Smithsonian

STC
SCIENCE AND TECHNOLOGY CONCEPTS™
MIDDLE SCHOOL

ENGAGE. INSPIRE. CONNECT.

LEARNING PROGRESSIONS
GRADES 6-8

LESSON SUMMARIES FOR
STC MIDDLE SCHOOL™

SETTING THE STANDARD IN
3D LEARNING AND 3D ASSESSMENT

CAROLINA®
www.carolina.com

Smithsonian

Smithsonian's STCMS—Setting the Standard in 3D Learning and 3D Assessment in Middle School

NEW Smithsonian's STCMS™ empowers students and teachers for success in middle school science and beyond!

Connect directly to the three dimensions of NGSS

With three-dimensional instruction that goes beyond the Next Generation Science Standards*, STCMS is setting the standard in 3D learning and 3D assessment:

- Coherent storylines
- Proven results
- Teacher support

STCMS™ Learning Framework

Grades 6–8

LIFE Sciences	EARTH/SPACE Sciences	PHYSICAL Sciences
Ecosystems and Their Interactions	Weather and Climate Systems	Energy, Forces, and Motion
Structure and Function	Earth's Dynamic Systems	Matter and Its Interactions
Genes and Molecular Machines	Space Systems Exploration	Electricity, Waves, and Information Transfer
Why Are Honey Bees Disappearing?		
What Evidence Suggests Similarities Among Organisms?		
How Can We Use Technology to Monitor Aquatic Ecosystems?		

Three-dimensional learning is the signature innovation of the Next Generation Science Standards. STCMS™ supports teachers and students by weaving together Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts to address Performance Expectations over time.

*Next Generation Science Standards® (NGSS) is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards were involved in the production of, and do not endorse, these products.

Smithsonian's STCMS™ modules are grounded in NGSS three-dimensional learning:

- Research-based curriculum proven to **raise test scores in science, math, and reading**
- **Engineering design challenges** and science **investigations** to **integrate** seamlessly the **Science and Engineering Practices**
- Real-world phenomena that anchor practices-based instruction
- **Coherent learning progressions** that revisit and expand student understandings

The NGSS Are Clear: Students Need Hands-On Experiences

Out-of-the-box NGSS instruction

With STCMS™, there's no need to purchase lab equipment separately. Everything you need—print, digital, and lab materials—is in one package.

Electricity, Waves, and Information Transfer
1-Class Unit Kit

Each STCMS™ module features:

- **Teacher Edition** (print and digital) that offers support for educators transitioning to NGSS
- **Access to Carolina Science Online®**
  - Teacher edition eBook access
  - Digital student resources and assessments
  - Student sheets and lesson masters, including Spanish
  - Student guide eBook access
- **16 Hardbound Student Guides**
- **Hands-On Materials Kit of Choice:**
  - **1-Class Kit** (with enough materials for up to 32 students)
  - **5-Class Kit** (with enough materials for up to 160 students)

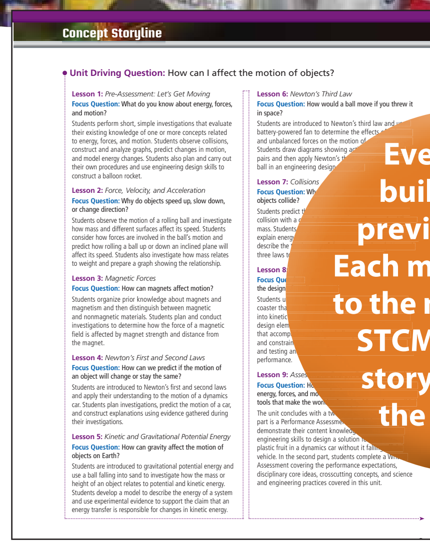
No "Random Acts of Science" When You Have the Smithsonian's STCMS™ in Your Classroom

In need of instruction with a coherent learning progression? Look no further.

For more than 30 years, the Smithsonian Science Education Center has built inquiry science programs that work. What's the secret to this success? Concept storylines that use authentic STEM experiences to help students construct learning.

With the STCMS™ program:

- Each module provides a driving question to focus the entire module.
- Each lesson builds on the previous lesson. This sequence allows students to answer the unit driving question by the end of the module.



Concept Storyline

Unit Driving Question: How can I affect the motion of objects?

Lesson 1: *Pre-Assessment: Let's Get Moving*
Focus Question: What do you know about energy, forces, and motion?
Students perform short, simple investigations that evaluate their existing knowledge of one or more concepts related to energy, forces, and motion. Students observe collisions, construct and analyze graphs, predict changes in motion, and model energy changes. Students also plan and carry out their own procedures and use engineering design skills to construct a balloon rocket.

Lesson 2: *Force, Velocity, and Acceleration*
Focus Question: Why do objects speed up, slow down, or change direction?
Students observe the motion of a rolling ball and investigate how mass and different surfaces affect its speed. Students consider how forces are involved in the ball's motion and predict how rolling a ball up or down an inclined plane will affect its speed. Students also investigate how mass relates to weight and prepare a graph showing the relationship.

Lesson 3: *Magnetic Forces*
Focus Question: How can magnets affect motion?
Students organize prior knowledge about magnets and magnetism and then distinguish between magnetic and nonmagnetic materials. Students plan and conduct investigations to determine how the force of a magnetic field is affected by magnet strength and distance from the magnet.

Lesson 4: *Newton's First and Second Laws*
Focus Question: How can we predict if the motion of an object will change or stay the same?
Students are introduced to Newton's first and second laws and apply their understanding to the motion of a dynamics car. Students plan investigations, predict the motion of a car, and construct explanations using evidence gathered during their investigations.

Lesson 5: *Kinetic and Gravitational Potential Energy*
Focus Question: How can gravity affect the motion of objects on Earth?
Students are introduced to gravitational potential energy and use a ball falling into sand to investigate how the mass or height of an object relates to potential and kinetic energy. Students develop a model to describe the energy of a system and use experimental evidence to support the claim that an energy transfer is responsible for changes in kinetic energy.

Lesson 6: *Newton's Third Law*
Focus Question: How would a ball move if you threw it in space?
Students are introduced to Newton's third law and
battery-powered fan to determine the effects
and unbalanced forces on the motion of
Students draw diagrams showing
pairs and then apply Newton's
ball in an engineering design

Lesson 7: *Collisions*
objects collide?

performance.

Lesson 9:
energy, forces, and
tools that make the
The unit concludes with a
part is a Performance Assessment
demonstrate their content knowledge
engineering skills to design a solution
plastic fruit in a dynamics car without it falling
vehicle. In the second part, students complete a
Assessment covering the performance expectations, disciplinary core ideas, crosscutting concepts, and science and engineering practices covered in this unit.

Every lesson builds on the previous lesson. Each module builds to the next module. STCMS™ concept storylines show the pathway.

What can you expect from every lesson?

- To ignite learning through the introduction of **phenomena**
- To **integrate literacy and math**, which will create deep understanding and provide key tools for success in science
- To engage students in **investigative experiences**, during which they **study, model, and explain phenomena**

Why Phenomena? How Do You Teach It?

The Why: Phenomena-based learning drives curiosity and motivates all students!

Phenomena are a big part of the new standards and the link between all three dimensions of the NGSS. Connecting phenomena to science provides concrete experiences that ignite all students' interest in learning more.

The How: There's a right way to teach phenomena.

Building students' understanding of phenomena requires instruction that is rooted in hands-on experiences rather than students reading about phenomena and "experiencing" them through computer simulations.

The Smithsonian's STCMS™ puts real-world and experiential phenomena in students' hands every day.

To teach phenomena, present events for students to study, model, and explain.

How Do You Know Students Understand?

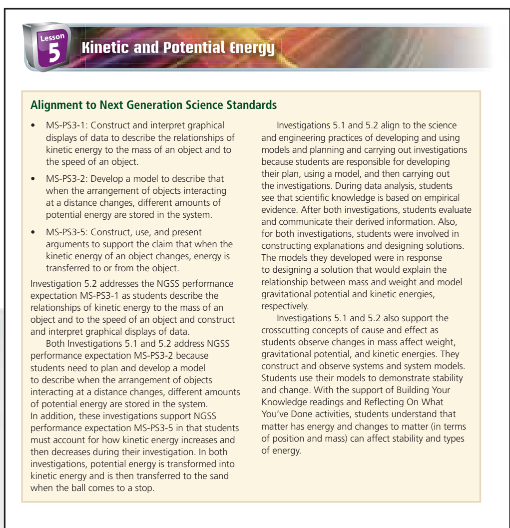
STCMS™ provides powerful assessment every step of the way.

A good assessment system positions students for success on any external assessment that builds toward NGSS standards. **A great assessment system goes further**, providing a coherent structure of classroom-based assessments that give powerful information to inform not only teacher instruction but also student learning.

