Westerville City Schools
Science 8
Course of Study
Course Number: 840

Course Description

Grade Level: 8
Course Length: Year, 1 Period

Science 8 follows Ohio's Learning Standards for Science and includes topics in Physical, Earth and Space, and Life Science. Science 8 incorporates scientific practices such as inquiry, experimental design, the use of models, data analysis, critical thinking, and using evidence to construct and communicate explanations. Content addressed includes: (1) forces and motion; (2) Earth science (Earth's composition and movement, geologic processes, geologic time); (3) change over time (species diversification and fossil records); and (4) inheritance and adaptation.

Course Rationale

The State of Ohio and Westerville City School District require all 8th grade students to complete a grade level science course. Science 8 follows - and then goes above and beyond - expectations outlined in the most recent version (2018) of Ohio's Learning Standards for Science. As a grade band theme, Order and Organization focuses on helping students use scientific inquiry to discover patterns, trends, structures and relationships that may be inferred by simple principles. The ideas that (1) systems can be described and understood by analysis of the interaction of their components; (2) energy, forces and motion combine to change the physical features of the Earth; (3) the changes of the physical Earth and the species that have lived on Earth are found in the rock record; and (4) for species to continue, reproduction must be successful connect the grade band theme to the content strands. The integration of science content and scientific practices (including the knowledge and skills needed for preparing for the 21st century workforce and higher education) helps students become scientifically literate citizens. Incorporating Ohio's Learning Standards for Literacy and Writing in Science throughout the course further fosters college and career readiness.

Considerations for Cultural Relevancy, Inclusivity, and Diversity

Where possible teachers will create opportunities to incorporate the histories, values, beliefs and perspectives of people from different cultural backgrounds to meet the needs of all learners. Strategies for meeting the needs of all learners including gifted students, English Language Learners and students with disabilities can be found at this ODEW site.

Considerations for Intervention and Acceleration

This rigorous and highly relevant curriculum is built upon high quality, research-based instructional strategies.Teachers may need to provide targeted Tier II support (e.g., remediation of particular skills and concepts, as well as scaffolded or supplemental instruction) beyond the Tier I level

of universal instruction to underachieving students. Intensive and individualized Tier III instruction (e.g., skill-specific intervention, one-on-one support).

Scope and Sequence

Unit	Approximate Length
Relative Motion and Contact Forces	3-4 weeks
Noncontact Forces	4-5 weeks
Earth's Interior	1-2 weeks
Earth's Lithosphere	3-4 weeks
Erosion and Deposition	3-4 weeks
Earth's History	2-3 weeks
Species Diversity	1-2 weeks
Species Reproduction	3-4 weeks
Inheritance	3-4 weeks
Surviving in a Changing Environment	1-2 weeks
Nature of science, scientific method, safety and inquiry should be integrated in every unit.	

Expectations for Learning

Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise, and extend this knowledge. It is a way of knowing about the world based on evidence from experimentation and observations. Science assumes that objects and events occur in consistent patterns that are understandable through measurement and observation. Scientific theories are based on a body of scientific evidence; science explanations can change based on new scientific evidence.

One goal of science education is to help students become scientifically literate citizens that are able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science, to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact not only themselves but others too.

Scientifically literate students

- know, use, and interpret scientific explanations of the natural world;
- generate and evaluate scientific evidence and explanations;
- understand the nature and development of scientific knowledge; and
- participate productively in scientific practices and discourse.

These four proficiencies link the content and practices of science. The standards statements, descriptions, elaborations and learning targets clarify the science *content* students should know and understand. The science practices describe the *skills, processes,* and *actions* of scientists; what scientists do and how science looks in an authentic setting. Scientific practices include:

1. Asking questions
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

The scientific practices allow students to use science content they have acquired. They involve doing something and learning something in such a way that the doing and learning cannot really be separated. Students learn how to do science while learning about science. When students engage in scientific practices, activities and lessons become the basis for learning about experiments, data and evidence, social discourse, models and tools, and mathematics and for developing the ability to evaluate knowledge claims, conduct empirical investigations, and develop explanations.

