Grade 8 Science

Grade(s):	☐ K ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☑ 8	☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ Other _____
Discipline/Course:	**Discipline:** Science **Course: Grade 8 Science**		
Course Title:	Grade 8 Science		
Prerequisite(s):	N/A		
Course Description: *Program of Studies*	In Grade 8 Science, students investigate a series of real-world phenomena that help them develop a deep understanding of forces, energy, waves, Earth and space science, genetics, and evolution. Throughout the year, students explore why objects are damaged during collisions, how sound waves transfer energy, how magnets exert forces without contact, and how Earth's movements in space create predictable patterns. They then examine how genetic information is inherited and expressed and how evidence from fossils, genetics, and natural selection explain the diversity and evolution of life on Earth. Students engage in scientific and engineering practices by asking questions, developing and revising models, planning investigations, analyzing data, constructing evidence-based explanations, and designing solutions to real-world problems. Across all six units, students build an understanding of crosscutting concepts such as cause and effect, systems and system models, energy and matter, patterns, and structure and function, enabling them to explain complex phenomena and apply scientific thinking to new situations.		
Course Essential Questions:	● Why do things sometimes get damaged when they hit each other? ● How can sound make something move?		

	• How can a magnet move another object without touching it? • How are we connected to the patterns we see in the sky and space? • Why are living things different from one another? • How could things living today be connected to things that lived long ago?	
Course Enduring Understandings:	• The physical interactions between objects and within systems of objects can be described and predicted. • The interactions of objects can be explained and predicted using the concept of transfer of energy from one object or system of objects to another, and the total change of energy in any system is always equal to the total energy transferred into or out of the system. • Waves transfer energy and information without transporting matter, making them essential for communication, sensing, and understanding natural phenomena. • Gravitational, magnetic, and electric forces act across distances, allowing objects to interact even without direct contact. • The motions of Earth, the Moon, and the Sun create observable patterns that can be used to explain seasons, eclipses, tides, and the appearance of objects in the sky. • The traits of organisms result from the interaction of inherited genetic information and environmental influences, leading to variation within populations. • Evolution explains both the diversity and unity of life. Natural selection acting on inherited variation over long periods of time explains how populations change, adapt, and share common ancestry. • Scientists continually revise models and explanations as new evidence is collected, improving our understanding of natural systems.	
Duration: **Credit:**	☐ Semester ☑ Full-Year	☐ 0.5 Credit (s) ☐ 1.0 Credit(s) ☐ 1.5 Credit(s) ☑ N/A
Course	*OpenSciEd Grade 8 Instructional Materials*	

Materials/Resources:	*Inspire Science Course 3* Integrated Middle School Text (McGraw Hill)
FPS Course Academic Expectation(s):	☑ Exploring and Understanding (EU) ☑ Synthesizing and Evaluating (SE) ☐ Creating and Constructing (CC) ☐ Conveying Ideas (CI) ☐ Collaborating Strategically (CS) ☐ Using Communication Tools (UCT)
Year at a Glance (Units):	**Unit 1** - Contact Forces (~28 classes/7 weeks) **Unit 2** - Sound Waves (~20 classes/5 weeks) **Unit 3** - Forces at a Distance (~20 classes/5 weeks) **Unit 4** - Earth in Space (~24 classes/6 weeks) **Unit 5** - Genetics (~28 classes/7 weeks) **Unit 6** - Natural Selection and Common Ancestry (~24 classes/6 weeks)

Unit Number and Title:	**Unit 1 -** Contact Forces
Duration:	~ 28 classes/7 weeks
Resource(s):	*OpenSciEd Unit 8.1 Contact Forces* *Inspire Science Course 3* Integrated Middle School Text (McGraw Hill)

Unit Overview:	This unit is anchored in observations that objects sometimes get damaged when they hit each other. Students develop questions about the factors that determine whether or not objects are damaged during collisions, and this leads to investigating what is really happening to any object during a collision. Throughout the unit, students explore various collision scenarios to understand why some impacts result in permanent changes while others do not. They make their thinking visible with free-body diagrams, mathematical models, and system models to explain the effects of relative forces, mass, speed, and energy in collisions. Students then use what they have learned about collisions to engineer something that will protect a fragile object from damage in a collision. They investigate which materials to use, gather design input from stakeholders to refine the criteria and constraints, develop micro and macro models of how their solution is working, and optimize their solution based on data from investigations.
Learning Goals	
Standard(s):	*Next Generation Science Standards:* **Disciplinary Core Ideas (DCIs)** **PS2.A: Forces and Motion** ● For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). ● The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. ● All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. **PS3.A: Definitions of Energy** ● Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. **ETS1.B: Developing Possible Solutions**

	● There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. ● Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. **ETS1.C: Optimizing the Design Solution** ● 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 those characteristics may be incorporated into the new design. **LS1.D: Information Processing** ● Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. **Science and Engineering Practices (SEPs):** **Planning and Carrying out Investigations** ● Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. ● Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. **Analyzing and Interpreting Data** ● Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. ● Analyze and interpret data to provide evidence for phenomena. **Constructing Explanations** ● Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. ● Construct an explanation using models or representations. ● Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events. ● Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.

	● Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing. **Engaging in Argument from Evidence** ● Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. ● Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. ● Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. **Crosscutting Concepts (CCCs):** **Systems and system models** ● Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. ● Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. **Energy and matter** ● Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. ● The transfer of energy can be tracked as energy flows through a designed or natural system. **Structure and function** ● Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. ● Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. **Stability and change** ● Explanations of stability and change in natural or designed systems can be constructed by

	examining the changes over time and forces at different scales, including the atomic scale. ● Small changes in one part of a system might cause large changes in another part. ● Stability might be disturbed either by sudden events or gradual changes that accumulate over time. *Common Core State Standards for Mathematics* CCSS.MATH.7.G.A.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. CCSS.MATH.7.RP.A.2 Recognize and represent proportional relationships between quantities. There are multiple connections between the work students will be doing in Lesson 7 and the work they will be doing in math class this year (grade 8). CCSS.MATH.CONTENT.8.F.B.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models and in terms of its graph or a table of values. CCSS.MATH.8.F.B.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). CCSS.MATH.8.EE.A.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. *Common Core State Standards for English Language Arts* CCSS.ELA-LITERACY.W.8.1 Write arguments to support claims with clear reasons and relevant evidence. CCSS.ELA-LITERACY.W.8.1.B Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text. CCSS.ELA-LITERACY.SL.8.1.C Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas. CCSS.ELA-LITERACY.SL.8.1.D Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.

Essential Question(s):	Why do things sometimes get damaged when they hit each other?
Enduring Understanding(s):	● For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction. ● Objects change their motion only when forces act during interactions, and the size of those forces determines how objects move ● During collisions, energy is transferred between objects. The structure and properties of materials influences how energy is absorbed, transferred, and dissipated, affecting the amount of damage that occurs. ● Scientific evidence and iterative testing enable engineers to design, evaluate, and improve solutions within given criteria and constraints.
Learning Goal(s): *Students will know and will be able to use their learning to:* ***Note all NGSS learning goals NGSS are three-dimensional integrating a DCI, a SEP, and a CCC**	**Three-Dimensional Performance Expectations:** **MS-PS2-1** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.] **MS-PS-2-2** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one dimension and in an inertial reference frame and to change in one variable at a time.] ● Plan and carry out investigations to gather evidence that, during collisions, the shape of the objects and/or their motion changes. ● Plan and carry out investigations and analyze and interpret data to figure out that all solid objects behave elastically up to a point and that the forces between objects in a collision are always equal in size and opposite in direction.

	● Develop and use free-body diagram models to represent the changes in the relative strength of forces on different objects in a collision. ● Carry out investigations to determine how changing the speed or mass of an object affects the amount of damage it does in a collision. ● Conduct investigations to gather evidence to explain how friction and air resistance affect the kinetic energy of an object before a collision. ● Develop and use system models to support explanations for how contact forces, including friction and air resistance, cause energy to be transferred from one part of the system to another before, during, and after a collision. **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. ● Use mathematical models to determine how changes in the mass and speed of an object affect the amount of kinetic energy that object has. **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. ● Identify trade-offs, analyze and critique design solutions, and optimize design solutions using evidence from investigations to solve different design problems for different contexts. **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. ● Plan and carry out investigations to determine which materials reduce forces the most in a collision. **MS-LS1-8.** Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. ● Gather information from text about how the nervous system senses pain, temperature, and

	pressure. ● Develop a causal chain for how mechanical sense receptors in nerve cells in our skin transmit signals to other nerve cells to our brain that these signals are then processed in the brain, resulting in immediate behaviors or memories, and that responses can be sent back from our brain to our muscles through other neurons to make them move. **Content:** (Students will know…) ● mass and speed affect the kinetic energy of an object. ● potential energy is stored energy. ● Newton's laws. ● an object's motion is described relative to a reference frame. ● contact forces. ○ applied forces ○ friction ○ air resistance ● balanced and unbalanced forces. ● free-body diagrams. ● during a collision, kinetic energy can be transferred into other forms associated with deformation, sound, and thermal energy. ● deformation can be temporary/elastic or permanent. ● how the nervous system responds to stimuli. ○ sensory receptors ○ neurons and neuron structures ○ the brain ● material properties and how different materials respond to forces. ● engineering design. ○ criteria ○ constraints ○ optimization. **Skills:** (Students will be able to…)

	• design their own fair tests by identifying independent and dependent variables as well as variables that will stay constant and by constructing data tables to collect results from multiple trials in order to compare results from collision investigations. • construct, analyze, and interpret graphical displays to identify linear and nonlinear relationships and determine that the kinetic energy of a moving object is proportional to its mass and the kinetic energy is related to the square of its speed. • find lines of best fit and identify quantitative relationships in their data related to the amount of deformation per Newton of force and the change in kinetic energy as a scale factor. • create and revise models of collisions, including particle-level (microscopic) models, that explain how forces and energy are transferred.