The Smithsonian's STCMS™ system includes:

- **Pre-assessment**
- Multiple forms of **formative assessment** in each lesson, including **Exit Slips**
- Powerful **self-assessment** for students
- **Summative assessment**—performance and written components targeting the full range of the module's concepts and practices
- Module-specific **NGSS rubrics** to assess three-dimensional learning

STCMS™ provides NGSS rubrics for every module.


Lesson 5 Kinetic and Potential Energy

Alignment to Next Generation Science Standards

- MS-PS3-1: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- MS-PS3-2: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- MS-PS3-5: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Investigation 5.2 addresses the NGSS performance expectation MS-PS3-1 as students describe the relationships of kinetic energy to the mass of an object and to the speed of an object and construct and interpret graphical displays of data.

Both Investigations 5.1 and 5.2 address NGSS performance expectation MS-PS3-2 because students need to plan and develop a model to describe when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
In addition, these investigations support NGSS performance expectation MS-PS3-5 in that students must account for how kinetic energy increases and then decreases during their investigation. In both investigations, potential energy is transformed into kinetic energy and is then transferred to the sand when the ball comes to a stop.

Investigations 5.1 and 5.2 align to the science and engineering practices of developing and using models and planning and carrying out investigations because students are responsible for developing their plan, using a model, and then carrying out the investigations. During data analysis, students see that scientific knowledge is based on empirical evidence. After both investigations, students evaluate and communicate their derived information. Also, for both investigations, students were involved in constructing explanations and designing solutions. The models they developed were in response to designing a solution that would explain the relationship between mass and weight and model gravitational potential and kinetic energies, respectively.

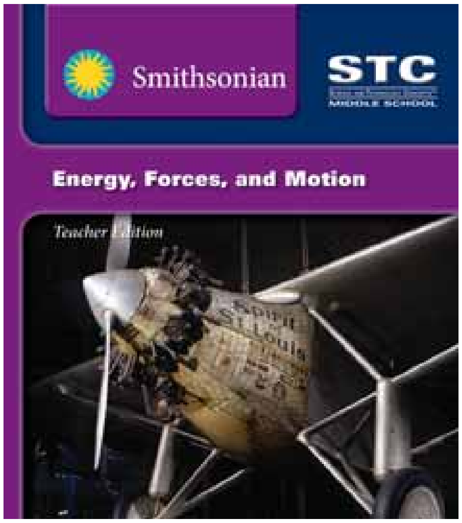
Investigations 5.1 and 5.2 also support the crosscutting concepts of cause and effect as students observe changes in mass affect weight, gravitational potential, and kinetic energies. They construct and observe systems and system models. Students use their models to demonstrate stability and change. With the support of Building Your Knowledge readings and Reflecting On What You've Done activities, students understand that matter has energy and changes to matter (in terms of position and mass) can affect stability and types of energy.

Support for Teachers Transitioning to the New Standards

Three-dimensional learning calls for building to Performance Expectations over time with Science and Engineering Practices, Crosscutting Concepts, and Disciplinary Core Ideas. STCMS™ provides educators with support for this new teaching innovation every step of the way.

STCMS™ truly supports the new NGSS standards and three-dimensional learning.

Energy, Forces, and Motion



Unit Driving Question:

How can I affect the motion of objects?

Performance Expectations: MS-PS2-1, MS-PS2-2, MS-PS2-3, MS-PS2-5, MS-PS3-1, MS-PS3-2, MS-PS3-5, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

Unit Highlight: Students design, refine, and redesign a roller coaster for optimal performance. As part of the unit assessment, students are challenged to apply their content knowledge and science and engineering practice skills to design a solution for safely transporting fruit in a dynamics car.

Lesson 1 *Pre-Assessment*

Focus Question: What do you know about energy, forces, and motion?

Students perform short, simple **investigations** that evaluate their existing knowledge of one or more concepts related to energy, forces, and motion. Students observe collisions, **construct and analyze** graphs, **predict** changes in motion, and **model** energy changes. Students also **plan and carry out** their own procedures and use **engineering design skills** to **construct a balloon rocket**.

Lesson 2 *Force, Velocity, and Acceleration*

Focus Question: Why do objects speed up, slow down, or change direction?

Students observe the motion of a rolling ball and **investigate** how mass and different surfaces affect its speed. Students consider how forces are involved in the ball's motion and **predict** how rolling a ball up or down an inclined plane will affect its speed. Students also **investigate** how mass relates to weight and **prepare a graph** showing the relationship.

Lesson 3 *Magnetic Forces*

Focus Question: How can magnets affect motion?

Students organize prior knowledge about magnets and magnetism and then distinguish between magnetic and nonmagnetic materials. Students **plan and conduct investigations** to determine how the force of a magnetic field is affected by magnet strength and distance from the magnet.

Lesson 4 *Newton's First and Second Laws*

Focus Question: How can we predict if the motion of an object will change or stay the same?

Students are introduced to Newton's first and second laws and **apply their understanding** to the motion of a dynamics car. Students **plan investigations**, **predict** the motion of a car, and **construct explanations using evidence** gathered during their **investigations**.

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Lesson 5 *Kinetic and Potential Energy*

Focus Question: How can gravity affect the motion of objects on Earth?

Students are introduced to gravitational potential energy and use a ball falling into sand to **investigate** how the mass or height of an object relates to potential and kinetic energy. Students **develop a model** to describe the energy of a system and use experimental **evidence to support the claim** that an energy transfer is responsible for changes in kinetic energy.

Lesson 6 *Newton's Third Law*

Focus Question: How would a ball move if you threw it in space?

Students are introduced to Newton's third law and use a battery-powered fan to determine the effects of balanced and unbalanced forces on the motion of a (dynamics) car. Students **draw diagrams** showing action-reaction force pairs and then apply Newton's third law to move a tennis ball in an **engineering design challenge.**

Lesson 7 *Collisions*

Focus Question: What happens to energy when two objects collide?

Students **predict** the motion of a dynamics car following a collision with a car of the same mass and a car of a different mass. Students **apply** the law of conservation of energy to explain energy transfer during a collision, **develop a model** to describe the total energy of the system, and apply Newton's three laws to explain the outcome of a collision.

Lesson 8 *Transforming Energy*

Focus Question: How do energy transformations influence the design of a roller coaster?

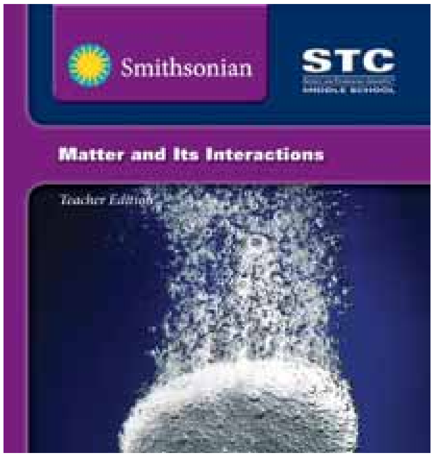
Students use foam pipe insulation to **build a basic roller coaster** that transforms gravitational potential energy into kinetic energy and can be used to test roller coaster design elements. Next, students **construct a roller coaster** that accomplishes a **design challenge** by defining criteria and constraints, evaluating competing design solutions, and **testing and refining designs** to optimize roller coaster performance.

Lesson 9 *Assessment*

Focus Question: How do people use an understanding of energy, forces, and motion to make predictions and design tools that make the world safe, enjoyable, and accessible?

The unit concludes with a two-part assessment. The first part is a performance assessment in which students demonstrate their content knowledge and science and engineering skills to **design a solution** for transporting plastic fruit in a dynamics car without it falling off the vehicle. In the second part, students complete a written assessment that covers the performance expectations, disciplinary core ideas, crosscutting concepts, and science and engineering practices incorporated in this unit.

Matter and Its Interactions



Unit Driving Question:

How do matter and its interactions affect everyday life?

Performance Expectations: MS-PS1-1, MS-PS1-2, MS-PS1-3, MS-PS1-4, MS-PS1-5, MS-PS1-6, MS-PS3-4, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

Unit Highlight: Students utilize content knowledge to design a method to remove impurities from rock salt, a practice that allows us to have salt for our food. As part of the unit assessment, students demonstrate content knowledge and science and engineering practices to design an eco- and pet-friendly cold pack.

Lesson 1 *Pre-Assessment*

Focus Question: What do you know about matter?

Students perform short, simple **investigations** that evaluate their existing knowledge of one or more concepts related to matter and its interactions. Students make observations of pure substances and mixtures, and determine if new substances are formed. Students also **evaluate predictions**, use **evidence to support claims**, and infer **cause-and-effect** relationships.

Lesson 2 *The Nature of Matter*

Focus Question: What can properties of matter help you determine?

Students **observe and describe** samples of matter based on their physical and chemical properties (including solubility and reactivity). Students also identify mystery samples on the basis of their physical and chemical properties.

Lesson 3 *Density Makes a Difference*

Focus Question: How can density be used to identify a substance and predict how it will behave under different conditions?

