: 8th

Unit Summary:

Students provide molecular-level accounts of states of matter and changes between states, of how chemical reactions involve regrouping of atoms to form new substances, and of how atoms rearrange during chemical reactions. Students are also able to apply an understanding of optimization design and process in engineering to chemical reaction systems. The crosscutting concepts of structure and function, cause and effect, interdependence of science, engineering, and technology, and influence of science, engineering, and technology on society and on the natural world provide a framework for understanding the disciplinary core ideas. Students are expected to demonstrate grade appropriate proficiency in obtaining, evaluating, and communicating information and developing and using models. Students are also expected to use the scientific and engineering practices to demonstrate understanding of the core ideas.

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

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

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Interdisciplinary Connections and Standards:
Career Readiness, Life Literacies, and Key Skills:

9.4.8.CI.1: Assess data gathered on varying perspectives on causes of climate change (e.g., cross cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions.

9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).

9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option.

9.4.8.GCA.2: Demonstrate openness to diverse ideas and perspectives through active discussions to achieve a group goal.
9.4.8.IML.1: Critically curate multiple resources to assess the credibility of sources when searching for information.
9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.
9.4.8.IML.4: Ask insightful questions to organize different types of data and create meaningful visualizations.
9.4.8.IML.12: Use relevant tools to produce, publish, and deliver information supported with evidence for an authentic audience.
9.4.8.TL.1: Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.
9.4.8.TL.2: Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
9.4.8.TL.3: Select appropriate tools to organize and present information digitally.
9.4.8.TL.4: Synthesize and publish information about a local or global issue or event.

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:
RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts.
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.
RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
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).
NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
WHST.6-8.1. Write arguments focused on discipline-specific content.

A. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
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.
C. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
D. Establish and maintain a formal/academic style, approach, and form.
E. Provide a concluding statement or section that follows from and supports the argument presented.

Unit Understandings:
Students will understand that…

- Changes in particle motion, temperature, and state of a pure substance occur when thermal energy is added or removed.
- Qualitative molecular-level models of solids, liquids, and gases can be used to show that adding or removing thermal energy increases or decreases the kinetic energy of the particles until a change of state occurs.
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.
- In a liquid, the molecules are constantly in contact with others.
- In a gas, the molecules are widely spaced except when they happen to collide.
- In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.
- The changes of state that occur with variations in temperature or pressure can be described and predicted using models of matter.
- The term heat as used in everyday language refers both to thermal energy and the transfer of that thermal energy from one object to another.
- Thermal energy is the motion of atoms or molecules within a substance.
- In science, heat is used to refer to the energy transferred due to the temperature difference between two objects.
- The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material).
- The details of the relationship between the average internal kinetic energy and the potential energy per atom or molecule depend on the type of atom or molecule and the interactions among the atoms in the material.
- Temperature is not a direct measure of a system's total thermal energy.
- The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material.
- Cause-and-effect relationships may be used to predict and describe changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed in natural systems.
- Each pure substance has characteristic physical and chemical properties that can be used to identify it.
- Substances react chemically in characteristic ways.
- In a chemical process, the atoms that make up the original substances are regrouped into different molecules.
- New substances that result from chemical processes have different properties from those of the reactants.
- Natural resources can undergo a chemical process to form synthetic material.
- Structures can be designed to serve particular functions by taking into account properties of different materials and how materials can be shaped and used.
- Engineering advances have led to discoveries of important synthetic materials, and scientific discoveries have led to the development of entire industries and engineered systems using these materials.
- Technology use varies from region to region and over time.

- The uses of technologies (engineered/synthetic materials) and any limitations on their use are driven by individual or societal needs, desires, and values.
- The uses of technologies (engineered/synthetic materials) and any limitations on their use are driven by the findings of scientific research and by differences in such factors as climate, natural resources, and economic conditions.

Unit Essential Questions:

- How can you tell what the molecules are doing in a substance?
- How can we trace synthetic materials back to natural ingredients?

Knowledge and Skills:

Students will know...

- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.
- 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.
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.
- The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary) The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material.

Students will be able to...

- Students obtain information from published, grade-level appropriate material from at least two sources (e.g., text, media, visual displays, data) about:
    - Synthetic materials and the natural resources from which they are derived.
    - Chemical processes used to create synthetic materials from natural resources (e.g., burning of limestone for the production of concrete).
    - The societal need for the synthetic material (e.g., the need for concrete as a building material).
- Determine and describe whether the gathered information is relevant for determining:
    - That synthetic materials, via chemical reactions, come from natural resources.
    - The effects of the production and use of synthetic resources on society.

- Determine the credibility, accuracy, and possible bias of each source of information, including the ideas included and methods described. c Students synthesize information that is presented in various modes (e.g., graphs, diagrams, photographs, text, mathematical, verbal) to describe:
    - How synthetic materials are formed, including the natural resources and chemical processes used.
    - The properties of the synthetic material(s) that make it different from the natural resource(s) from which it was derived.
    - How those physical and chemical properties contribute to the function of the synthetic material.
    - How the synthetic material satisfies a societal need or desire through the properties of its structure and function.
    - The effects of making and using synthetic materials on natural resources and society.
- Make sense of a given phenomenon, students develop a model in which they identify the relevant components, including:
    - Particles, including their motion.
    - The system within which the particles are contained.
    - The average kinetic energy of particles in the system.
    - Thermal energy of the system. Temperature of the system.
    - A pure substance in one of the states of matter (e.g., solid, liquid, gas at the macro scale).
- Describe relationships between components, including:
    - The relationships between:
        - 1. The motion of molecules in a system and the kinetic energy of the particles in the system.
        - 2. The average kinetic energy of the particles and the temperature of the system. 3. The transfer of thermal energy from one system to another and:
            - A change in kinetic energy of the particles in that new system, or
            - A change in state of matter of the pure substance.
        - 4. The state of matter of the pure substance (gas, liquid, solid) and the particle motion (freely moving and not in contact with other particles, freely moving and in loose contact with other particles, vibrating in fixed positions relative to other particles).
- Provide a causal account of the relationship between the addition or removal of thermal energy from a substance and the change in the average kinetic energy of the particles in the substance.
- Use their model to provide a causal account of the relationship between:
    - The temperature of the system.
    - Motions of molecules in the gaseous phase.
    - The collisions of those molecules with other materials, which exerts a force called pressure.
- Use their model to provide a causal account of what happens when thermal energy is transferred into a system, including that:
    - An increase in kinetic energy of the particles can cause:

        - 1. An increase in the temperature of the system as the motion of the particles relative to each other increases, or
        - 2. A substance to change state from a solid to a liquid or from a liquid to a gas.
    - The motion of molecules in a gaseous state increases, causing the moving molecules in the gas to have greater kinetic energy, thereby colliding with molecules in surrounding materials with greater force (i.e., the pressure of the system increases).
- Use their model to provide a causal account of what happens when thermal energy is transferred from a substance, including that:
    - Decreased kinetic energy of the particles can cause: 1. A decrease in the temperature of the system as the motion of the particles relative to each other decreases, or 2. A substance to change state from a gas to a liquid or from a liquid to a solid.
    - The pressure that a gas exerts decreases because the kinetic energy of the gas molecules decreases, and the slower molecules exert less force in collisions with other molecules in surrounding materials.
- Use their model to provide a causal account for the relationship between changes in pressure of a system and changes of the states of materials in the system
    - With a decrease in pressure, a smaller addition of thermal energy is required for particles of a liquid to change to gas because particles in the gaseous state are colliding with the surface of the liquid less frequently and exerting less force on the particles in the liquid, thereby allowing the particles in the liquid to break away and move into the gaseous state with the addition of less energy.
    - With an increase in pressure, a greater addition of thermal energy is required for particles of a liquid to change to gas because particles in the gaseous state are colliding with the surface of the liquid more frequently and exerting greater force on the particles in the liquid, thereby limiting the movement of particles from the liquid to gaseous state.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?
End of Unit Assessment: Students will …

- Develop a model that predicts and describes changes in particle motion that could include molecules or inert atoms or pure substances.
- Use cause-and-effect relationships to predict changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed in natural or designed systems.
- Obtain, evaluate, and communicate information to show that synthetic materials come from natural resources and affect society.

- Gather, read, and synthesize information about how synthetic materials formed from natural resources affect society.
- Assess the credibility, accuracy, and possible bias of each publication and methods used within the publication.
- Describe how information about how synthetic materials formed from natural resources affect society is supported or not supported by evidence.

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

RESOURCES

Teacher Resources include but are not limited to:

- Middle school Chemistry, Chapter 1: Solids, Liquids, and Gases Students are introduced to the idea that matter is composed of atoms and molecules that are attracted to each other and in constant motion. Students explore the attractions and motion of atoms and molecules as they experiment with and observe the heating and cooling of a solid, liquid, and gas.
- Middle school Chemistry, Chapter 2: Changes of State Students help design experiments to test whether the temperature of water affects the rate of evaporation and whether the temperature of water vapor affects the rate of condensation. Students also look in more detail at the water molecule to help explain the state changes of water.

- States of Matter: Use interactive computer models to trace an atom's trajectory at a certain physical stage, and investigate how molecular behavior is responsible for the substance's state.
- Molecular View of a Gas: Explore the structure of a gas at the molecular level. Molecules are always in motion. Molecules in a gas move quickly. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts.
- Molecular View of a Liquid: Explore the structure of a liquid at the molecular level. Molecules are always in motion. Molecules in a liquid move moderately. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts.
- Molecular View of a Solid: Explore the structure of a solid at the molecular level. Molecules are always in motion, though molecules in a solid move slowly. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts.
- Chemical and Physical Changes: STEM Case: The Secret Service has arrested suspects accused of counterfeiting coins from the year 1915 valued at $50,000 each. The students act as a forensic scientist to investigate the crime scene and evidence. Students learn about the properties of matter to recreate the methods used to make the coins as evidence for the trial.
- Chemical Changes: Chemical changes result in the formation of new substances. But how can you tell if a chemical change has occurred? Explore this question by observing and measuring a variety of chemical reactions. Along the way you will learn about chemical equations, acids and bases, exothermic and endothermic reactions, and conservation of matter.
- MosaMack: Atoms & Molecules: In Mosa Mack's Atoms and Molecules unit, students solve two atomic mysteries through which they discover the components of molecules and atoms. They are then led through an activity in which they construct atomic and molecular models. The unit culminates in an element challenge in which students select an element and bring it to life by either creating a profile for it or designing a product based on it.
- MosaMack: Chemical & Physical Changes: In the Chemical & Physical Interactions unit, students are led through a progression of three inquiry lessons that focus on the differences between physical and chemical changes.
- StudyJams (Scholastic): Physical and Chemical Changes: Physical changes mean matter changes size or shape, not its atomic makeup. Chemical and nuclear changes alter matter on an atomic level.
- StudyJams (Scholastic): Properties of Matter: Matter is anything that has mass and takes up space. That is why mass and volume are the properties of matter.
- ExploreLearning.com:
    - Phase Changes: Heat or cool a container of water and observe the phase changes that take place. Use a magnifying glass to observe water molecules as a solid, liquid, or gas. Compare the volumes of the three phases of water.

- Reaction Energy: Exothermic chemical reactions release energy, while endothermic reactions absorb energy. But what causes some reactions to be exothermic, and others to be endothermic? In this simulation, compare the energy absorbed in breaking bonds to the energy released in forming bonds to determine if a reaction will be exothermic or endothermic.

Equipment Needed:

- Foss:Chemical Interactions- "Kinetic Energy" Investigation 4 all parts ("Gas:Expansion and Contraction," "Liquid: Expansion and Contraction," and "Solid Expansion/Contraction")
  - Notebook Sheets 17 & 18
  - Reading "Particles in Motion" and "Expansion and Contraction"
  - Online resource:
    - "Particles in Solids, Liquids, and Gases"

- Foss: Chemical Interactions- "Energy Transfer" Investigation 5 all parts ("Mixing Hot and Cold," "Particle Collisions," and "Heat.")
  - Notebook Sheets 25-38
  - Reading "Energy on the Move"
  - Online Activity:
    - "Chemical Interactions"
    - "Energy Transfer by Collision"
    - "Mixing Hot and Cold Water"
    - "Thermometer"
    - "Energy Flow"

- Foss:Chemical Interactions- "Phase Change" Investigation 8 all parts ("Melting Temerature," "Adding Thermal Energy," "Freezing Water," and "Changing Phase.")
  - Notebook Sheet 43-52
  - Readings:
    - "Rock Solid"
    - "Heat of Fusion"
    - "Science Practices"
    - "Engineering Practices"
  - Online Activity:
    - "Chemical Interactions"
    - "Particles in Solids, Liquids, and Gases"

UNIT OVERVIEW

Content Area: Science

Unit Title: Structure and Properties of Matter

Target Course/Grade Level: 8th Grade

Unit Summary:

Students build understandings of what occurs at the atomic and molecular scale. Students apply their understanding that pure substances have characteristic properties and are made from a single type of atom or molecule. They also provide a molecular level accounting to explain states of matter and changes between states. The crosscutting concepts of cause and effect, scale, proportion and quantity, structure and function, interdependence of science, engineering, and technology, and the influence of science, engineering and technology on society and the natural world provide a framework for understanding the disciplinary core ideas. Students demonstrate grade appropriate proficiency in developing and using models, and obtaining, evaluating, and communicating information, Students are also expected to use the scientific and engineering practices to demonstrate understanding of the core ideas.