Unit Number and Title:	**Unit 2 -** Sound Waves
Duration:	~ 20 classes/5 weeks
Resource(s):	*OpenSciEd 8.2 Sound Waves* *Inspire Science Course 3* Integrated Middle School Text (McGraw Hill)
Unit Overview:	In this unit, students develop ideas related to how sounds are produced, how they travel through media, and how they affect objects at a distance. Throughout this unit, students will conduct investigations and make observations of sound sources to figure out that patterns of differences in those vibrations are tied to differences in characteristics of the sounds being made. They gather data on how objects vibrate when making different sounds to characterize how a vibrating object's motion is tied to the loudness and pitch of the sounds it makes. Students also conduct experiments to support the idea that sound needs matter to travel through, and they will use models and simulations to explain how sound travels through matter at the particle level.
Learning Goals	
Standard(s):	*Next Generation Science Standards:*

	Disciplinary Core Ideas (DCIs) **PS4.A: Wave Properties** ● A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. ● A sound wave needs a medium through which it is transmitted. **LS1.D: Information Processing** ● Sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or memory storage. **Science and Engineering Practices (SEPs):** **Using Mathematics and Computational Thinking** ● Use mathematical representations to describe and/or support scientific conclusions and design solutions. ● Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems. **Engaging in Argument from Evidence** ● Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. ● Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. ● Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. **Developing and Using Models** ● Develop or modify a model — based on evidence — to match what happens if a variable or component of a system is changed. ● Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. ● Develop and/or use a model to predict and/or describe phenomena. ● Develop a model to describe unobservable mechanisms.

	Crosscutting Concepts (CCCs): **Scale, Proportion, and Quantity** ● Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. ● Scientific relationships can be represented through the use of algebraic expressions and equations. ● Phenomena that can be observed at one scale may not be observable at another scale. **Patterns** ● Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. ● Patterns can be used to identify cause and effect relationships. ● Graphs, charts, and images can be used to identify patterns in data. **Energy and Matter** ● Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. ● The transfer of energy can be tracked as energy flows through a designed or natural system. **Cause and Effect** *Common Core State Standards for Mathematics* CCSS.MATH.8.FA.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). CCSS.MATH.6.SP.B.5: Summarize numerical data sets in relation to their context, such as by giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. CCSS.MATH.8.F.B.5: Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

	CCSS.MATH.8.F.A.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change. *Common Core State Standards for English Language Arts* CCSS.ELA-LITERACY.RST.6-8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. CCSS.ELA-LITERACY.RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). CCSS.ELA-LITERACY.RST.6-8.9: Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. CCSS.ELA-LITERACY.SL.8.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. CCSS.ELA-LITERACY.SL.8.1.C: Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas. CCSS.ELA-LITERACY.W.8.1: Write arguments to support claims with clear reasons and relevant evidence. CCSS.ELA-LITERACY.W.8.1.A: Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically. CCSS.ELA-LITERACY.W.8.1.B: Support claims with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
Essential Question(s):	How can sound make something move?
Enduring Understanding(s):	• Sound is produced by vibrating objects: Louder sounds are caused by higher amplitude vibrations, and higher pitched sounds are caused by higher frequency vibrations.

	● Sound needs matter to travel: When an object vibrates, it causes collisions between the particles in the medium which result in compression bands moving away from a sound source, thus allowing a transfer of energy through the medium. Proportional increases in amplitude have a bigger effect on the energy transferred in a wave than increases in frequency. ● Sound energy is transferred through the parts of the ear to the nerve cells that send signals to the brain.
Learning Goal(s): *Students will know and will be able to use their learning to:* ***Note all NGSS learning goals NGSS are three-dimensional integrating a DCI, a SEP, and a CCC**	**Three-Dimensional Performance Expectations:** MS-PS4-1: Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. ● Carry out investigations to provide evidence that all objects move back and forth (vibrate) when making sounds. ● Carry out investigations to determine that louder sounds have higher amplitude and softer sounds have lower amplitude. ● Carry out investigations to determine that the highness or lowness of a sound depends on the frequency of vibrations. ● Carry out investigations to gather evidence that waves with bigger amplitude or higher frequency transfer more energy. ● Identify that energy of a wave is related to the square of the amplitude. MS-PS4-2: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. ● Conduct investigations to gather evidence that sound moves through any type of matter, but sound cannot move across empty space (a vacuum). ● Use a simulation to observe a sound source hitting a particle, causing it to collide into the particle next to it, transferring energy to the next particle. ● Use a simulation to conduct an investigation changing either the pitch or loudness of the sound produced to see how the motion of the particles in the medium is affected. MS-LS1-8: Gather and synthesize information that sensory receptors respond to stimuli by sending

	messages to the brain for immediate behavior or storage as memories. ● Use text, videos, and animations to gather information about the structures of the ear and how hearing loss can occur. ● Develop a model showing how energy is transferred through the parts of the ear to the nerve cells that send signals to the brain. **Content:** (Students will know…) ● sound is a wave created by vibrating objects. ● sound is transmitted through matter by particle collisions. ● sound requires a medium to travel and cannot propagate in a vacuum. ● wave characteristics and properties. ○ wavelength ○ frequency ○ amplitude ○ energy transfer ○ wave speed ● wave interactions with matter. ○ reflection ○ absorption ○ transmission ● the relationship between pitch and frequency of vibration. ● the relationship between amplitude and loudness. ● the energy of a wave is related to the square of the amplitude. ● the role of human ear structure and function in hearing and sound detection. **Skills:** (Students will be able to…) ● conduct investigations to determine how sound travels through different materials/media.

	• analyze wave and vibration data to identify patterns in frequency, amplitude, wavelength, and energy. • use measurements and mathematical relationships to describe wave properties. • create diagrams to represent the characteristics and behaviors of sound waves. • model how energy is transferred from particle to particle through a medium. • interpret position vs time graphs in order to describe patterns and support conclusions. • use evidence from investigations to support claims that sound requires a medium to travel through.