Students compare the densities of different substances, including liquids and irregularly shaped objects. Students also **make and test predictions** about the floating of solids in liquids and use their findings to re-create the density bottle they explored in the pre-assessment.

Lesson 4 *Just a Phase*

Focus Question: How is energy related to physical changes in matter?

Students record the temperature of water as it melts, warms, and boils and then make connections with molecular-level observations in a computer simulation of the same experiment. Students also **apply their understanding** of the law of conservation of mass to **plan and carry out investigations** of the mass of water as it melts or freezes in a sealed container.

Lesson 5 *Building Blocks of Matter*

Focus Question: How can you use a model to describe the composition of matter?

Students rotate through stations to collect information about 16 different element samples. Next, students combine elements to **create models** of simple molecules using plastic atoms and computer simulations.

Lesson 6 *Pure Substances and Mixtures*

Focus Question: How can mixtures be separated?

Students observe and describe samples of pure substances and mixtures. Students use chromatography to separate inks and to distill flavoring from a carbonated beverage. Students **apply engineering skills to design a method** for removing impurities from rock salt.

Lesson 7 *Reacting Chemically*

Focus Question: How can the properties of matter be used to determine if a chemical reaction has occurred?

Students **analyze and interpret data** on the properties of substances before and after different chemical reactions. Students also use their **data to support the claim** that a new substance has been formed. Chemical reactions include the electrolysis of water; the formation of precipitates; and the combination of sodium bicarbonate, calcium chloride, and phenol red.

Lesson 8 *Releasing Energy*

Focus Question: What is the relationship between changes in substances and changes in thermal energy?

Students **plan and conduct an investigation** to study temperature change that accompanies the oxidation of iron in steel wool. Students also **apply their engineering skills to design** a hot pack that utilizes the exothermic reaction between calcium chloride and water.

Lesson 9 *Conservation of Matter*

Focus Question: What happens to the total mass of matter in a chemical reaction?

Students will **apply their understanding** of the law of conservation of matter to **create models** that explain situations in which matter seems to appear or disappear. Chemical reaction investigations include dissolving an effervescent tablet in water and burning steel wool.

Lesson 10 *Compounds from Natural Resources*

Focus Question: How are synthetic compounds made and used?

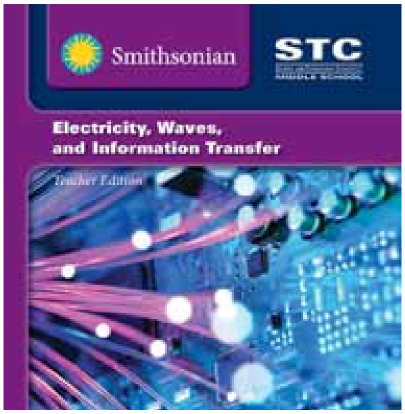
Students read about and **investigate** natural resources that undergo chemical reactions to produce synthetic materials. Students **plan and conduct an investigation** to determine which solutions can be combined with sodium alginate to form a gelatinous product.

Lesson 11 *Assessment*

Focus Question: How can we use our knowledge of matter and its interactions to solve problems?

The unit concludes with a two-part assessment. The first part is a performance assessment in which students demonstrate their content knowledge and **science and engineering skills to design a cold pack** using one of six chemical compounds. Students must set up their own experiments and justify their selection based on safety for humans, safety for the environment, and cost of material per gram. In the second part, students complete a written assessment that covers the performance expectations, disciplinary core ideas, crosscutting concepts, and science and engineering practices incorporated in this unit.

Electricity, Waves, and Information Transfer



Unit Driving Question:

How do the properties of electricity and waves influence the technology of information transfer?

Performance Expectations: MS-LS1-8, MS-PS2-3, MS-PS2-5, MS-PS3-3, MS-PS3-4, MS-PS3-5, MS-PS4-1, MS-PS4-2, MS-PS4-3, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

Unit Highlight: Applying what they know about energy transfer, students design and build a solution to maximize or minimize thermal energy transfer. As part of the unit assessment, students research and present information about neurological disorders that affect sensory receptors and the storage or use of information.

Lesson 1 *Pre-Assessment*

Focus Question: What do you know about electricity, waves, and information transfer?

Students **observe and investigate** electric devices, sources of waves, and simple examples of energy transfer and transformation. They also **construct explanations** and consider how humans sense light and sound, and the role electricity plays in the body.

Lesson 2 *Electricity Basics*

Focus Questions: What is electricity, and how is it measured?

Students use **models** to represent electrical systems and construct circuits using different battery arrangements. Students also **plan and carry out investigations** using ammeters and voltmeters. Students **ask questions**, **generate hypotheses**, and **make predictions** about how batteries and different battery arrangements affect current and voltage in a circuit.

Lesson 3 *Resistance in Electric Circuits*

Focus Question: How can components in an electric circuit affect current and voltage?

Students **ask questions** and **make predictions** about how different resistors affect the voltage and current in a circuit, and **investigate** how different properties of wire affect their resistance. They also use **models** and graphs to describe the mathematical relationship between voltage, current, and resistance (Ohm's Law). Students **observe and explain phenomena** related to resistance and electrical power, and use their understanding of cause-and-effect relationships to generate hypotheses and make predictions about electrical systems.

Lesson 4 *Electricity in Motion*

Focus Question: How do components in an electrical system transform electrical energy into kinetic energy?

Students **observe phenomena** and **use evidence to support claims** about the relationship between electricity and magnetism. Students also build an electromagnet and **investigate** factors that affect its strength. Next, students disassemble a manufactured electric motor and consider how electromagnets can be used to transform electrical energy into kinetic energy. They also build a spinning coil motor and **use data as evidence to construct explanations and make claims** about the source of the motor's kinetic energy.

Lesson 5 *Transforming and Transferring Electrical Energy*

Focus Question: How can energy transfer be maximized or minimized?

Students use energy transfers and transformations to describe **energy** flowing into, out of, and within **systems**. Students use light bulbs and metal cans to **investigate** how **system** components can affect energy transfer. They also **use evidence and scientific reasoning to support claims** and apply what they learn about thermal energy transfer to **design, build, and test** a device that maximizes or minimizes it.

Lesson 6 *Modeling Waves*

Focus Question: How can we use models to understand wave properties?

Students **use models** to investigate the properties of transverse and longitudinal waves, including wavelength, frequency, and amplitude.

Lesson 7 *Wave Transmission*

Focus Question: How can we use waves to encode and transmit information?

Students observe light and sound waves interacting with different types of matter and **create models** describing absorption, transmission, reflection, and refraction. Students **apply their knowledge** of electromagnetic waves to **construct an explanation** about whether light waves always travel in straight lines. Students also apply their understanding of mechanical waves to **construct an explanation** about how sound waves move through different states of matter.

Lesson 8 *Communicating and Storing Information with Waves*

Focus Question: How can electricity and waves be used to communicate information from one place to another?

Students listen to a portable radio and **use evidence to support claims** about the reliability of analog and digital methods for storing and transferring information. Next, students **investigate** sending light signals along optical fiber and practice encoding and transmitting messages. Students also apply what they have learned to **design, build, and test prototypes** of technological systems that utilize electricity and waves to communicate information.

Lesson 9 *The Electric Body*

Focus Question: How does your body use electrical signals to detect and respond to your environment?

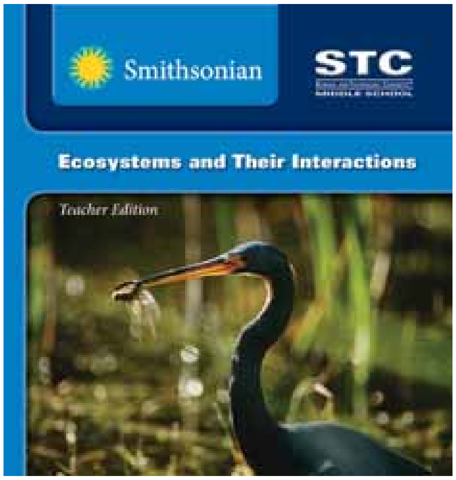
Students **investigate** and **model** how neurons use electrical signals to transmit information from the sense organs to the brain and from the brain to muscles and organs so that the body can detect and respond to its environment and store information in the form of memories. Students also **obtain, evaluate, and communicate information** on how the structures of the nervous system support the functions of transmitting and storing information.

Lesson 10 *Assessment*

Focus Question: What have you learned about electricity, waves, and information transfer?

The unit concludes with a two-part assessment. The first part is a **performance assessment** in which students **apply the knowledge and skills** they have acquired to **research and report** on a medical condition affecting the nervous system. Students will describe how the problem affects job functions of a celebrity and alters the **cause-effect relationship** between sensory receptors and the use or storage of information. In the second part, students complete a **written assessment** covering the performance expectations, disciplinary core ideas, crosscutting concepts, and science and engineering practices covered in the unit.