Via the Model Curriculum and Visions into Practices, Ohio's Learning Standards for Science include and incorporate scientific practices with the learning of science content. The nature of science is intentionally integrated throughout content units rather than be taught or experienced as a stand-alone unit. Throughout grades 6, 7, and 8, learning targets specific to the scientific practices include:

1. **Asking questions**
    - Develop a testable question.
2. **Developing and using models**
    - Interpret models to help explain scientific concepts.
    - Create and revise models to demonstrate science concepts.
3. **Planning and carrying out investigations**
    - Explain and follow basic safety rules to perform lab activities.
    - Select the correct pieces of equipment for a particular investigation.
    - Define sample size, control, variable, and constants.
    - Identify the control, constants, independent and dependent variables in an experiment.
    - Explain how the sample size can affect the results of an experiment.
    - Explain why an experiment can only test one variable at a time.
    - Explain the importance of repeating an experiment.
4. **Analyzing and interpreting data**
    - Analyze charts and graphs for patterns and trends.
    - Interpret charts and graphs looking for evidence to support claims.
    - Create charts and graphs with collected data.
5. **Using mathematics and computational thinking**
    - Use appropriate mathematics, tools and techniques to gather data and information.
    - Use mean, median, and/or mode to interpret data.
    - Use and interpret SI units of measurement.
6. **Constructing explanations**
    - State the difference between the description (observation, summary) and explanation (inference, prediction, significance, and importance) of a scientific situation.
    - Recognize and analyze alternative explanations and predictions.
7. **Engaging in argument from evidence**
    - Distinguish between an observation and an inference.
    - Explain why it is important to examine data objectively.
    - Explain why scientists can not allow bias to affect the interpretation of the results of an experiment.
8. **Obtaining, evaluating, and communicating information**
    - Evaluate the credibility of scientific information from multiple sources.
    - Communicate scientific information through a variety of media.

Scientific inquiry is one form of scientific practice. Inquiry is an active learning process in which students answer research questions through data analysis. Inquiry-based activities start with a scientific question and involve students analyzing relevant data. There are many levels of inquiry that students can progress through (at any grade level) as they move toward deeper scientific thinking.

Name	Summary
Confirmation	Students confirm a principle through an activity in which the **results are known in advance.**
Structured	Students investigate a teacher-presented question through a **prescribed procedure.**
Guided	Students investigate a teacher-presented question using **student designed/selected procedures.**
Open	Students investigate topic-related questions that are **student formulated** through **student designed/selected procedures.**

Essential Standards

8.PS.1 Objects can experience a force due to an external field such as magnetic, electrostatic, or gravitational fields.
Magnetic, electrical and gravitational forces can act at a distance.

8.PS.2 Forces can act to change the motion of objects.

8.ESS.1 The composition and properties of Earth's interior are identified by the behavior of seismic waves.
The refraction and reflection of seismic waves as they move through one type of material to another is used to differentiate the layers of Earth's interior. Earth has a core, a mantle, and a crust.

8.ESS.2 Earth's lithosphere consists of major and minor tectonic plates that move relative to each other.
Historical data and observations such as fossil distribution, paleomagnetism, continental drift and seafloor spreading contributed to the theory of plate tectonics. Convection currents in the asthenosphere cause the movement of the lithospheric plates.There are three main types of plate boundaries: divergent, convergent and transform. Each type of boundary results in specific motion and causes events (such as earthquakes or volcanic activity) or features (such as mountains or trenches) that are indicative of the type of boundary.

8.ESS.3 A combination of constructive and destructive geologic processes formed Earth's surface.
Factors that affect the patterns and features associated with streams and floodplains (e.g., discharge rates, gradients, velocity, erosion, deposition), glaciers (e.g., moraines, outwash, tills, erratics, kettles, eskers), tectonic activity (includes the features listed in the previous content statement), coastlines, flooding and deserts should be studied.

8.ESS.4 Evidence of the dynamic changes of Earth's surface through time is found in the geologic record.
Within a sequence of undisturbed sedimentary rocks, the oldest rocks are at the bottom (superposition). The geologic record can help identify past environmental and climate conditions.

8.LS.1 Diversification of species, a result of variation of traits, occurs through the process of evolution and extinction over many generations. The fossil records provide evidence that changes have occurred in number and types of species.
Changes in environmental conditions can affect how beneficial a trait will be for the survival and reproductive success of an organism or an entire species.

8.LS.2 Every organism alive today comes from a long line of ancestors who reproduced successfully every generation.
Reproduction is the transfer of genetic information from one generation to the next. It can occur with mixing of genes from two individuals (sexual reproduction). It can occur with the transfer of genes from one individual to the next generation (asexual reproduction). Mitosis and meiosis are addressed in preparation for the study of Mendelian genetics.

8.LS.3 The characteristics of an organism are a result of inherited traits received from parent(s).
Expression of all traits is determined by genes and environmental factors to varying degrees.

Relative Motion and Contact Forces

8.PS.2 Forces can act to change the motion of objects.