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

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

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.

Interdisciplinary Connections and Standards:
Career Readiness, Life Literacies, and Key Skills:

9.4.8.CI.1: Assess data gathered on varying perspectives on causes of climate change (e.g., cross cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions.

9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).

9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option.

9.4.8.GCA.2: Demonstrate openness to diverse ideas and perspectives through active discussions to achieve a group goal.
9.4.8.IML.1: Critically curate multiple resources to assess the credibility of sources when searching for information.
9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.
9.4.8.IML.4: Ask insightful questions to organize different types of data and create meaningful visualizations.
9.4.8.IML.12: Use relevant tools to produce, publish, and deliver information supported with evidence for an authentic audience.
9.4.8.TL.1: Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.
9.4.8.TL.2: Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
9.4.8.TL.3: Select appropriate tools to organize and present information digitally.
9.4.8.TL.4: Synthesize and publish information about a local or global issue or event.

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:
RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts.
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.
RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
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).
NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
WHST.6-8.1. Write arguments focused on discipline-specific content.

A. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
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.
C. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
D. Establish and maintain a formal/academic style, approach, and form.
E. Provide a concluding statement or section that follows from and supports the argument presented.

Unit Understandings:

Students will understand that…

- Substances are made from different types of atoms.
- Atoms are the basic units of matter.
- Substances combine with one another in various ways.
- Molecules are two or more atoms joined together.
- Atoms form molecules that range in size from two to thousands of atoms. Molecules can be simple or very complex.
- 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.
- Substances react chemically in characteristic ways.
- In a chemical process, the atoms that make up the original substances are regrouped into different molecules; these new substances have different properties from those of the reactants.
- The analysis of data on the properties of products and reactants can be used to determine whether a chemical process has occurred.
- Density, melting point, boiling point, solubility, flammability, and odor are characteristic properties that can be used to identify a pure substance.
- Macroscopic patterns are related to the nature of the atomic-level structure of a substance.

Unit Essential Questions:

- If the universe is not made of Legos®, then what is it made of?
- Is it possible to tell if two substances mixed or if they reacted with each other?

Knowledge and Skills:

Students will know...

- 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.
- 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.

Students will be able to...

- Students develop models of atomic composition of simple molecules and extended structures that vary in complexity. In the models, students identify the relevant components, including:
    - Individual atoms.
    - Molecules.
    - Extended structures with repeating subunits
    - Substances (e.g., solids, liquids, and gases at the macro level).

- In the model, students describe relationships between components, including:
    - Individual atoms, from two to thousands, combine to form molecules, which can be made up of the same type or different types of atom.
    - Some molecules can connect to each other.
    - In some molecules, the same atoms of different elements repeat; in other molecules, the same atom of a single element repeats.
- Students use models to describe that:
    - Pure substances are made up of a bulk quantity of individual atoms or molecules. Each pure substance is made up of one of the following:
        - 1. Individual atoms of the same type that are connected to form extended structures.
        - 2. Individual atoms of different types that repeat to form extended structures (e.g., sodium chloride).
        - 3. Individual atoms that are not attracted to each other (e.g., helium).
        - 4. Molecules of different types of atoms that are not attracted to each other (e.g., carbon dioxide).
        - 5. Molecules of different types of atoms that are attracted to each other to form extended structures (e.g., sugar, nylon).
        - 6. Molecules of the same type of atom that are not attracted to each other (e.g., oxygen).
            - Students use the models to describe how the behavior of bulk substances depends on their structures at atomic and molecular levels, which are too small to see.
- Organize given data about the characteristic physical and chemical properties (e.g., density, melting point, boiling point, solubility, flammability, odor) of pure substances before and after they interact.
- Organize the given data in a way that facilitates analysis and interpretation.
- Analyze the data to identify patterns (i.e., similarities and differences), including the changes in physical and chemical properties of each substance before and after the interaction (e.g., before the interaction, a substance burns, while after the interaction, the resulting substance does not burn)
- Use the analyzed data to determine whether a chemical reaction has occurred.
- Support their interpretation of the data by describing that the change in properties of substances is related to the rearrangement of atoms in the reactants and products in a chemical reaction (e.g., when a reaction has occurred, atoms from the substances present before the interaction must have been rearranged into new configurations, resulting in the properties of new substances).

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- Develop a model of a simple molecule.

- Use the model of the simple molecule to describe its atomic composition.
- Develop a model of an extended structure.
- Use the model of the extended structure to describe its repeating subunits.
- Analyze and interpret data to determine similarities and differences from results of chemical reactions between substances before and after they undergo a chemical process.
- Analyze and interpret data on the properties of substances before and after they undergo a chemical process.
- Identify and describe possible correlation and causation relationships evidenced in chemical reactions.
- Make logical and conceptual connections between evidence that chemical reactions have occurred and explanations of the properties of substances before and after they undergo a chemical process

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

RESOURCES

Teacher Resources include but are not limited to:

- Middle school Chemistry, Chapter 1: Solids, Liquids, and Gases Students are introduced to the idea that matter is composed of atoms and molecules that are attracted to each other and in constant motion. Students explore the attractions and motion of atoms and molecules as they experiment with and observe the heating and cooling of a solid, liquid, and gas.