Ecosystems and Their Interactions



Unit Driving Question:

How do organisms interact with one another and their environments?

Performance Expectations: MS-LS1-5, MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-LS2-5, MS-LS4-4, MS-LS4-6, MS-ESS3-3, MS-ETS1-1, MS-ETS1-2

Unit Highlight: As the unit opens, pond ecosystems and butterfly ecosystems provide the launching pad for learning how various elements of systems interact. Students build models and work with simulations to learn how the food web, predation, genetics, and the energy pyramid affect ecosystems. By the end of the unit, students apply their learning to timely issues such as invasive species, runoff and its impact on drinking water, and landslides.

Lesson 1 *Pre-Assessment*

Focus Question: What do you already know about ecosystems and their interactions?

Students perform short, simple **investigations** that evaluate their existing knowledge of one or more concepts related to ecosystems and the interactions that occur within them. Students **engineer a model** pond that they will use throughout the unit to investigate different aspects of ecosystems. Students also create concept maps and KWL charts to explore their existing knowledge.

Lesson 2 *Ecosystem Organization*

Focus Question: How are ecosystems organized?

Students investigate the organization of ecosystems and begin laying the framework for further studies of ecosystems. They begin learning about **engineering** and its relationship to ecology as they discuss the criteria and constraints that would have to be met to create an artificial habitat for an organism. Students conclude the lesson by **applying their understanding** of ecosystem organization **to their model** pond ecosystem.

Lesson 3 *Resources*

Focus Question: How does the availability of resources affect a population of organisms?

Students **design and carry out an investigation** to determine how the availability of resources affects plant growth and extrapolate that to the environment. Students also **analyze data** based on a model of an ecosystem showing carrying capacity. In the final investigation of the lesson, students consider the resources available in their ponds. Then they **apply their understanding** of resources **to their model** pond ecosystem.

Lesson 4 *Matter Cycles*

Focus Question: How do organisms get matter to grow and repair their bodies?

After reading about the water cycle, students **design a model** to show the movement of water in an ecosystem. Then they conduct an experiment using algae and yeast, and construct an explanation for the flow of carbon in an ecosystem. Students also take the role of a nitrogen atom as they **model** the flow of nitrogen through an ecosystem. Based on the information gathered in this lesson and the **data** they have collected from their ponds, students **explain** how matter is flowing through their model ponds.

Lesson 5 *Energy Flow*

Focus Question: How do organisms get energy to live and grow?

Students **model** the flow of energy through an ecosystem to develop an understanding of energy transfer, trophic levels, food chains, and food webs. Students begin to grow *Brassica* to observe the relationship between *Brassica* and the cabbage white butterfly throughout its life cycle. The lesson concludes as students use the **data** they have collected about their **model** ponds to construct food chains for the organisms in the pond.

Lesson 6 *Relationships Among Organisms*

Focus Question: How do organisms interact with one another?

Students **model** predation and competition. They also **analyze** presented information to **determine the relationships** that exist between different sets of organisms. Students begin to **ask questions** that will be answered in a later lesson as they **carry out investigations** on natural selection. Using their **model** ponds, students **cite evidence** to identify relationships that exist between different organisms.

Lesson 7 *Population Changes*

Focus Question: How do changes to the physical or biological components of an ecosystem affect a population?

Students continue to explore how changes to an ecosystem can affect the populations of organisms that live within it by **modeling** the introduction of a non-native species to an ecosystem. Students also examine the different types of succession that occur in an ecosystem and consider the importance of natural disturbances. Students **plan and carry out an investigation** to see how a change to a biotic or an abiotic component of their model ponds will affect the ecosystem.

Lesson 8 *Natural Selection*

Focus Question: How does natural selection change a population over time?

Students **construct explanations** about the importance of variation in a population after conducting several investigations. Students examine sunflower seeds to observe the variation that occurs between them. Students then **model** sea turtle survival to begin understanding natural selection. Next, students **model** natural selection in a population. They revisit their ponds and sample ponds, and discuss how changing conditions can lead to selection within their models.

Lesson 9 *Biodiversity*

Focus Questions: What is biodiversity, and why is it important?

Students **model** ways in which scientists measure biodiversity and then use mathematics to approximate the number of organisms in their ecosystem. Students explore ecological engineering as they **obtain, evaluate, and communicate information** about the reintroduction of a species. They **engage in argument from evidence** as they determine whether a species should be reintroduced to an area in which it no longer exists. Students use their newly learned techniques for measuring biodiversity to measure the biodiversity in their **model** ponds.

Lesson 10 *Human Impact*

Focus Question: How can human impact on the environment be monitored and minimized?

Students **plan and carry out an investigation** to determine how human activities affect plant growth. They also **research** the impact that a human activity is having on the ecosystem. Then students take on a community stakeholder role and work to **design a solution** to mediate the impact that human activity is having on the ecosystem.

Lesson 11 *Assessment*

Focus Question: What have you learned about ecosystems and their interactions?

This unit concludes with a two-part assessment. The first part is a performance assessment in which students **apply the knowledge and skills** they have acquired during the unit to **obtain, evaluate, and communicate information** about ecosystem services. Students will be presented with a threat to an ecosystem service and must **design a solution to the problem**. In the second part, students complete a written assessment that covers the performance expectations, disciplinary core ideas, crosscutting concepts, and science and engineering practices incorporated in this unit.

Structure and Function

Unit Driving Question:

How do the structure and function of organisms contribute to their survival?

Performance Expectations: MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-6, MS-LS1-7, MS-LS1-8, MS-LS4-2, MS-LS4-3

Unit Highlight: Whether it's the deadly leaves of a Venus flytrap or the startling camouflage techniques of a brilliant octopus, Earth's diverse array of creatures and plants have unique structures that assist our common quest for survival. Starting at the cellular level for plants and animals, students learn about cells and how those cells work in systems to contribute to survival. Students investigate how photosynthesis and cellular respiration drive the flow of energy and matter in an organism. A close investigation of the nervous system and a frog dissection show the interdependence of organs and their systems. At the end of the unit, students research unique systems of organisms—who knew hippos can sweat their own sunscreen?

Lesson 1 *Pre-Assessment*

Focus Question: What do we already know about how living things survive in their environment and how can we learn more?

Students build on their understanding of life by observing various cellular structures, predicting their function, and then relating those structures to a living thing's survival. They think about what they already know about how living things survive in their environments. The observations students make and the ideas they discuss in this lesson will prepare them for future investigations.

Lesson 2 *Cells*

Focus Question: What roles can cells play in the development and survival of organisms?

Students explore various microorganisms, **investigating** the structures found in their bodies and determining how these structures allow them to function and ultimately survive. They then **investigate** the diversity of cells found in macroorganisms and attempt to determine their function for survival. Finally, students explore how cells become "different" from one another during the development of a new organism.

Lesson 3 *Cell Organelles*

Focus Question: What structures does a cell need in order to survive?

Students **investigate** the organelles found inside of cells and examine the interrelatedness of these structures. They also **observe** how organelles have particular functions within the cell that work together to help the cell survive.

Lesson 4 *Photosynthesis*

Focus Question: What role do matter and energy play during photosynthesis?

Students learn about the cellular process known as photosynthesis and investigate how matter and energy flow between the living and nonliving parts of the environment during this process, continuously being recycled by autotrophs such as plants.

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Lesson 5 *Cellular Respiration*

Focus Question: Where do cells get the resources they need to aid an organism's survival?

Students explore the energy producing process known as cellular respiration and determine the role that oxygen plays in it. By the end of the lesson, they **construct a scientific explanation** about how organisms obtain the energy that they need to survive.

Lesson 6 *Levels of Organization*

Focus Question: How does the organization of an organism's body aid in survival?

Students **investigate** how a body is a system made up of many smaller subsystems that work together to perform various functions and keep an organism alive. They begin to understand that the cells in multicellular organisms are organized in a particular way because the cells rely on each other in order to survive.

Lesson 7 *The Nervous System*

Focus Question: How does the brain send and receive information?

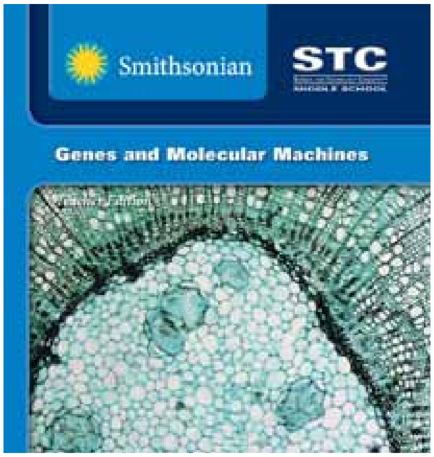
Students **observe** and explore nerves and nerve cells and evaluate information to gain an understanding of the role these cells in tissue have in sending and receiving information. They then **conduct several investigations** to gain an understanding of the relationship between the senses and the brain in communicating information.