The motion of an object is always measured with respect to a reference point. Forces can be added. The net force on an object is the sum of all the forces acting on the object. If there is a nonzero net force acting on an object, its speed and/or direction will change. Kinetic friction and drag are forces that act in a direction opposite the relative motion of objects.

Content Elaboration:
Motion can be described in different ways by different observers (e.g., a pencil held in someone's hand may appear to be at rest, but to an observer in a car speeding by, the pencil may appear to be moving).

When multiple forces act on an object, their combined effort is what influences the object's motion (speed and direction). Forces can cancel to a net force of zero if they are equal in strength and act in opposite directions. Such forces are said to be balanced. If all forces are balanced, the object will maintain its current motion (both speed and direction). This means if the object is stationary, it will remain stationary. If the object is moving, it will continue moving in the same direction and at the same speed. When the net force is nonzero, the forces are unbalanced and the object's motion will change. The forces acting on an object can be modeled by a force diagram. Forces are represented by arrows drawn on an isolated picture of the object. The direction of each arrow shows the direction of the force. The length of each arrow represents the magnitude of the force. The effect of the net force on the motion of an object can be predicted from a force diagram. The direction and relative size of the net force can be identified from force diagrams involving multiple forces. Diagrams with forces in both the horizontal and vertical directions can be considered, but at this grade level there should be unbalanced forces in only one of these dimensions. Forces can also act to change the direction of objects. If a force on an object acts toward a single center, the object's path may curve into an orbit around the center.

Friction is a force that opposes sliding between two surfaces. For surfaces that are sliding relative to each other, the force on an object always points in the direction opposite the relative motion of the object. This force is known as kinetic friction. Drag is a force that opposes the motion of an object when a solid object moves through a fluid (e.g., gas, liquid). Kinetic friction and drag affect the motion of objects and may even cause moving objects to slow to a stop unless another force is exerted in the direction of motion. A lack of understanding of friction can lead to the misconception that objects require a sustained force to continue moving. Experimentation with objects that have limited friction (e.g., a puck on an air hockey table, dry ice on a surface) can address this misconception.

Note: Friction will only be calculated from force diagrams. Static friction, as well as the equations for static and kinetic friction, are not appropriate for this level of study.

Essential Questions:	**Enduring Understandings:**
● How can one describe movement and physical interactions between objects and within systems of objects? (overarching)	● All objects and systems in nature move relative to each other.

• How could motion be described differently from different perspectives? • What characteristics help explain linear motion? • What does it take to move an object? • What does it take to stop an object from moving?	• The motion of an object is always measured with respect to a reference point. • Forces either maintain or cause changes in this motion.

Learning Targets:

<u>How could motion be described differently from different perspectives?</u>

- Recognize that the motion of objects is determined with respect to a fixed reference point.
- Given real-world examples, explain how the frame of reference of an observer affects the appearance of motion.
- Describe the motion of an object based on multiple reference points.
- Determine the displacement and/or distance of an object as measured from a frame of reference.
- Describe how an object can have a distance that is not the same as the displacement.

<u>What characteristics help explain linear motion?</u>

- Distinguish average speed from instantaneous speed.
- Use the mathematical relationship between distance and time to determine speed.
- Determine the speed of a moving object using its position vs. time graphs.
- Describe the motion of an object from a position vs. time graph.
- Graph motion as a relationship between distance and time and speed and time.
- Differentiate between speed and velocity.
- Describe the velocity of an object using speed and direction.
- Calculate the velocity of an object by measuring the time to travel different distances and determine if the object moves with constant or changing velocity.
- Provide examples demonstrating positive and negative acceleration that produce changes in speed of an object.
- On a speed vs. time graph, identify when an object is showing no motion, constant speed and constant acceleration.

<u>What does it take to move an object?</u>

- Distinguish between balanced and unbalanced forces.
- Recognize that an unbalanced force acting on an object changes that object's speed and/or direction.
- Compare the motion of an object acted on by balanced and unbalanced forces in a given specific scenario.
- Differentiate between applied and normal forces.
- Use vectors to determine the total force acting on an object.
- Use a force diagram to show the strength and direction of forces on an object in equilibrium (free body diagram).
- Create a force diagram to illustrate the combined forces acting on an object.
- Given a simple contact interaction between two objects, identify the objects involved and give the direction of the force on each object.
- Use force diagrams of two objects to identify interacting force pairs.
- Use a force diagram to predict the motion of an object.
- Calculate the net force on an object from a force diagram.

- Explain how the force of gravity can be acting on a book at rest on a table and yet the book does not move.
- Explain why a heavy cabinet does not change its motion, even though a strong pushing force is applied.

What does it take to stop an object from moving?