- Middle school Chemistry, Chapter 2: Changes of State Students help design experiments to test whether the temperature of water affects the rate of evaporation and whether the temperature of water vapor affects the rate of condensation. Students also look in more detail at the water molecule to help explain the state changes of water.
- States of Matter: Use interactive computer models to trace an atom's trajectory at a certain physical stage, and investigate how molecular behavior is responsible for the substance's state.
- Molecular View of a Gas: Explore the structure of a gas at the molecular level. Molecules are always in motion. Molecules in a gas move quickly. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts.
- Molecular View of a Liquid: Explore the structure of a liquid at the molecular level. Molecules are always in motion. Molecules in a liquid move moderately. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts.
- Molecular View of a Solid: Explore the structure of a solid at the molecular level. Molecules are always in motion, though molecules in a solid move slowly. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts.
- Stick and Ball Model Activities
- Explorelearning.com:
    - Element Builder: Use protons, neutrons, and electrons to build elements. As the number of protons, neutrons, and electrons changes, information such as the name and symbol of the element, the Z, N, and A numbers, the electron dot diagram, and the group and period from the periodic table are shown. Each element is classified as a metal, metalloid, or nonmetal, and its state at room temperature is also given.
    - Properties of Matter: STEM Case: The Secret Service has arrested suspects accused of counterfeiting coins from the year 1915 valued at $50,000 each. The students act as a forensic scientist to investigate the crime scene and evidence. Students learn about the properties of matter to recreate the methods used to make the coins as evidence for the trial.
    - Chemical and Physical Changes: STEM Case: The Secret Service has arrested suspects accused of counterfeiting coins from the year 1915 valued at $50,000 each. The students act as a forensic scientist to investigate the crime scene and evidence. Students learn about the properties of matter to recreate the methods used to make the coins as evidence for the trial.
    - Chemical Changes: Chemical changes result in the formation of new substances. But how can you tell if a chemical change has occurred? Explore this question by observing and measuring a variety of chemical reactions. Along the way you will learn about chemical equations, acids and bases, exothermic and endothermic reactions, and conservation of matter.
- Brainpop

- MosaMack: Atoms & Molecules: In Mosa Mack's Atoms and Molecules unit, students solve two atomic mysteries through which they discover the components of molecules and atoms. They are then led through an activity in which they construct atomic and molecular models. The unit culminates in an element challenge in which students select an element and bring it to life by either creating a profile for it or designing a product based on it.
- MosaMack: Chemical & Physical Changes: In the Chemical & Physical Interactions unit, students are led through a progression of three inquiry lessons that focus on the differences between physical and chemical changes.
- StudyJams (Scholastic): Physical and Chemical Changes: Physical changes mean matter changes size or shape, not its atomic makeup. Chemical and nuclear changes alter matter on an atomic level.
- StudyJams (Scholastic): Properties of Matter: Matter is anything that has mass and takes up space. That is why mass and volume are the properties of matter.

Equipment Needed:

- Foss:Chemical Interactions- "Substances" Investigation 1 all parts ("Mystery Mixture," and "Mixing Substances")
    - Notebook Sheets 1-6
    - Reading "White Substances"
    - Fossweb Online Activity:
        - "Chemical Interactions"
        - "Two Substance Reactions"
- Foss:Chemical Interactions- "Reaction" Investigation 9 all parts ("Substance Models," "Limewater Reaction," "Baking Soda and Acid.")
    - Notebook Sheets 56-60
    - Readings:
        - "Better Living through Chemistry"
        - "The Periodic Table of the Elements"
        - "Atoms and Compounds"
        - "Compound Structure"
        - "How Do Atoms Rearrange?"
        - "Fireworks"
        - "Antoine-Laurent Lavoisier"
        - "Organic Compounds"
    - Fossweb Online Activity:
        - "Chemical Interactions"
        - "Two Substance Reactions"
        - "Burning Sugar Demonstration"

UNIT OVERVIEW

Content Area: Science

Unit Title: Chemical Reactions

Target Course/Grade Level: 8th

Unit Summary:

Students provide molecular-level accounts of states of matters and changes between states, of how chemical reactions involve regrouping of atoms to form new substances, and of how atoms rearrange during chemical reactions. Students also apply their understanding of optimization design and process in engineering to chemical reaction systems. The crosscutting concept of energy and matter provides a framework for understanding the disciplinary core ideas. Students are expected to demonstrate proficiency in developing and using models, analyzing and interpreting data, designing solutions, and obtaining, evaluating, and communicating information

Approximate Length of Unit: 5 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

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.

MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

Career Readiness, Life Literacies, and Key Skills:

9.4.8.CI.1: Assess data gathered on varying perspectives on causes of climate change (e.g., cross cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions.

9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).

9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option.

9.4.8.GCA.2: Demonstrate openness to diverse ideas and perspectives through active discussions to achieve a group goal.

9.4.8.IML.1: Critically curate multiple resources to assess the credibility of sources when searching for information.

9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting

techniques such as form, position, size, color, movement, and spatial grouping.

9.4.8.IML.4: Ask insightful questions to organize different types of data and create meaningful visualizations.

9.4.8.IML.12: Use relevant tools to produce, publish, and deliver information supported with evidence for an authentic audience.

9.4.8.TL.1: Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.

9.4.8.TL.2: Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).

9.4.8.TL.3: Select appropriate tools to organize and present information digitally.

9.4.8.TL.4: Synthesize and publish information about a local or global issue or event.

Interdisciplinary Connections and Standards:

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

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

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.

RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

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).

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

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

NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.

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

A. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.

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.

C. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.

D. Establish and maintain a formal/academic style, approach, and form.

E. Provide a concluding statement or section that follows from and supports the argument presented.

Unit Understandings:

Students will understand that…

- Substances react chemically in characteristic ways.
- In a chemical process, the atoms that make up the original substances are regrouped into different molecules.

- New substances created in a chemical process have different properties from those of the reactants.
- The total number of each type of atom in a chemical process is conserved, and thus the mass does not change (the law of conservation of matter).
- Matter is conserved because atoms are conserved in physical and chemical processes.
- The law of conservation of mass is a mathematical description of natural phenomena.
- Some chemical reactions release energy, while others store energy.
- The transfer of thermal energy can be tracked as energy flows through a designed or natural system.
- Models of all kinds are important for testing solutions.
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.
- 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.
- A solution needs to be tested and then modified on the basis of the test results in order for it to be improved.
- 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.
- Some of the characteristics identified as having the best performance may be incorporated into the new design.

Unit Essential Questions:

- What happens to the atoms when I bake a cake?
- How do substances combine or change (react) to make new substances?
- How can a device be designed, constructed, tested, and modified that either releases or absorbs thermal energy by chemical processes?