Lesson 8 *Assessment*

Focus Question: How are different animals specially adapted to survive in their environments?

As a culminating activity, students work in groups to research an animal with a unique/extreme organ system or structure within an organ system that helps it survive. In its research, each group **investigates** the purpose of the organ or system involved, investigates all the organs involved in that particular system and how they work together, and describes the specialized cells that are involved in the system and how their organelles may be specially adapted for that system. Each group **presents its research** to the class.

Genes and Molecular Machines



Unit Driving Question:

How has human understanding of inheritance allowed us to influence change in biodiversity?

Performance Expectations: MS-LS1-1, MS-LS1-4, MS-LS3-1, MS-LS3-2, MS-LS4-4, MS-LS4-5, MS-LS4-6

Unit Highlight: Beginning at the cellular level, students explore the different ways that organisms reproduce and what that means for their genetics. Students learn how traits are passed from one generation to the next as they study zebra fish, plants, protists, and humans. By the end of the unit, students create their own "creatures" with unique characteristics and follow those traits to the creatures' offspring to learn about inheritance. Using Punnett squares, DNA, and mutations, they predict future generations.

Lesson 1 *Pre-Assessment*

Focus Question: What do you already know about cells, reproduction, and genetics?

Students perform short, simple **investigations** that evaluate their existing knowledge of one or more concepts related to genetics. Students plant Wisconsin Fast Plants® seeds, root a coleus plant, observe variations in zebra fish, examine cells, and look for similarities between parents and offspring. Students also are introduced to **model** organisms and their significance in life science.

Lesson 2 *Cells*

Focus Question: What are the building blocks of life?

Students **carry out investigations** relating to cells by creating wet-mount slides of various organisms that allow them to distinguish between unicellular and multicellular organisms. Next, students analyze prepared slides and attempt to interpret cell **function** within a multicellular organism. Finally, students consider the **function** of bones in an animal and **design a cell** whose structure would adequately meet that function.

Lesson 3 *Organism Reproduction*

Focus Question: What can cells tell us about how organisms reproduce?

Students cross-pollinate the flowers of their Wisconsin Fast Plants®, simulating sexual reproduction. Students then **investigate** various asexual methods of reproduction under the microscope by observing paramecium undergoing fission and hydras undergoing budding. Students continue to explore asexual reproduction by regenerating a blackworm segment and **analyzing** the results of their coleus clipping. Students then **consider the advantages and disadvantages** of sexual and asexual reproduction and the offspring that are created as a result.

Lesson 4 *Cellular Reproduction*

Focus Question: Where do cells come from?

Students explore cell division and how it relates to reproduction. Students prepare and stain a wet-mount slide of onion root cells undergoing mitosis. Students then **design and construct a model** of a cell and **predict** the behaviors of the cell during mitosis. Next, students explore plant reproductive cells undergoing meiosis. Students use their **observations to design and construct a model of a cell** and **predict** the cell behaviors that occur during meiosis. Students compare and contrast these two cellular divisions and how they both relate to reproduction.

Lesson 5 *Genetics*

Focus Question: Why do family members look similar but not identical to one another?

Students begin to **investigate** variation by observing a lady beetle population. Students then explore complete dominance by using probability to determine genotypes and phenotypes in a newly created creature. Next, students take those creatures and demonstrate heredity by using a die to randomly pass on genes to an offspring. Students then create Punnett square **models** that allow them to **analyze and interpret** the passing of traits from parents to offspring.

Lesson 6 *DNA to Trait*

Focus Question: How does DNA determine the traits that organisms have?

Students **analyze** the structure of DNA and **determine the patterns** that exist in the structure. Students then **carry out an investigation** to extract DNA from strawberries. Next, students use pop beads to **model** DNA transcription into RNA, and then translate the RNA into amino acids, forming proteins. Using their creatures from Lesson 5, students then explore how changes in DNA can lead to changes in a protein, which leads to changes in each creature's traits.

Lesson 7 *Successful Reproduction and Offspring*

Focus Question: How do behaviors and structures allow plants and animals to reproduce more successfully and better survive?

Students **analyze** various flowers and pollinators to determine which pair relies on one another for reproductive success. Then students **plan and carry out an investigation** to determine how various seeds are dispersed. Next, students **plan and carry out an investigation** to explore materials and ideal conditions needed for a seed to germinate. Then students **develop and present a model** of a new species of flower, its pollinator, its seed structure, and its method of dispersal. To end the lesson, students determine the reproductive success of some animals based on parenting strategies.

Lesson 8 *Variation*

Focus Question: How do differences within a population help a species survive?

Students harvest and germinate the Wisconsin Fast Plants® seeds from their plants. Students then observe the variations that exist between the plants. Next, students use the phenotypes that they observe to **predict** the genotype of the parents by using Punnett square **models**. Students then use beads to **investigate** genetic diversity within asexual and sexual reproducing organisms.

Lesson 9 *Selection*

Focus Question: How do natural and artificial selection change a population over time?

Students work in groups to **carry out an investigation** relating to natural selection using beads and different types of habitats. Then students intentionally hunt for certain colors of beads, **modeling the process** of artificial selection. Students then consider the selection pressures of both processes and how they lead to evolution.

Lesson 10 *Human Manipulation*

Focus Question: What are some ways that humans have influenced the inheritance of desired traits in organisms?

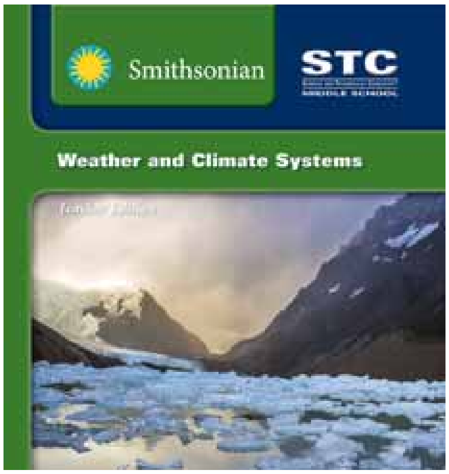
Students organize **prior knowledge** about genetics to consider reasons why humans would want to manipulate an organism's DNA. Then students **observe** the different variants of zebra fish in their classroom to **construct an explanation** of how the different kinds of zebra fish were created. Next, students research different types of genetic modification technologies and compile a list of reliable sources of information.

Lesson 11 *Assessment*

Focus Question: What have you learned about genes and molecular machines?

The unit concludes with a two-part assessment. The first part is a performance assessment in which students **apply the knowledge and skills** they have acquired during the unit to **research and report** on human manipulation of organisms' genetics to produce desirable traits. In the second part, students complete a written assessment that covers the performance expectations, disciplinary core ideas, crosscutting concepts, and science and engineering practices incorporated in this unit.

Weather and Climate Systems



Unit Driving Question:

How can data be used to understand weather and climate?

Performance Expectations: MS-ESS2-4, MS-ESS2-5, MS-ESS2-6, MS-ESS3-2, MS-ESS3-4, MS-ESS3-5, MS-PS3-4, MS-ETS1-1, MS-ETS1-2

Unit Highlight: Students apply content knowledge and engineering practices to create a design solution to minimize the impact of a storm surge. As a unit assessment, students use provided weather data to determine if they will have a day off from school due to weather conditions.

Lesson 1 *Pre-Assessment*

Focus Question: What do you know about weather and climate on Earth?

Students **reflect on what they already know** about weather and climate in a series of activities. Through these activities, they reflect on many different parts of weather and climate. Students ask questions about these topics to set the stage for later lessons.

Lesson 2 *Heating Earth's Surface*

Focus Question: How do different surfaces on Earth warm and cool?

Students **investigate** the unequal heating of Earth's surface by **planning and carrying out an investigation** to **collect data** about how different materials—water and soil—absorb and release heat. Then students **analyze and interpret their collected data**. Students consider how these interactions between material and heat relate to weather and climate.

Lesson 3 *Water Cycle, Cloud Formation, and Air Masses*

Focus Question: How do water and air move in the atmosphere?

Students **investigate** the movement of air and water in the atmosphere, which allows them to obtain a foundational knowledge of air masses. In their **investigations**, students **model** the atmospheric process of condensation and evaporation. They **create a model** of the water cycle, allowing them to visualize the flow of water through the atmosphere and land. They determine the roles that sun and gravity play in this cycle. Using a **model**, students also **investigate** how surfaces cause the warming and cooling of air above them. Then they continue using their **models** to see how warm and cool air move. Students then relate this to the formation of clouds and other weather phenomena.

Lesson 4 *Wind and Air Pressure*

Focus Question: How can meteorologists use air pressure measurements to predict changes in weather and different types of cloud formations?

Students **model** the movement of air masses as they **design an investigation** in which they **model** the collision of types of air masses. They conduct an **investigation** to see how different air pressure conditions relate to the formation of clouds. Then they **create a barometer**, which they use as they **plan and carry out an investigation** to determine how air pressure is correlated to weather conditions. Students recognize the **patterns** that exist between changing air pressure and certain **weather phenomena**, such as clouds.