Unit Number and Title:	**Unit 3 -** Forces at a Distance
Duration:	~ 20 days/5 weeks
Resource(s):	*OpenSciEd 8.3 Forces at a Distance* *Inspire Science Course 3* Integrated Middle School Text (McGraw Hill)
Unit Overview:	In this unit, students investigate a technology that relies on electromagnetism. Students investigate the interaction between electromagnets and magnets that are a key component of the technology's function. Students dissect a device to explore the inner workings, and engineer homemade versions of the device. Students learn that forces that act at a distance can be explained by fields and can be mapped by their effect on an object. They also learn that the sizes of electric and magnetic forces depend on the distances between the interacting objects as well as the magnitudes of the charges, currents, or magnetic strengths involved. In addition, they identify that all devices that use electromagnets have a magnet and a coil of wire. Finally, students investigate each of these parts to figure out how they work together in the system. Along the way, students manipulate the components (e.g. changing the strength of the magnet, number of coils, direction of current) to see how this technology can be modified and applied to a variety of contexts, like MagLev trains, junkyard magnets, and electric motors.
Learning Goals	

Standard(s):	*Next Generation Science Standards:* **Disciplinary Core Ideas (DCIs)** **PS2.B: Types of Interactions** ● Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). ● Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. **PS3.A: Definitions of Energy** ● A system of objects may also contain stored (potential) energy, depending on their relative positions. **PS3.C: Relationship Between Energy and Forces** ● When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. **Science and Engineering Practices (SEPs):** **Developing and using models** ● Develop or modify a model — based on evidence — to match what happens if a variable or component of a system is changed. ● Use and/or develop a model of simple systems with uncertain and less predictable factors. ● Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. ● Develop and/or use a model to predict and/or describe phenomena. ● Develop a model to describe unobservable mechanisms. ● Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. **Asking questions and identifying problems**

	● Determine relationships between independent and dependent variables and relationships in models. ● Clarify and/or refine a model, an explanation, or an engineering problem. ● Ask questions that require sufficient and appropriate empirical evidence to answer. **Planning and carrying out investigations** ● Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. ● Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. ● Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. **Analyzing and interpreting data** ● Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. ● Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. **Using mathematics and computational thinking.** ● Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. ● Analyze and interpret data to provide evidence for phenomena. **Constructing Explanations and Designing Solutions.** **Crosscutting Concepts (CCCs):** **Cause and Effect** ● Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. ● Cause and effect relationships may be used to predict phenomena in natural or designed systems. ● Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

	Systems and System Models ● Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. **Energy and Matter** ● Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. ● Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). ● The transfer of energy can be tracked as energy flows through a designed or natural system. **Patterns** **Scale, Proportion, and Quantity** *Common Core State Standards for Mathematics* CCSS.MATH.8.F.B.4: Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (*x, y*) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values**.** CCSS.MATH.8.F.B.5: Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally. *Common Core State Standards for English Language Arts* CCSS.ELA-Literacy.SL.6.1.c: Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion. CCSS.ELA-LITERACY.W.8.1 Write arguments to support claims with clear reasons and relevant evidence. CCSS.ELA-LITERACY.SL.8.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

Essential Question(s):	How can a magnet move another object without touching it?
Enduring Understanding(s):	● Forces that act over a distance can be described by a field which can store potential energy in the system. ● An electric current can create a magnetic field that can interact with a permanent magnet. ● Electromagnetic force depends on the magnitudes of the charges, currents, magnetic strength, and the distances between the objects.
Learning Goal(s): *Students will know and will be able to use their learning to:* ***Note all NGSS learning goals NGSS are three-dimensional integrating a DCI, a SEP, and a CCC**	**Three-Dimensional Performance Expectations:** **MS-PS2-5**: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. ● Plan and carry out investigations to analyze and interpret data to figure out how magnets interact with each other and with other objects. ● Gather evidence to support the claim that magnetic forces can act across a vacuum. ● Conduct investigations to determine that a current in a wire coil generates a magnetic field. **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. ● Carry out investigations to determine how the distance between two magnets affects the force between them. ● Develop a model that explains how the arrangement and interaction of a permanent magnet and coil of wire in a device aid its function. **MS-PS2-3:** Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. ● Conduct investigations to gather evidence to determine the factors that affect the strength of an electromagnet. **Content:** (Students will know…) ● forces can act between objects that are not touching. ● magnetic forces can be attractive or repulsive.

	● the strength of magnetic interactions depends on factors such as magnetic strength and distance. ● magnetic fields extend through the space around a magnet. ● potential energy can be stored in electric and magnetic fields. ● the arrangement of interacting objects can determine how much potential energy is stored in a system. ● magnetic forces can act across a vacuum. ● a coil of wire carrying electric current can interact with a magnet. ● the major components of a speaker (magnet, coil of wire, and membrane). ● technological applications of magnetic forces. ○ speakers ○ electric motors ○ maglev trains ○ industrial/junkyard magnets **Skills:** (Students will be able to…) ● develop and revise models of magnetic fields and magnetic interactions to explain how forces act without objects touching. ● create and use a model to explain how the interaction between a permanent magnet and coil of wire are used in technology, and use the model to explain the cause and effect relationships that determine the function of the technology. ● design investigations of electromagnetic forces to collect data, identifying variables and constants. ● analyze linear and nonlinear relationships in data to identify factors affecting magnetic forces. ● analyze quantitative relationships involving distance, force, and energy and use mathematical representations to describe patterns. ● use evidence to explain how magnetic fields produce forces at a distance and how those forces affect objects.