Knowledge and Skills:

Students will know...

- 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.
- Some chemical reactions release energy, others store energy.
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
- 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.

Students will be able to...

- To make sense of a given phenomenon, students develop a model in which they identify the relevant components for a given chemical reaction, including:
    - The types and number of molecules that make up the reactants.
    - The types and number of molecules that make up the products.
- In the model, students describe relationships between the components, including:
    - Each molecule in each of the reactants is made up of the same type(s) and number of atoms.
    - When a chemical reaction occurs, the atoms that make up the molecules of reactants rearrange and form new molecules (i.e., products).
    - The number and types of atoms that make up the products are equal to the number and types of atoms that make up the reactants.
    - Each type of atom has a specific mass, which is the same for all atoms of that type.
- Use the model to describe that the atoms that make up the reactants rearrange and come together in different arrangements to form the products of a reaction.
- Use the model to provide a causal account that mass is conserved during chemical reactions because the number and types of atoms that are in the reactants equal the number and types of atoms that are in the products, and all atoms of the same type have the same mass regardless of the molecule in which they are found.
- Given a problem to solve that requires either heating or cooling, students design and construct a solution (i.e., a device). In their designs, students:
    - Identify the components within the system related to the design solution, including:
        - 1. The components within the system to or from which energy will be transferred to solve the problem.
        - 2. The chemical reaction(s) and the substances that will be used to either release or absorb thermal energy via the device.
    - Describe how the transfer of thermal energy between the device and other components within the system will be tracked and used to solve the given problem.
- Students test the solution for its ability to solve the problem via the release or absorption of thermal energy to or from the system. Students use the results of their tests to systematically determine how well the design solution meets the criteria and constraints, and which characteristics of the design solution performed the best.
- Students modify the design of the device based on the results of iterative testing, and improve the design relative to the criteria and constraints.

EVIDENCE OF LEARNING

Assessment:

What evidence will be collected and deemed acceptable to show that students truly "understand"?

- **End of Unit Assessment: Students will …**

- Use physical models or drawings, including digital forms, to represent atoms in a chemical process.
- Use mathematical descriptions to show that the number of atoms before and after a chemical process is the same.
- Undertake a design project, engaging in the design cycle, to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
- Specific criteria are limited to amount, time, and temperature of a substance.
- Analyze and interpret data for the amount, time, and temperature of a substance in testing a device that either releases or absorbs thermal energy by chemical processes to determine similarities and differences in findings.
- Develop a model to generate data for testing a device that either releases or absorbs thermal energy by chemical processes, including those representing inputs and outputs of thermal energy.
- Track the transfer of thermal energy as energy flows through a designed system that either releases or absorbs thermal energy by chemical processes.

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

RESOURCES

Teacher Resources:

- Middle School Chemistry, Chapter 4: Periodic Table and Bonding: (Lesson 1 and 2 only) Students look deeply into the structure of the atom and play a game to better understand

the relationship between protons, neutrons, electrons, and energy levels in atoms and their location in the periodic table. Predict how elements will react to each other based on their location in the periodic table. Lesson 1: Students are constructing an explanation of why charges attract or repel.

- Middle School Chemistry, Chapter 5: The Water Molecule and Dissolving: Students investigate the polarity of the water molecule and design tests to compare water to less polar liquids for evaporation rate, surface tension, and ability to dissolve certain substances. Students also discover that dissolving applies to solids, liquids, and gases.
- Middle School Chemistry, Chapter 6: Chemical Change: Students explore the concept that chemical reactions involve the breaking of certain bonds between atoms in the reactants, and the rearrangement and re-bonding of these atoms to make the products. Students also design tests to investigate how the amount of products and the rate of the reaction can be changed. Students will also explore endothermic and exothermic reactions. Students are using models to match what happens during a chemical change and mass is conserved.
- Gumdrop Models: Students will design a model to explain the structure of an atom. This activity will allow for fast pacing for the gifted and talented students. Students will be given Data Cards to develop and modify models of molecules. Content will be differentiated Data Cards will begin with the construction of an atom. As students finish construction, they will draw the atom/molecule as a summative assessment.
- MosaMack: Chemical & Physical Changes: In the Chemical & Physical Interactions unit, students are led through a progression of three inquiry lessons that focus on the differences between physical and chemical changes.
- StudyJams (Scholastic): Physical and Chemical Changes: Physical changes mean matter changes size or shape, not its atomic makeup. Chemical and nuclear changes alter matter on an atomic level.
- Explorelearning.com:
    - Chemical and Physical Changes: STEM Case: The Secret Service has arrested suspects accused of counterfeiting coins from the year 1915 valued at $50,000 each. The students act as a forensic scientist to investigate the crime scene and evidence. Students learn about the properties of matter to recreate the methods used to make the coins as evidence for the trial.
    - Chemical Changes: Chemical changes result in the formation of new substances. But how can you tell if a chemical change has occurred? Explore this question by observing and measuring a variety of chemical reactions. Along the way you will learn about chemical equations, acids and bases, exothermic and endothermic reactions, and conservation of matter.
    - Brainpop: Chemical Equations

Equipment Needed:

- Foss: Chemical Interactions- "Reaction" Investigation 9 all parts ("Substance Models," "Limewater Reaction," "Baking Soda and Acid.")
    - Notebook Sheets 56-60
    - Readings:
        - "Better Living through Chemistry"
        - "The Periodic Table of the Elements"

        - “Atoms and Compounds”
        - “Compound Structure”
        - “How Do Atoms Rearrange?”
        - “Fireworks”
        - “Antoine-Laurent Lavoisier”
        - “Organic Compounds”
    - Fossweb Online Activity:
        - “Chemical Interactions”
        - “Two Substance Reactions”
        - “Burning Sugar Demonstration”

UNIT OVERVIEW

Content Area: Science

Unit Title: Earth Systems

Target Course/Grade Level: 8th

Unit Summary:

Students examine geoscience data in order to understand processes and events in Earth's history. Important crosscutting concepts in this unit are scale, proportion, and quantity, stability and change, and patterns in relation to the different ways geologic processes operate over geologic time. An important aspect of the history of Earth is that geologic events and conditions have affected the evolution of life, but different life forms have also played important roles in altering Earth's systems. Students understand how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students investigate the controlling properties of important materials and construct explanations based on the analysis of real geoscience data.