Lesson 5 *Ocean Currents*

Focus Question: How do temperature, salinity, and wind affect ocean currents?

Students **investigate** the movement of ocean currents. In separate investigations, they **model** how salinity, temperature, and wind affect the movement of water. These activities allow students to view the real-world processes that allow the ocean conveyor belt to move. Students relate the movement of ocean currents to weather and climate.

Lesson 6 *Storms*

Focus Questions: What is a vortex, and how does it relate to hurricanes and tornadoes?

Students **model** a vortex and relate it to the movement of tornadoes and hurricanes. Students learn what conditions are necessary for the formation of thunderstorms, tornadoes, and hurricanes.

Lesson 7 *Predicting Weather*

Focus Question: How can weather data and patterns be used to predict future weather events?

Students **collect weather data** for five days and then **examine the data for patterns and relationships**. Then they examine weather maps and again look for **patterns and relationships** in the maps. Students then **analyze and interpret collected data** to **predict** weather events.

Lesson 8 *Tracking Severe Storms*

Focus Question: How can severe storms be tracked in order to predict their impact?

Students examine how severe storms are tracked and **model** it by tracking the path of Hurricane Katrina. They also **investigate** storm surges and the damage that is caused by them. Students **design a solution** to minimize the impact of a storm surge and share their designs with their classmates. Students then get the opportunity to **modify their designs based on feedback** from the class.

Lesson 9 *Introduction to Climate*

Focus Question: What is climate and how is it determined?

Students examine climate and how it differs from weather. Students **analyze weather data** from several locations and **draw conclusions** about the climate of each region. They propose the climate classification for a region, **support their argument with evidence**, and **present it to the class**.

Lesson 10 *Climate Change Research*

Focus Question: What data have scientists collected and analyzed to support theories about climate change?

Students learn about climate change through a research **investigation**. Students **research** climate change and **present their findings to the class**. They **use the data** that they find to **formulate conclusions** regarding climate change.

Lesson 11 *Impact of Climate Change*

Focus Question: How does climate change impact Earth's systems?

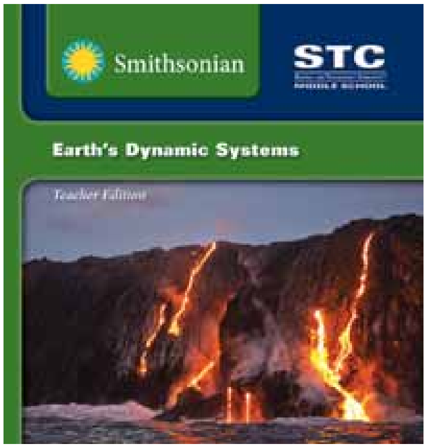
Students **evaluate** how evidence of climate change can be used **to make projections** of the impacts of climate change on the future. Students study how scientists **model** climate change and study its potential effects.

Lesson 12 *Assessment*

Focus Question: What have you learned about weather and climate on Earth?

The unit concludes with a two-part assessment. The first part is a performance assessment. Students **demonstrate their content knowledge and science and engineering skills to analyze** a scenario in which they have to decide whether to close a school due to impending weather conditions. Students analyze available weather data to formulate an argument based on evidence on whether the conditions necessitate closing schools in a region. They present their findings to the class. In the second part, students complete a written assessment that covers the performance expectations, disciplinary core ideas, crosscutting concepts, and science and engineering practices incorporated in this unit.

Earth's Dynamic Systems



Unit Driving Question:

How do the dynamic systems of Earth change its surface?

Performance Expectations: MS-LS4-1, MS-ESS1-4, MS-ESS2-1, MS-ESS2-2, MS-ESS2-3, MS-ESS3-1, MS-ESS3-2, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

Unit Highlight: How did that aquatic fossil end up on the top of that mountain? Students learn about gradual processes (erosion, deposition, plate motion, and fossilization) and catastrophic events (earthquakes, volcanoes) and how they contribute to changes on the earth's surface. Students track the transfer of energy, build models, and investigate mineral resources. Students conclude the unit with research on preparedness for catastrophic events. Are we ready for "The Big One"?

Lesson 1 *Pre-Assessment*

Focus Question: What do you know about geological processes?

Students are introduced to two geologic events—the eruption of Krakatau in 1883 and the discovery of the Burgess Shale in 1909—through primary source documents and images. They consider these events, **predict** the way they may have occurred, and **develop questions to explore** these events during the unit.

Lesson 2 *When the Earth Shakes*

Focus Question: Why are some structures damaged when the earth shakes?

Students **observe** videos of earthquakes and are introduced to shake tables as a way to model earthquakes. They **design and conduct an experiment** to **investigate** the effect of design variables on the way model buildings respond to shaking. Students use experimental data to describe conditions for areas with greatest and least risk for future quake damage. Students then use iterative **testing and modification** to **design a model** of an earthquake-resistant house.

Lesson 3 *Analyzing Earthquake Data*

Focus Question: How can we collect data about earthquakes?

Students explore how **data** pertaining to earthquakes can be **collected and analyzed**. They explore wave motion, use seismographs to collect simulated quake data, analyze seismogram readings, and use earthquake data to locate the epicenter of a quake. Through these investigations, students come to understand how earthquake data can show patterns that help in the prediction of future quakes.

Lesson 4 *Investigating Plate Movement*

Focus Question: How do changes in the lithosphere affect Earth's surface?

Students plot earthquake data to **investigate** patterns caused by earthquakes. They also examine the structure of Earth's interior to gain an understanding of the dynamic nature of Earth. Using **models**, students also simulate the movement of tectonic plates and examine the cause and effect of plate movements along faults.

Lesson 5 *Cycling Matter and Energy*

Focus Question: How do heat and pressure impact geologic features?

Students **model** the rock cycle and investigate the role of heat and pressure in cycling matter and energy. They also examine rock samples and **use observational data** to engage in an **argument from evidence**.

Lesson 6 *Volcanoes: Building Up*

Focus Question: How are volcanoes formed?

Students gain an understanding of how volcanoes are formed by **modeling** the movement of magma through the earth's surface. They then examine information pertaining to different types of volcanoes and gain an understanding of the relationship between earthquakes and volcanoes.

Lesson 7 *Volcanoes: Eruption*

Focus Question: How do volcanoes change Earth's surface?

Students **conduct investigations** to gain an understanding of how volcanoes contribute to the modification and creation of landforms. Students then revisit the Krakatau event and **construct an explanation for the phenomenon**, which involves changes at Earth's surface. Students make **predictions** for how surface features will continue to change in the future as geoscience processes continue to occur.

Lesson 8 *Changing Earth's Surface*

Focus Question: How have geoscience processes changed Earth's surface?

Students **model** several different geoscience processes to gain an understanding of their effect on Earth's surface. They research a real-world example of a process they **modeled** and **present their findings**. Students then revisit the Burgess Shale event and **construct an explanation** for rock deformation.

Lesson 9 *Emergence and Extinction*

Focus Question: What do fossils and layers of sediment tell us about Earth's past?

Students **investigate** how fossils are formed and what they can tell us about the planet's history and the organisms that they represent. Through **modeling** and simulations, students examine the role of fossils in explaining the geologic events of the past. Students also use fossils to **analyze and interpret** patterns related to existence, diversity, anatomical structures, and extinction of organisms.

Lesson 10 *Distribution of Resources on Earth*

Focus Question: How do geoscience processes impact the distribution of resources on Earth?

Students map the location of a specific mineral resource to reveal its uneven distribution and **construct a scientific explanation**. They use a **model** to simulate drilling for a natural resource and calculate the cost of the simulated exploration. Students also **conduct research** related to the mineral, energy, and groundwater resources of Earth and **present their findings** to the class.

Lesson 11 *Evidence of a Dynamic Earth*

Focus Question: What evidence suggests that Earth is a dynamic geologic system?

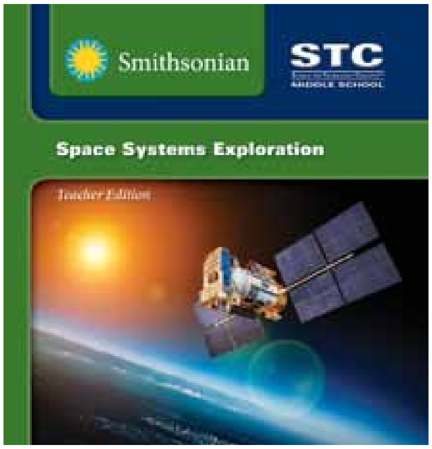
Students revisit Burgess Shale fossils and **construct an explanation** for an aquatic fossil being found well above sea level. Students describe an appropriate timescale for the time since the fossil was underwater and the rate of elevation increase. Students also **analyze and interpret data** related to the distribution of fossils and rocks, continental landforms, and features on the seafloor as evidence for plate motion in Earth's past.