Unit Number and Title:	**Unit 4 -**Earth in Space

Duration:	~ 24 days/6 weeks
Resource(s):	*OpenSciEd 8.4 Earth in Space* *Inspire Science Course 3* Integrated Middle School Text (McGraw Hill)
Unit Overview:	This unit is driven by observations of the repeating patterns of the motion of the Sun and Moon across the sky over days, months, and years. To explain these phenomena, students develop models for the Earth-Sun and Earth-Sun-Moon systems that explain seasons, eclipses, and lunar phases. Students further investigate content such as rainbows, sunsets, and other sky and space patterns related to changes in color and light. Students then explore planets and other objects farther out in space (beyond the stars they can see with the unaided eye). They explore the concept of scale and develop a model of the solar system and figure out that gravity is the driving force behind the patterns of motion of these objects and the organization of the solar system as well as the driving force behind the organization of more distant systems (galaxies) that we cannot see without the assistance of technology.
Learning Goals	
Standard(s):	*Next Generation Science Standards:* **Disciplinary Core Ideas (DCIs)** **ESS1.A: The Universe and Its Stars** ● Patterns of the apparent motion of the Sun, the Moon, and stars in the sky can be observed, described, predicted, and explained with models. ● Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. **ESS1.B: Earth and the Solar System** ● The solar system consists of the Sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the Sun by its gravitational pull on them. ● This model of the solar system can explain eclipses of the Sun and the Moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the Sun. The seasons

	are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. ● The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. **PS2.B: Types of Interactions** ● Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the Sun. **PS4.B: Electromagnetic Radiation** ● A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. ● However, because light can travel through space, it cannot be a matter wave, like sound or water waves. **Science and Engineering Practices (SEPs):** **Developing and Using Models** ● Develop or modify a model — based on evidence — to match what happens if a variable or component of a system is changed. ● Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. ● Develop and/or use a model to predict and/or describe phenomena. ● Develop a model to describe unobservable mechanisms. **Planning and Carrying Out Investigations** ● Collect data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. **Analyzing and Interpreting Data** ● Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. ● Analyze and interpret data to provide evidence for phenomena. **Obtaining, Evaluating and Communicating Information** ● Critically read scientific texts adapted for classroom use to determine the central ideas and/or

obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).
- Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings.

Crosscutting Concepts (CCCs):
Patterns

- Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.
- Patterns can be used to identify cause and effect relationships.
- Graphs, charts, and images can be used to identify patterns in data.

Scale, Proportion, and Quantity:

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
- The observed function of natural and designed systems may change with scale.
- Phenomena that can be observed at one scale may not be observed at another scale.

System and System Models:

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

Common Core State Standards for Mathematics
CCSS.MATH.CONTENT.7.SP.B.3 Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability.
CCSS.MATH.CONTENT.7.RP.A.1 Compute unit rates associated with ratios of fractions, including

	ratios of lengths, areas and other quantities measured in like or different units. *Common Core State Standards for English Language Arts* CCSS.ELA-LITERACY.SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. CCSS.ELA-LITERACY.SL.8.1.B Follow rules for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles as needed. CCSS.ELA-LITERACY.SL.8.1.C Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas. CCSS.ELA-LITERACY.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. CCSS.ELA-LITERACY.RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions CCSS.ELA-LITERACY.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics. CCSS.ELA-LITERACY.RST.6–8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
Essential Question(s):	How are we connected to the patterns we see in the sky and space?
Enduring Understanding(s):	● Gravity is the attractive force that holds the solar system and galaxies together; and is affected both by the objects'masses and the distance between objects. ● As light shines on an object, it is either reflected, absorbed, transmitted, or refracted depending on the material and the frequency of the light (color). ● The Earth-Sun-Moon system causes cyclic patterns of lunar phases, eclipses of the sun and moon, and the seasons.
Learning Goal(s):	**Three-Dimensional Performance Expectations:**

Students will know and will be able to use their learning to: ***Note all NGSS learning goals NGSS are three-dimensional integrating a DCI, a SEP, and a CCC**	MS-PS2-4: Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. ● Collect, analyze and interpret data to determine the effect of mass and distance on the gravitational force between objects. MS-PS4-2: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. ● Investigate light phenomena and develop a model of light that can account for changes in color and brightness when it interacts with matter. ● Revise a lunar eclipse model to represent the Earth-Sun-Moon system to show that matter in Earth's atmosphere refracts light from the Sun to make the Moon appear red. MS-ESS1-1: Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. ● Analyze data on daily and yearly changes in temperature, the changes in the length of a day, and angle of elevation of the Sun in the sky over the course of the year. ● Develop and use both physical and conceptual models of objects in space to explain seasonal temperature variation across the globe, lunar phases, lunar eclipses, solar eclipses, and transits of Venus and Mercury. MS-ESS1-2: Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. ● Use simulations to investigate how changing the distance and the mass affects the object's orbit around another object in the solar system. ● Understand that gravity is an attractive force between all matter and more massive objects have stronger attractive gravitational forces between them than objects that are less massive and closer objects have stronger attractive gravitational forces between them than objects farther away. MS-ESS1-3: Analyze and interpret data to determine scale properties of objects in the solar system.