Approximate Length of Unit: 4 weeks

LEARNING TARGETS

NJ Student Learning Standards:
Science:

MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.

MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

MS-ESS2-3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

Career Readiness, Life Literacies, and Key Skills:

9.4.8.CI.1: Assess data gathered on varying perspectives on causes of climate change (e.g., cross cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions.

9.4.8.CT.1: Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective (e.g., MS-ETS1-2).

9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option.
9.4.8.GCA.2: Demonstrate openness to diverse ideas and perspectives through active discussions to achieve a group goal.
9.4.8.IML.1: Critically curate multiple resources to assess the credibility of sources when searching for information.
9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.
9.4.8.IML.4: Ask insightful questions to organize different types of data and create meaningful visualizations.
9.4.8.IML.12: Use relevant tools to produce, publish, and deliver information supported with evidence for an authentic audience.
9.4.8.TL.1: Construct a spreadsheet in order to analyze multiple data sets, identify relationships, and facilitate data-based decision-making.
9.4.8.TL.2: Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
9.4.8.TL.3: Select appropriate tools to organize and present information digitally.
9.4.8.TL.4: Synthesize and publish information about a local or global issue or event.

NJ SLS Companion Standards: Reading and Writing Standards for History, Social Studies, Science, and Technical Subjects:

RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts.
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.
RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
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).
NJSLSA.W1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
NJSLSA.W6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
NJSLSA.W7. Conduct short as well as more sustained research projects, utilizing an inquiry-based research process, based on focused questions, demonstrating understanding of the subject under investigation.
WHST.6-8.1. Write arguments focused on discipline-specific content.

A. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
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.
C. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
D. Establish and maintain a formal/academic style, approach, and form.
E. Provide a concluding statement or section that follows from and supports the argument presented.

Unit Understandings:

Students will understand that…

- The geologic time scale is used to organize Earth's 4.6-billion-year-old history.
- Rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history.
- The geologic time scale interpreted from rock strata provides a way to organize Earth's history.
- Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale.
- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
- Energy drives the process that results in the cycling of Earth's materials.
- The processes of melting, crystallization, weathering, deformation, and sedimentation act together to form minerals and rocks through the cycling of Earth's materials.
- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems.
- Energy flowing and matter cycling within and among the planet's systems derive from the sun and Earth's hot interior.
- Energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.
- Explanations of stability and change in Earth's natural systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.
- Geoscience processes have changed Earth's surface at varying time and spatial scales.
- Processes change Earth's surface at time and spatial scales that can be large or small; many geoscience processes usually behave gradually but are punctuated by catastrophic events.
- Geoscience processes shape local geographic features.
- The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years.
- Interactions among Earth's systems have shaped Earth's history and will determine its future.
- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.
- Time, space, and energy phenomena within Earth's systems can be observed at various scales using models to study systems that are too large or too small.
- Tectonic processes continually generate new sea floor at ridges and destroy old sea floor at trenches.
- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart.
- Patterns in rates of change and other numerical relationships can provide information about past plate motions.
- The distribution of fossils and rocks, continental shapes, and sea floor structures to provide evidence of past plate motions.

- Similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches) provide evidence of past plate motions.

Unit Essential Questions:

- How do we know that the Earth is approximately 4.6-billion-year-old history?
- What drives the cycling of Earth's materials?
- Do all of the changes to Earth systems occur in similar time scales?
- How is it possible for the same kind of fossils to be found in New Jersey and in Africa?

Knowledge and Skills:

Students will know...

- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale.
- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.
- The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.
- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.
- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches.
- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart.

Students will be able to...

- Articulate a statement that relates the given phenomenon to a scientific idea, including how events in the Earth's 4.6 billion-year-old history are organized relative to one another using the geologic time scale.
- Use evidence and reasoning to construct an explanation. In their explanation, students describe how the relative order of events is determined on the geologic time scale using:
    - Rock strata and relative ages of rock units (e.g., patterns of layering).
    - Major events in the Earth's history and/or specific changes in fossils over time (e.g., formation of mountain chains, formation of ocean basins, volcanic eruptions, glaciations, asteroid impacts, extinctions of groups of organism).
- Identify and describe the evidence necessary for constructing the explanation, including:
    - Types and order of rock strata.
    - The fossil record.
    - Identification of and evidence for major event(s) in the Earth's history (e.g., volcanic eruptions, asteroid impacts, etc.).
- Students use multiple valid and reliable sources of evidence, which may include students' own experiments.

- Students use reasoning, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to connect the evidence and support an explanation for how the geologic time scale is used to construct a timeline of the Earth's history. Students describe the following chain of reasoning for their explanation:
    - Unless they have been disturbed by subsequent activity, newer rock layers sit on top of older rock layers, allowing for a relative ordering in time of the formation of the layers (i.e., older sedimentary rocks lie beneath younger sedimentary rocks).
    - Any rocks or features that cut existing rock strata are younger than the rock strata that they cut (e.g., a younger fault cutting across older, existing rock strata).
    - The fossil record can provide relative dates based on the appearance or disappearance of organisms (e.g., fossil layers that contain only extinct animal groups are usually older than fossil layers that contain animal groups that are still alive today, and layers with only microbial fossils are typical of the earliest evidence of life).
    - Specific major events (e.g., extensive lava flows, volcanic eruptions, asteroid impacts) can be used to indicate periods of time that occurred before a given event from periods that occurred after it.
    - Using a combination of the order of rock layers, the fossil record, and evidence of major geologic events, the relative time ordering of events can be constructed as a model for Earth's history, even though the timescales involved are immensely vaster than the lifetimes of humans or the entire history of humanity.
- To make sense of a given phenomenon, students develop a model in which they identify the relevant components, including:
    - General types of Earth materials that can be found in different locations, including:
        - 1. Those located at the surface (exterior) and/or in the interior
        - 2. Those that exist(ed) before and/or after chemical and/or physical changes that occur during Earth processes (e.g., melting, sedimentation, weathering).
    - Energy from the sun.
    - Energy from the Earth's hot interior.
    - Relevant earth processes
    - The temporal and spatial scales for the system
- Describe relationships between components, including:
    - Different Earth processes (e.g., melting, sedimentation, crystallization) drive matter cycling (i.e., from one type of Earth material to another) through observable chemical and physical changes.
    - The movement of energy that originates from the Earth's hot interior and causes the cycling of matter through the Earth processes of melting, crystallization, and deformation.
    - Energy flows from the sun cause matter cycling via processes that produce weathering, erosion, and sedimentation (e.g., wind, rain).
    - The temporal and spatial scales over which the relevant Earth processes operate.