Lesson 12 *Assessment*

Focus Question: What have you learned about Earth's dynamic systems?

Students, acting as scientists, **prepare and present proposals** for mitigating the effects of future geodynamic events. Students also **evaluate** proposals from other groups and **make recommendations** for which proposals should receive funds.

Space Systems Exploration



Unit Driving Question:

What can we observe and learn about the universe from our earthly perspective?

Performance Expectations: MS-PS2-4, MS-ESS1-1, MS-ESS1-2, MS-ESS1-3, MS-ETS1-1, MS-ETS1-2

Unit Highlight: Using physical and mathematical models and data analysis, students develop a thorough understanding of the sun-Earth-moon system and our entire solar system. They apply what they learn to investigate the criteria and constraints involved with space exploration. As part of the unit assessment, students use those criteria and constraints to engineer a solution to human habitation on another celestial body.

Lesson 1 *Pre-Assessment*

Focus Question: What do you know about how space is explored?

Students **conduct a series of investigations** to reveal what they know about the properties of scale models, lunar phases, the sun-Earth-moon system, and the relationship between mass and gravity in the solar system.

Lesson 2 *The Sun-Earth-Moon System*

Focus Question: What cycles occur on Earth due to the interactions of the sun, Earth, and the moon?

Students **develop and use a model** to **analyze and interpret** the cyclic **patterns** caused by the rotations and orbits of Earth and the moon. They **construct explanations** about how the orbits of Earth and the moon relate to the Gregorian calendar.

Lesson 3 *Why Earth's Tilt Matters*

Focus Question: Why does Earth have seasons?

Students use **models** to **investigate** how Earth's tilted axis changes the distribution of solar energy on Earth's surface as the planet orbits the sun. They explore shadow phenomena and gather **evidence** of seasonality **patterns** and additional **cause-and-effect relationships** associated with Earth's tilted axis.

Lesson 4 *Investigating Lunar Patterns*

Focus Question: Why do patterns in the moon's appearance occur?

Students use **models** to **investigate patterns** and changes in the appearance of the moon as it orbits Earth and how these changes relate to the positions of the sun, Earth, and the moon. They also **analyze** tidal data and infer how the lunar cycle affects tides.

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Lesson 5 *Solar and Lunar Eclipses*

Focus Question: What causes solar and lunar eclipses?

Students use **models** to **investigate** how the arrangement of orbital planes within the sun-Earth-moon system create the special circumstances needed for eclipses to occur.

Lesson 6 *Modeling the Solar System*

Focus Question: How can we use models to understand the relative sizes of bodies in the solar system and the distances between them?

Students research the Apollo 11 space mission and determine the criteria and constraints engineers had to address to make possible manned space travel to our closest celestial body, the moon. Students then develop a **scaled model** of the solar system to observe the varying sizes of and distances between the planetary bodies. They use their models to make **predictions** about the seasonality of climates on other planets and the likelihood of space travel to the planets.

Lesson 7 *Gravity: Bending Space-Time*

Focus Question: How does gravity influence our solar system?

Students compare the weight of an object on different planets with respect to each planet's mass and diameter. They use a physical **model** to **investigate** gravitational attraction between objects of different masses. Students **analyze** their observations and results to **construct scientific explanations** using the claims, evidence, and reasoning (CER) strategy.

Lesson 8 *Gravity's Role in the Universe*

Focus Question: How do planets and moons stay in their specific orbits to maintain the structure of our solar system?

Students use both a digital and a physical **model** to explore the relationships between planetary mass, the distances between planets and moons, and the resulting speed of an orbiting body. They also use evidence to **construct an explanation** for how gravity affects the orbital properties of planets and their moons.

Lesson 9 *The Challenges of Space Exploration*

Focus Question: What are the criteria and constraints for humans to live in space?

Students **research** the conditions and composition of Mars and compare them to Earth's conditions and composition. They determine the **criteria and constraints** involved with space travel to and habitation on a planet like Mars. Finally, students **construct an evidence-based argument** for or against long-term habitation on another celestial body.

Lesson 10 *Assessment*

Focus Question: What can we observe and learn about the universe from our earthly perspective?

The unit concludes with a two-part assessment. In a performance assessment, students **design a model** for human habitation in space by **analyzing** planetary conditions, implementing **design criteria**, **planning and modeling design solutions**, and **evaluating competing designs**. In the second part, students complete a written assessment covering the performance expectations, disciplinary core ideas, crosscutting concepts, and science and engineering practices covered in the unit.

Smithsonian

Why Are Honey Bees Disappearing?

Unit Driving Question:

Why are honey bees important, and what can we do to minimize human impact on these populations?

Performance Expectations: MS-LS3-2; MS-LS1-4; MS-LS1-5; MS-ESS3-3; MS-ETS1-1

Unit Highlight: Honey bees are responsible for producing approximately one in three bites of the food we eat and a variety of consumer goods we rely on. Unfortunately, honey bee populations are on the decline, which could have far-reaching consequences for humans. Throughout the unit, students gather evidence to explain the importance of honey bees and consider reasons why the population may be declining. At the end of the unit, students develop a solution to minimize and monitor human impact on honey bees and develop a communication plan to promote community involvement.

Investigation 1 *What Do I Already Know?*

Students are pre-assessed on their knowledge of reproduction and honey bees. Students will reflect back to their initial thoughts and ideas throughout the unit.

Investigation 2 *Honey Bee Research*

Students use print and digital resources to **obtain, evaluate, and communicate information** about honey bees. Some topics they **research** include the bees' life cycle, methods of reproduction, social structure, diet, and interactions with the environment. Students use **evidence** from their research to **make a claim** that states whether or not they believe honey bees are essential to their environment.

Investigation 3 *Methods of Reproduction*

Students investigate asexual and sexual reproduction among different organisms, including the honey bee, using a digital simulation. Students **analyze and interpret** their findings to determine the **patterns** that exist with both types of reproduction. Students use their analysis to make an initial **evidence-based argument** about each type of reproductive strategy and present their argument to the class.

Investigation 4 *Modeling Reproduction*

Students **develop and use models** to display the process of asexual and sexual reproduction. Students use their models to explore the **cause-and-effect relationships** that occur as well as the advantages and disadvantages for each reproductive strategy. Students **modify their argument** from the previous investigation to reflect the new evidence obtained during this investigation.

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Investigation 5 *Researching Courtship Displays*

Students **obtain, evaluate, and communicate information** about courtship displays in the animal kingdom. Students analyze their research and identify **cause-and-effect relationships** that exist as a result of courtship behavior. Students choose an animal and its courtship display to research and **present** their findings to the class. As students present their information, they identify **patterns** associated with courtship behaviors. Students consider whether honey bees engage in courtship behavior when the queen is ready to reproduce.

Investigation 6 *Parental Investment*

Students investigate parental care and investment in the animal kingdom, including the parental care provided in a honey bee hive. Students identify the **cause-and-effect relationship** between parental investment and the offspring's chance of survival. Students use evidence collected throughout the unit thus far to **construct an argument** about how animal behaviors and structures can affect the probability of reproductive success.

Investigation 7 *Investigating Flowers and Their Pollinators*

Students use a digital simulation to explore the **cause-and-effect relationships** between flowers and their pollinators, such as honey bees. Students use evidence from the investigation to **construct an initial evidence-based argument** that explains how specialized structures in plants and specialized behaviors in animals can affect a plant's reproductive success.

Investigation 8 *Seed Dispersal*

Students **investigate** seed structures and dispersal methods to understand how these affect the probability of reproductive success in seed-producing plants. Students **modify their initial argument** from the previous investigation to reflect new evidence obtained during this investigation.

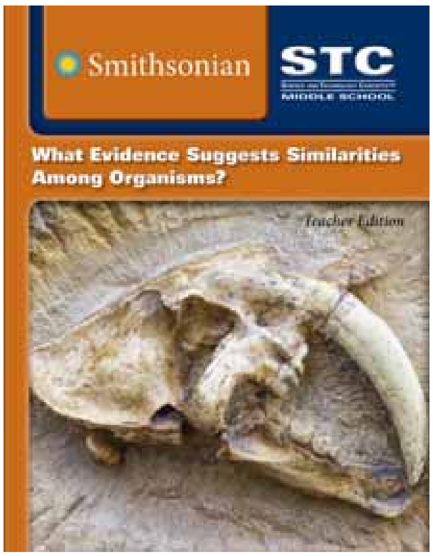
Investigation 9 *Can an Organism's Environment Influence Its Growth and Development?*

Students **analyze and interpret data** to determine if a trait has been influenced by an organism's genetic material, its environment, or both factors. Students **construct an evidence-based explanation** for how both genetic and environmental factors can influence the growth of an organism. Students extend these **cause-and-effect relationships** by reflecting on how honey bee growth and development is influenced by both genetic and environmental factors.