	• Explore the galactic scale by analyzing photos and videos of the objects in the solar system. **Content:** (Students will know…) • Earth's rotation causes the cycle of day and night. • Moon phases are caused by the changing positions of the Moon, Earth, and Sun as the Moon orbits Earth. • the regular motions of the Earth, Moon, and Sun periodically create alignments that can result in solar and lunar eclipses. • the Moon's orbit around Earth is slightly tilted relative to Earth's orbit around the Sun. • a solar eclipse occurs when the Moon moves between the Sun and Earth, blocking some or all of the Sun's light from reaching a portion of Earth. • a lunar eclipse occurs when Earth moves between the Sun and the Moon, causing Earth's shadow to fall on the Moon. • Earth's atmosphere affects what we see in the sky, including the reddening of the Moon during a lunar eclipse and phenomena such as rainbows. • Earth's astronomical seasons are caused by Earth's axial tilt combined with Earth's revolution around the Sun. • gravity explains the motion and organization of objects in space, including orbits of planets and moons. • gravitational forces are affected by mass and distance. • formation of the solar system and the Milky Way galaxy. **Skills:** (Students will be able to…) • create and revise models of the Earth-Sun-Moon system to explain and predict moon phases, solar eclipses, lunar eclipses, and the seasons. • analyze images and data looking for patterns in data to identify cause and effect relationships. • use data to determine the scale properties of objects in the solar system and to analyze seasonal temperatures on Earth. • construct evidence-based explanations for astronomical phenomena including day and night, Moon phases, eclipses, and seasons.

	● use cause-and-effect reasoning to connect gravitational interactions and the observed motion of objects.

Unit Number and Title:	**Unit 5 -** Genetics
Duration:	~ 28 days/7 weeks
Resource(s):	*OpenSciEd 8.5 Genetics* *Inspire Science Course 3* Integrated Middle School Text (McGraw Hill)
Unit Overview:	This unit on genetics is anchored in observations that living organisms of different species, and even the same species, have differences in their traits. Students explore photos of organisms showing a range of visible differences. Students gather other examples of trait variation they've seen in their lives. Students use videos, photos, data sets, and readings to investigate and figure out how traits are influenced by environmental factors, and they use data about chromosomes and proteins to figure out the genetic factors that influence phenotype. Students develop models to explain how traits are passed from parents to offspring. They investigate plant reproduction, including selective breeding and asexual reproduction (in plants and other organisms) as well as examples of traits that are influenced by both genetic and environmental factors.
Learning Goals	
Standard(s):	*Next Generation Science Standards:* **Disciplinary Core Ideas (DCIs)** **LS1.B: Growth and Development of Organisms** ● Genetic factors as well as local conditions affect the growth of the adult plant. ● Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. ● Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

	LS3.A: Inheritance of Traits ● 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. ● Variations of inherited traits between parent and offspring arise from genetic differences that result from the sub-set of chromosomes (and therefore genes) inherited. **LS3.B: Variation of 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 are harmful, and some are neutral to the organism. ● 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. **LS4.B:Natural Selection** ● 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 on to offspring. **LS1.A Structure and Function** ● Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. **Science and Engineering Practices (SEPs):** **Obtaining, Evaluating, and Communicating Information:** ● Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).

	● Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings. ● Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. ● Evaluate data, hypotheses, and/or conclusions in scientific and technical texts in light of competing information or accounts. ● Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations. **Using Mathematics and Computational Thinking** ● Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems. ● Create algorithms (a series of ordered steps) to solve a problem. ● Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends. **Developing and Using Models:** ● Develop and/or use a model to predict and/or describe phenomena. ● Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. ● Develop a model to describe unobservable mechanisms. **Planning and Carrying Out Investigations** ● Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. ● Collect data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. **Constructing Explanations and Designing Solutions** ● Construct an explanation using models or representations. ● Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events. **Asking questions and defining problems**

	Crosscutting Concepts (CCCs): **Patterns** ● Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. ● Graphs, charts, and images can be used to identify patterns in data. **Cause and Effect** ● Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. ● Cause and effect relationships may be used to predict phenomena in natural or designed systems. ● Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. **Scale Proportion and Quantity** ● Phenomena that can be observed at one scale may not be observable at another scale. **Structure and Function** ● Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. *Common Core State Standards for Mathematics* CCSS.MATH.CONTENT.6.SP.B.4: Display numerical data in plots on a number line, including dot plots, histograms, and box plots. CCSS.MATH.CONTENT.3.MD.B.3: Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs.

	CCSS.MATH.CONTENT.7.SP.C.5: Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event. CCSS.MATH.CONTENT.7.SP.C.6: Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. CCSS.MATH.CONTENT.7.SP.C.7: Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. CCSS.MATH.CONTENT.7.RP.A.2: Recognize and represent proportional relationships between quantities. CCSS.MATH.CONTENT.5.NF.B.4: Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction. *Common Core State Standards for English Language Arts* CCSCCSS.ELA-Literacy.SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. CCSS.ELA-LITERACY.SL.8.1.A Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion. CCSS.ELA-LITERACY.SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. CCSS.ELA-LITERACY.RI.8.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.