- Use the model to describe (based on evidence for changes over time and processes at different scales) that energy from the Earth's interior and the sun drive Earth processes that together cause matter cycling through different forms of Earth materials.
- Use the model to account for interactions between different Earth processes, including:
    - The Earth's internal heat energy drives processes such as melting, crystallization, and deformation that change the atomic arrangement of elements in rocks and that move and push rock material to the Earth's surface where it is subject to surface processes like weathering and erosion.
    - Energy from the sun drives the movement of wind and water that causes the erosion, movement, and sedimentation of weathered Earth materials.
    - Given the right setting, any rock on Earth can be changed into a new type of rock by processes driven by the Earth's internal energy or by energy from the sun.
- Describe that these changes are consistently occurring but that landforms appear stable to humans because they are changing on time scales much longer than human lifetimes.
- Articulate a statement that relates a given phenomenon to a scientific idea, including that geoscience processes have changed the Earth's surface at varying time and spatial scales.
- Use evidence and reasoning to construct an explanation for the given phenomenon, which involves changes at Earth's surface.
- Identify and describe the evidence necessary for constructing an explanation, including:
    - The slow and large-scale motion of the Earth's plates and the results of that motion.
    - Surface weathering, erosion, movement, and the deposition of sediment ranging from large to microscopic scales (e.g., sediment consisting of boulders and microscopic grains of sand, raindrops dissolving microscopic amounts of minerals).
    - Rapid catastrophic events (e.g., earthquakes, volcanoes, meteor impacts)
- Identify the corresponding timescales for each identified geoscience process.
- Use multiple valid and reliable sources, which may include students' own investigations, evidence from data, and observations from conceptual models used to represent changes that occur on very large or small spatial and/or temporal scales (e.g., stream tables to illustrate erosion and deposition, maps and models to show the motion of tectonic plates).
- Use reasoning, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to connect the evidence and support an explanation for how geoscience processes have changed the Earth's surface at a variety of temporal and spatial scales. Students describe the following chain of reasoning for their explanation:
    - The motion of the Earth's plates produces changes on a planetary scale over a range of time periods from millions to billions of years. Evidence for the motion of plates can explain large scale features of the Earth's surface (e.g., mountains, distribution of continents) and how they change.
    - Surface processes such as erosion, movement, weathering, and the deposition of sediment can modify surface features, such as mountains, or create new features, such as canyons. These processes can occur at spatial scales ranging from large to microscopic over time periods ranging from years to hundreds of millions of years.

    - Catastrophic changes can modify or create surface features over a very short period of time compared to other geoscience processes, and the results of those catastrophic changes are subject to further changes over time by processes that act on longer time scales (e.g., erosion of a meteor crater).
    - A given surface feature is the result of a broad range of geoscience processes occurring at different temporal and spatial scales.
    - Surface features will continue to change in the future as geoscience processes continue to occur
- Organize given data that represent the distribution and ages of fossils and rocks, continental shapes, seafloor structures, and/or age of oceanic crust.
- Describe what each dataset represents.
- Organize the given data in a way that facilitates analysis and interpretation.
- Students analyze the data to identify relationships (including relationships that can be used to infer numerical rates of change, such as patterns of age of seafloor) in the datasets about Earth features.
- Use the analyzed data to provide evidence for past plate motion. Students describe:
    - Regions of different continents that share similar fossils and similar rocks suggest that, in the geologic past, those sections of continent were once attached and have since separated.
    - The shapes of continents, which roughly fit together (like pieces in a jigsaw puzzle) suggest that those land masses were once joined and have since separated.
    - The separation of continents by the sequential formation of new seafloor at the center of the ocean is inferred by age patterns in oceanic crust that increase in age from the center of the ocean to the edges of the ocean.
    - The distribution of seafloor structures (e.g., volcanic ridges at the centers of oceans, trenches at the edges of continents) combined with the patterns of ages of rocks of the seafloor (youngest ages at the ridge, oldest ages at the trenches) supports the interpretation that new crust forms at the ridges and then moves away from the ridges as new crust continues to form and that the oldest crust is being destroyed at seafloor trenches.

EVIDENCE OF LEARNING

Assessment:
What evidence will be collected and deemed acceptable to show that students truly "understand"?
End of Unit Assessment: Students will …

- Construct a scientific explanation based on valid and reliable evidence from rock strata obtained from sources (including the students' own experiments).
- Construct a scientific explanation based on rock strata 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.
- Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

- Construct a scientific explanation for how geoscience processes have changed Earth's surface at varying time and spatial scales based on valid and reliable evidence obtained from sources (including the students' own experiments).
- Construct a scientific explanation for how geoscience processes have changed Earth's surface at varying time and spatial scales based on the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
- Collect evidence about processes that change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges).
- Collect evidence about processes that change Earth's surface at time and spatial scales that can be small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events.

Learning Activities:

What differentiated learning experiences and instruction will enable all students to achieve the desired results?

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

RESOURCES

Teacher Resources include but are not limited to:

- Rock Cycle Journey: This is an activity out of one of the DLESE Teaching boxes. The Teaching Box is titled Mountain Building. This activity is from Lesson 4 Activity #2 called Rock Cycle Journey. Stations are set up to represent different parts of the rock cycle. There is a die at each station. Students begin at one point and roll the die. The

students record on their data sheet what happens to them (the rock). The student may end up staying where they are at or going to another station. Students continue individually through a set number of rolls of the dice. Students then look at their data and answer some questions. At the very end they share their information with others.