Investigation 10 *Minimizing, Monitoring, and Communicating Human Impact on Bee Populations*

Students **obtain, evaluate, and communicate information** about colony collapse disorder (CCD) and how human activities may be negatively affecting this phenomenon. Students **design a solution** to mitigate human impact on CCD and develop a communication plan to educate their community about the importance of honey bees. Students **present** their solutions and communication plans to the class.

What Evidence Suggests Similarities Among Organisms?



Unit Driving Question:

Where did whales come from?

Performance Expectations: MS-LS4-1; MS-LS4-2; MS-LS4-3; MS-ESS1-4

Unit Highlight: Ninety percent of organisms that have ever lived on Earth—from trilobites to dinosaurs to saber-toothed cats—are now extinct. What can we learn from life-forms of the past? How are they similar to life-forms alive on Earth today? In this unit, students explore evolutionary relationships between organisms alive today and those that are now extinct. Students use a variety of digital resources to identify patterns of evolutionary relationships in embryos, bones, and other anatomical structures. Students explore fossils and rock strata and how they provide evidence for Earth's history. Throughout the unit, students analyze the evidence they collect to make a variety of claims pertaining to evolutionary relationships and the history of the Earth. Students end the unit by researching the evolutionary path of the modern-day whale.

Investigation 1 *Analyzing Animal Embryos*

Students use a digital resource to **analyze and interpret** images of animal embryos at different stages of development. During their analysis, students identify **patterns** of similarities in the development of different animal species. These similarities enable students to begin collecting **evidence** of common ancestry among some of these animals.

Investigation 2 *Exploring Patterns in Bones*

Students **analyze** and color-code bones in various tetrapod animals, observing **patterns** of similarities that may suggest additional **evidence** of common ancestry. Students use **evidence** from their investigation to **make a claim** about whether a whale's forelimb is more similar to a shark's pectoral fin or to a human's forelimb.

Investigation 3 *Analyzing Evolutionary Relationships*

Students use a digital resource to arrange animals in a cladogram to represent potential evolutionary relationships based on anatomical similarities and differences. Students use evidence from their investigation to construct an **evidence-based explanation** to describe how anatomical similarities and differences help scientists determine evolutionary relationships between both modern and extinct organisms.

Investigation 4 *Analyzing the Fossil Record*

Students investigate rock strata and **construct a model** as a class to begin to determine how strata can be used to organize Earth's history. Students **analyze and interpret** information from rock strata in a digital resource to identify various mystery fossils and determine their relative ages.

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Investigation 5 *Radioactive Dating Game*

Students use a computer simulation to **model** radiometric dating and how it can be used to organize Earth's history. Students develop an **evidence-based claim** to explain whether the analysis and interpretation of rock strata using various dating methods is a useful way to organize and explain Earth's history.

Investigation 6 *Exploring Earth's History*

Students **obtain, evaluate, and communicate** information about important biological events that occurred during Earth's history. Students research the absolute dates associated with each event and **create a model** of the geologic time scale that presents those events in a chronological time line. Students **analyze** their time lines to determine how the diversity and complexity of life on Earth has changed over time.

Investigation 7 *Researching Whale Ancestry*

Students **obtain, evaluate, and communicate** information about whale ancestry in the fossil record. Students use their **research**, along with evidence collected during previous investigations, to **construct an explanation** about how present-day whales evolved. Students **present** their research and claims to the class.

How Can We Use Technology to Monitor Aquatic Ecosystems?

Unit Driving Question:

How do phytoplankton affect aquatic ecosystems, and how can we use technology to monitor them?

Performance Expectations: MS-PS4-1; MS-PS4-2; MS PS4-3; MS-ESS3-4

Unit Highlight: Students explore phenomena related to wave properties, light absorption and transmission, information technologies, and human impact in the context of harmful algal blooms (HABs). Students use digital resources to create evidence-based models and to observe technologies frequently used to monitor phytoplankton populations. Students conclude the unit by preparing proposals to minimize the occurrence of future HABs or to mitigate their effects.

Investigation 1 *Observing Plankton and Waves*

Students observe phenomena related to bioluminescent waves and plankton blooms using a digital resource. Group and class discussions use prompts to reveal prior knowledge and misconceptions about plankton and waves.

Investigation 2 *Pacific Ocean Ecosystem*

Students use a digital resource to **obtain information** about plankton and their relationship to animals living in the Pacific Ocean. Students use **evidence** from the digital resource to **develop models** describing **matter flow** from phytoplankton to other organisms.

Investigation 3 *Harmful Algal Blooms*

Students read a vignette about an unusually large *Pseudo-nitzschia* bloom that affected the Pacific Coast. Students use multiple resources (visual, print, and digital) to **obtain information** about a phenomenon that adversely affects humans and other organisms: HABs. Students use their understanding of phytoplankton to anticipate factors that contribute to HABs and consider which might be related to human activity.

Investigation 4 *Light Interactions*

Students **develop and refine models** describing how different substances affect light absorption, transmission, and reflection. Students also use their **models** to describe how light interacts with both water and a water sample containing green-colored algae.

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Investigation 5 *Pigment Interactions*

Students use a computer simulation to **investigate** light absorption and transmission through a green pigment found in phytoplankton. Students graph the collected data and use it to **analyze and interpret** how the green pigment affects light absorption. Students use **evidence** from this investigation to **support or refute models** developed during the previous investigation.

Investigation 6 *Monitoring Lake Erie*

Students use multiple sources (visual, print, and digital) to **obtain information** about cyanobacteria blooms occurring in Lake Erie. Students apply their understanding of photosynthetic pigments to **design a solution** for monitoring water in the lake. Students also use a digital simulation to observe a floating monitoring system and use **mathematical models** to describe how water waves affect this **technology**.

Investigation 7 *Monitoring Aquatic Ecosystems*

Students use a digital resource to **obtain information** about **technologies** scientists use to monitor aquatic ecosystems. Students discuss **data** each technology collects, the benefits of using that technology, and monitoring **problems** that could be solved if scientists use a different technology.

Investigation 8 *Monitoring Phytoplankton in Aquaculture*

Students read a vignette describing a Euglena bloom that killed fish at an aquaculture farm in North Carolina. Next, students assume the role of aquaculture farm owners and **evaluate** analog and digital monitoring methods for water in their ponds. Students use **evidence and scientific reasoning to make a claim** about which method (analog or digital) is more reliable.

Investigation 9 *Minimizing and Mitigating Harmful Algal Blooms*

Students **obtain, evaluate, and communicate** information about HABs affecting different geographic regions. Students use the information they obtain to **propose region-specific solutions** to minimize human impact or to mitigate harmful effects of HABs. Students also describe **evidence and scientific reasoning that support the claim** that human activity contributes to HAB occurrence.

Notes

Notes

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Learning Framework

Units for Grades 6–8

LIFE *Sciences*	EARTH/SPACE *Sciences*	PHYSICAL *Sciences*
Ecosystems and Their Interactions LS1-5, LS1-6, LS2-1, LS2-2, LS2-3, LS2-4, LS2-5, LS4-4, LS4-6, ESS3-3, ETS1-1, ETS1-2	**Weather and Climate Systems** ESS2-4, ESS2-5, ESS2-6, ESS3-2, ESS3-4, ESS3-5, PS3-4, ETS1-1, ETS1-2	**Energy, Forces, and Motion** PS2-1, PS2-2, PS2-3, PS2-5, PS3-1, PS3-2, PS3-5, ETS1-1, ETS1-2, ETS1-3, ETS1-4
Structure and Function LS1-1, LS1-2, LS1-3, LS1-6, LS1-7, LS1-8, LS4-2, LS4-3	**Earth's Dynamic Systems** LS4-1, ESS1-4, ESS2-1, ESS2-2, ESS2-3, ESS3-1, ESS3-2, ETS1-1, ETS1-2, ETS1-3, ETS1-4	**Matter and Its Interactions** PS1-1, PS1-2, PS1-3, PS1-4, PS1-5, PS1-6, PS3-4, ETS1-1, ETS1-2, ETS1-3, ETS1-4
Genes and Molecular Machines LS1-1, LS1-4, LS3-1, LS3-2, LS4-4, LS4-5, LS4-6	**Space Systems Exploration** PS2-4, ESS1-1, ESS1-2, ESS1-3, ETS1-1, ETS1-2	**Electricity, Waves, and Information Transfer** LS1-8, PS2-3, PS2-5, PS3-3, PS3-4, PS3-5, PS4-1, PS4-2, PS4-3, ETS1-1, ETS1-2, ETS1-3, ETS1-4

Why Are Honey Bees Disappearing?
LS3-2, LS1-4, LS1-5, ESS3-3, ETS1-1

What Evidence Suggests Similarities Among Organisms?
LS4-1, LS4-2, LS4-3, ESS1-4

How Can We Use Technology to Monitor Aquatic Ecosystems?
PS4-1, PS4-2, PS4-3, ESS3-4

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