	CCSS ELA LITERACY RI.8.7 Evaluate the advantages and disadvantages of using different mediums (e.g., print or digital text, video, multimedia) to present a particular topic or idea. CCSS.ELA-LITERACY.RI.8.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced. CCSS.ELA-LITERACY.RI.8.10 By the end of the year, read and comprehend literary nonfiction at the high end of the grades 6-8 text complexity band independently and proficiently. CCSS.ELA-LITERACY.W.8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. CCSS.ELA-LITERACY.W.8.2.D Use precise language and domain-specific vocabulary to inform about or explain the topic. CCSS.ELA-LITERACY.W.8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. CCSS.ELA-LITERACY.RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. **C**CSS.ELA-LITERACY.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. CCSS.ELA-LITERACY.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.
Essential Question(s):	Why are living things different from one another?
Enduring Understanding(s):	● Genes, located on chromosomes, are inherited by offspring from their parents and are responsible for determining the traits of an organism. ● Traits are influenced by both genes and the environment to varying degrees, depending on the trait. ● Organisms can reproduce sexually, which increases genetic variation or asexually, which results in offspring with the identical phenotype as their parents.

	● Selective breeding by humans can alter the prevalence of a desired trait in a population.
Learning Goal(s): *Students will know and will be able to use their learning to:* ***Note all NGSS learning goals NGSS are three-dimensional integrating a DCI, a SEP, and a CCC**	**Three-Dimensional Performance Expectations:** MS-LS1-2: Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. ● Explain that, within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. ● Obtain information from text to explain that chromosomes have specific regions called genes, and that different possible forms of the genes are called alleles. ● Obtain, evaluate, and communicate information about the organization of chromosomes and alleles in cells, including the following: 1) individuals have two of each chromosome; 2) because of this, individuals also have two alleles of each gene, one acquired from each parent; and 3) these versions may be identical or may differ from each other. ● Develop and use a model to explain how genes provide instructions to rearrange building blocks from food into proteins, which then influence phenotypes. MS-LS1-4: Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. ● Construct an explanation for how specialized plant structures support sexual and asexual reproduction in plants. ● Conduct an investigation to study the structures of flowers involved in sexual reproduction, including structures equivalent to sperm and egg cells. ● Obtain information about how the structures of flowers can interact specifically with different pollinators in order to reproduce.

	MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. ● Analyze examples where genetic factors as well as local conditions affect the growth and development of organisms. ● Explain that most trait variations are influenced by a combination of multiple genes and the environment and to varying degrees depending on the trait. 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. ● Gather information from text about the role of proteins in organisms. ● Obtain information from text to explain that changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits; such mutations can have beneficial or harmful effects on an 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. ● Use mathematics and computational thinking to find the probability of offspring with certain genotypes from sexually-reproducing parents with certain genotypes. ● Use pedigrees to model the inheritance of traits within families. ● Use punnet squares to predict genotypes and phenotypes of offspring given the genotypes of the parents. ● Analyze karyotypes to provide evidence that chromosomes are passed from parents to offspring when the sperm and egg fuse during fertilization, and egg and sperm each have half the number of chromosomes as body cells. ● Conduct research to develop models of asexual reproduction that result in genetically identical offspring.

	MS-LS4-5: Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. ● Gather information from text about how humans have the capacity to influence certain characteristics of organisms by selective breeding. **Content:** (Students will know…) ● traits are observable or measurable characteristics. ● proteins affect the structure and function of organisms. ● genetic material contains information that influences the production of proteins, which contribute to an organism's traits. ● genetic material is passed from parents to offspring. ○ DNA ○ chromosomes ○ genes ○ alleles ● offspring inherit genetic information from their parents either through sexual and asexual reproduction. ● sexual reproduction results in offspring that vary in traits. ● asexual reproduction results in offspring that are identical genetically. ● genetic and environmental factors can work together to produce variation in traits. ● genotype is the combination of alleles an organism has for a particular gene. ● phenotype is an organism's observable or measurable characteristics. ● humans can influence inherited traits through artificial selection/selective breeding. ● mutations change the structure of a gene and can result in beneficial or harmful changes to traits. ● pedigrees are used to trace the inheritance of traits in families. ● genetic outcomes can be predicted using Punnett Squares and probability. ● plant structures involved in sexual and asexual reproduction. **Skills:** (Students will be able to…)

	• obtain and evaluate information from a variety of sources, including text, audio interviews, videos, charts, graphs, and images. • analyze histograms and distributions of trait variation in a population. • communicate information orally and in writing through formal and informal opportunities. • use probability and Punnett squares to predict inheritance patterns. • use digital tools to analyze very large data sets to identify patterns and trends in trait variation. • develop and use models to explain inheritance, mutations, and gene-protein-trait relationships. • use cause-and-effect reasoning to explain how genetic and environmental factors can combine to affect traits • construct an explanation for how specialized plant structures support sexual and asexual reproduction in plants.