- Interactives-Dynamic Earth: Dynamic Earth is an interactive website where students can learn about the structure of the Earth, the movements of its tectonic plates, as well as the forces that create mountains, valleys, volcanoes and earthquakes. This site consists of four sections with both embedded assessments to check progress and a final summative assessment. Each section explores one aspect of the earth's structure and the movement of its tectonic plates. The instructions are simple and are located on each screen. Students will view animations, read explanations, and use their mouse to drag and drop the earth's continents into the correct places, highlight features on a map and cause earth's tectonic plates to move. At various points, students will check their knowledge by taking a quick quiz or playing a game to see how much they have learned about the Dynamic Earth. This website does have teacher information tabs located as related resources.
- ExploreLearning.com
    - Rock Cycle: Play the role of a piece of rock moving through the rock cycle. Select a starting location and follow many possible paths throughout the cycle. Learn how rocks are formed, weathered, eroded, and reformed as they move from Earth's surface to locations deep within the crust.
    - Weathering: Weathering is the breakdown of rock at Earth's surface through physical or chemical means. Students will learn about the different types of mechanical and chemical weathering, then use a simulation to model the effects of weathering on different types of rocks in varying climate conditions.
    - Erosion Rates: Explore erosion in a simulated 3D environment. Observe how the landscape evolves over time as it is shaped by the forces of flowing water. Vary the initial landscape, rock type, precipitation amount, average temperature, and vegetation and measure how each variable affects the rate of erosion and resulting landscape features.
    - Building Pangea: In 1915, Alfred Wegener proposed that all of Earth's continents were once joined in an ancient supercontinent he called Pangaea. Wegener's idea of moving continents led to the modern theory of plate tectonics. Create your own version of Pangaea by fitting Earth's landmasses together like puzzle pieces. Use evidence from fossils, rocks, and glaciers to refine your map.
- Brainpop
- MosaMack: Plate Tectonics: Learners will help Mosa figure out how Lystrosaurus fossils were found on three different continents. Following the mystery, students construct a model of a supercontinent (Pangea) and engineer a device to track the motion of plates.
- MosaMack: Earthquakes & Volcanoes: In Mosa Mack's Earthquakes and Volcanoes unit, students are led through a progression of three inquiry lessons that focus on the interaction of tectonic plates, the causes of Earthquakes and Volcanoes, and the impact of these events.
- MosaMack: Rock Cycle & Earth's History: In Mosa Mack's Rock Cycle unit, students are led through a progression of three inquiry lessons that focus on the properties of igneous, sedimentary and metamorphic rocks and the forces responsible for creating them. Forces include heat, pressure, cooling, weathering and erosion.

Equipment Needed:

- Foss Earth History- "Weathering and Erosion" Investigation 2 parts 1-3 ("Sorting Earth Materials," "Stream Table," and "Weathering.")
    - Notebook sheets 10-19
    - Readings
        - "Wentworth Scale of Rock Particle Sizes"
        - "Grand Canyon Flood"
        - "Landforms Vocabulary"
        - "Colorado Plateau Map"
        - "Weathering and Erosion"
        - "Caverns"
        - "Sand Analysis"
        - "Sand on the Move"
        - "Mystery Sands"
    - Fossweb Online Activity:
        - "Earth History"
        - "Debris Flow"
        - "Rock Fall"
        - "Frost Wedging"
        - "Freezing Glass Bottle"
        - "Sand Types"

- Foss Earth History - "Deposition" Investigation 3 all parts ("Sandstone and Shale," "Limestone," and "Interpreting Sedimentary Layers.")
    - Notebook Sheets 21-22
    - Readings
        - "Modern Sedimentary Environments"
        - "Where in the World is Calcium Carbonate?"
        - "Water On Mars"
    - Fossweb Online Activity
        - "Sandstone Formation"
        - "Rock Database"
        - "Shale Formation"
        - "Zion National Park Expedition"
        - "Limestone Formation"
        - "Rock Column Movie Maker"
        - "Sedimentary Rocks"

- Foss Earth History - "Fossils and Past Environments" Investigation 4 parts 1, 2, & 4 ("Fossils," "A Long Time Ago," "Index Fossils.")
    - Notebook Sheets 24-29
    - Video Fearless Planet
    - Readings
        - "A Fossil Primer"
        - "Coconino Stories"

        - "Modern Sedimentary Environments"
        - "Other Features in Sedimentary Rocks"
        - "Fossil Identification: Invertebrates and Plants"
        - "Grand Canyon Fossils"
        - "Rocks, Fossils, and Time"
        - "Floating on a Prehistoric Sea"
        - "Colorado Plateau Map"
        - "Index Fossil Key"
        - "The Great Unconformity"
    - Fossweb Online Activities
        - "Sandstone Formation"
        - "Shale Formation"
        - "Limestone Formation"
        - "Rock Column Movie Maker"

- Foss Earth History - "Igneous Rocks" Investigation 5 all parts ("Earth's layers," "Salol Crystals," and "Types of Igneous Rocks.")
    - Notebook Sheets 30 -32
    - Readings:
        - "Minerals, Crystals, and Rocks"
        - "Looking at Igneous Rocks"
        - "Some Fairly Common Earth Rocks"
        - "Map of the Pacific Northwest: Igneous Rock Locations"
    - Fossweb Online Activities
        - "Pacific Northwest Tour"
        - "Earth's Interior"
        - "Salol Crystal Formation"
        - "Extrusive Rock Formation"
        - "Intrusive Rock Formation"
        - "Yosemite National Park Field Trip"
        - "Hawaii Field Trip"

- Foss Earth History - "Volcanoes and Earthquakes" Investigation 6 all parts ("Mapping Volcanoes and Earthquakes," "Moving Continents," and "Plate Tectonics.")
    - Notebook Sheets 33-40
    - Readings
        - "Volcanoes"
        - "The Human Story of the Theory of Plate Tectonics"
        - "Historical Debates about a Dynamic Earth"
    - Fossweb Online Activities
        - "Longitude and Latitude"
        - "Volcano Plotting Activity"
        - "Volcanoes around the World"
        - "Volcanoes Formation"
        - "Earthquake Plotting Activity"
        - "Earthquakes around the World"

        - "Mount St. Helens: The Eruption Impact"
        - "Wegner"
        - "NOAA Plate Tectonics"
        - "Convection Video"
        - "Plate Boundaries Map"
- Foss Earth History - "Mountains and Metamorphic Rocks" Investigation 7 parts 1-3 ("Plate Models," "Mountains," "Metamorphic Rocks.")
    - Notebook Sheets 42 -43
    - Readings
        - "Earth's Dynamic Systems"
        - "Rock Transformations"
        - "Some Fairly Common Earth Rocks"
    - Fossweb Online Activities
        - "Earth History"
        - "Mountain Types"
        - "Volcanoes around the World"
        - "Earthquakes around the World"
        - "Mountain-Card Locations"
        - "Appalachian Mountain Tour"
        - "How Metamorphic Rocks Form"
        - "Slate"