Unit Number and Title:	**Unit 6 -** Natural Selection & Common Ancestry
Duration:	~ 24 days/ 6 weeks
Resource(s):	*OpenSciEd 8.6 Natural Selection & Common Ancestry* *Inspire Science Course 3* Integrated Middle School Text (McGraw Hill)
Unit Overview:	Students analyze data about modern and ancient organisms that share many physical and behavioral traits but are still distinct species to develop explanations for how these organisms could be connected. Students analyze differences in the body structures and behaviors of ancient and modern species of various organisms to see whether these organisms have similar patterns. To figure out the cause of the changes they have observed in populations, students explore more recent cases of changing heritable trait distribution in populations and explain them by developing a model for natural selection. In the last part of the unit, students use their model for natural selection to explain how some body structure variations in different species of modern organisms could result from natural selection and how they could descend from a common ancient ancestor population. They analyze embryological data to provide

	further evidence to support their argument about how different species may be connected.
Learning Goals	
Standard(s):	**Next Generation Science Standards (DCI):** **LS1.B. Growth and Development of Organisms:** ● Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. **LS4.A. Evidence of Common Ancestry and Diversity** ● 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. **LS4.B. Natural Selection** ● Natural selection leads to the predominance of certain traits in a population and the suppression of others. **LS4.C. Adaptation** ● Natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common and those that do not become less common. Thus, the distribution of traits in a population changes. **Science and Engineering Practices (SEPs):** **Analyzing and interpreting data**

	● Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. ● Distinguish between causal and correlational relationships in data. ● Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible. ● Analyze and interpret data to determine similarities and differences in findings. **Constructing explanations and designing solutions** ● Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. ● Construct an explanation using models or representations. ● Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. ● Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events. **Engaging in argumentation from evidence** ● Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. ● Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. **Crosscutting Concepts (CCCs):** **Patterns** ● Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. ● Patterns can be used to identify cause and effect relationships. ● Graphs, charts, and images can be used to identify patterns in data. **Cause and effect**

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Stability and change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale.
- Small changes in one part of a system might cause large changes in another part.
- Stability might be disturbed either by sudden events or gradual changes that accumulate over time.

Structure and function

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

Common Core State Standards for Mathematics

CCSS.MATH.

CCSS.MATH.CONTENT.7.SP.A.1: Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.

CCSS.MATH.CONTENT.7.SP.B.3: Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability.

CCSS.MATH.CONTENT.6.SP.A.3: Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

CCSS.MATH.CONTENT.6.SP.B.4: Display numerical data in plots on a number line, including dot

	plots, histograms, and box plots. CCSS.MATH.CONTENT.8.SP.A.1: Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. CCSS.MATH.CONTENT.8.SP.A.2: Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line. *Common Core State Standards for English Language Arts* CCSS.ELA-LITERACY. CCSS.ELA-Literacy.RST.6-8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. CCSS.ELA-Literacy.SL.8.1.C: Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas. CCSS.ELA-LITERACY.SL.8.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. CCSS.ELA-LITERACY.SL.8.1.D: Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented. CCSS.ELA-LITERACY.SL.8.3: Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced. CCSS.ELA-LITERACY.RST.6-8: Cite specific textual evidence to support analysis of science and technical texts.. CCSS.ELA-LITERACY.RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

	CCSS.ELA-LITERACY.RST.6-8.10: By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.
Essential Question(s):	How could things living today be connected to things that lived long ago?
Enduring Understanding(s):	● Analyzing the fossil record shows that modern organisms are connected to ancient organisms through lines of descendants. ● Natural selection acting over generations is the process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common, while those that do not become less common. Thus, the distribution of traits in a population changes.
Learning Goal(s): *Students will know and will be able to use their learning to:* ***Note all NGSS learning goals NGSS are three-dimensional integrating a DCI, a SEP, and a CCC**	**Three-Dimensional Performance Expectations:** MS-LS1-4: Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively. ● Analyze and interpret data to provide evidence that characteristic behaviors and specialized structures affect the probability of successful reproduction of different species of organisms in different environments. 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. ● Analyze and interpret data regarding the changes that have occurred in different types of organisms and in the environment throughout the history of life on Earth. ● Organize and analyze data about modern and ancient organisms to identify patterns in bones and behaviors.

	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. ● Investigate real world-cases where populations changed over just a few generations ● Construct an explanation for lines of evolutionary descent using evidence for what traits remain relatively stable and which are changing, and explain how natural selection could cause these changes. 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. ● Argue using data from the physical structures apparent in different types of animals (species) at different stages of embryological development that emphasize new ideas about how different types of living things (species) may be connected. 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. ● Use simulations to test how changing environmental factors (like food distribution or predators) affect the probability of specific traits being passed on. ● Analyze trait frequency changes in a population over time as a result of environmental change. ● Obtain, evaluate, and communicate information about structures and how their functions support survival and successful reproduction in new environments. MS-LS4-6: Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. ● Analyze complex data sets using probability to understand survival chances of individual trait variations. ● Develop and use a model of cause-and-effect mechanisms (natural selection) that lead to the predominance of certain trait variations in a population and to the suppression or elimination of others.

	Content: (Students will know…) ● the geographic distribution of organisms (biogeography) provides evidence about how populations have changed over time and how species are related. ● different organisms are related through common ancestry. ● common ancestry is supported by evidence from the fossil record, similarities and differences in anatomy, embryology, and genetic/molecular evidence. ● competition within a population can result in differences in survival and reproduction among individuals. ● individuals with certain heritable traits are better suited to their environment and they are more likely to survive and reproduce (natural selection). ● natural selection can cause the frequency of traits in a population to change over time. ● adaptations are inherited characteristics that help organisms survive and reproduce in a particular environment. ● if environmental conditions change faster than a population can respond through natural selection, the population may decline or become extinct. **Skills:** (Students will be able to…) ● identify patterns in various types of data including traits, morphology, and geographic location to determine evolutionary relationships. ● develop and use models to explain natural selection. ● use multiple lines of evidence to support explanations for how populations have changed over time, connecting modern organisms to ancient ancestors. ● use probability and population data to predict and explain patterns of inherited variation and changes in populations over generations.