- Describe how friction forces caused by air resistance or interactions between surface materials affect the motion of objects.
- Identify situations where friction is beneficial, detrimental, or both.
- Describe the connection between friction forces to surface texture and friction type.
- Analyze the relationship between the frictional force on an object and the normal force between the object and the surface.
- Explain the use of seatbelts in automobiles as related to inertia.

Essential Vocabulary:
applied force, average speed, balanced force, displacement, distance, drag, force, force diagram (free body diagram), friction, inertia, kinetic friction, magnitude, net force, Newton, Newton's First Law, normal force, reference point, unbalanced force, vector, velocity

Instructional Materials and Strategies:

- Suggested Fusion Readings → Unit 7 Forces and Motion
  - Lesson 1: Forces
  - Lesson 2: Gravity and Motion

- Potential Simulations
  - **Explore Learning**: Distance-Time Graphs, Distance-Time and Velocity-Time Graphs, Fan Cart Physics, Force and Fan Carts, Inclined Plane - Sliding Objects, Roller Coaster Physics
  - **PhET**: Forces in 1 Direction, Forces and Motion Basics, Forces and Motion, Friction

- Potential Instructional Strategies
  - Calculate and compare the distance and displacement of a trip around the school.
  - Investigate the relationship between position and time for a cart that rolls down a ramp from rest. Graph the results. Make a claim about how position and time are related and use evidence to support the claim. Based on the presentations of other investigations, propose sources of error and provide suggestions for how the experiments can be improved.
  - Determine the speed and velocity of a toy car. Graphs its motion.
  - Design a procedure to investigate the motion of two objects with different constant speeds (e.g., battery operated cars). Predict where two objects will cross paths when released at different times.
  - Design an experiment to test the effect of multiple forces on the motion of objects (e.g., cars or marbles and ramps, student tug-o-war, spring launchers with different force amounts).
  - Design and test methods that decrease the force on an object (e.g., egg, cell phone) so that it will survive being dropped from a given height. The focus should be on reducing the magnitude of the forces that the object will experience. Redesign and retest the method based on initial testing.
  - Investigate the relationship between type of surface and the effects of kinetic friction on moving objects (e.g., experiment with moving an object across various surfaces).

- Assessment Resources
  - Item Analysis and Question Alignment

Noncontact Forces

8.PS.1 Objects can experience a force due to an external field such as magnetic, electrostatic, or gravitational fields.

Magnetic, electrical and gravitational forces can act at a distance.

Content Elaboration:
This content statement involves a basic introduction to the field model. A field model can be used to explain how two objects can exert forces on each other without touching. Details about the field model are not required other than the idea that a field is a concept that is used to understand forces that act at a distance. An object is thought to have a region of influence, called a field, surrounding it. When a second object with an appropriate property is placed in this region, the field exerts a force on and can cause changes in the motion of the object.

Three types of fields should be investigated: gravitational, electric, and magnetic.

Every object exerts a gravitational force on every other object with mass. These forces are hard to detect unless at least one of the objects is very massive (e.g., sun, planets). The gravitational force increases with the mass of the objects, decreases rapidly with increasing distance and points toward the center of objects. Weight is the force that a mass experiences in a gravitational field. Weight is often confused with mass. Weight is proportional to mass, but depends upon the gravitational field at a particular location. An object will have the same mass when it is on the moon as it does on Earth. However, the weight (force of gravity) will be different at these two locations.

Electrostatic fields exist around objects with a net charge. If a second object with a net charge is placed in the field, the two objects experience electric forces that can attract or repel them, depending on the sign of the charges involved. Magnetic fields exist around magnetic objects. If a second magnetic object is placed in the field, the two objects experience magnetic forces that can attract or repel them, depending on the orientation of the objects involved. Magnetic field lines can be seen when iron filings are sprinkled around a magnet.

Electricity is related to magnetism. In some circumstances, magnetic fields can produce electrical currents in conductors. Electric currents produce magnetic fields. Electromagnets are temporary magnets that lose their magnetism when the electric current is turned off. Building an electromagnet to investigate magnetic properties and fields can demonstrate this concept.

Note: Magnetic poles are often confused with electric charges. It is important to emphasize the differences as Mathematics is not used to describe fields at this level.

Essential Questions:
- How can objects exert a force without touching? (overarching)
- What roles does gravity play in our everyday lives?
- How can magnets and electricity be used together in everyday objects?

Enduring Understandings:
- There are a variety of forces acting on objects at all times affecting motion.
- Magnetic, electrical and gravitational forces can act at a distance.

Learning Targets:

How can objects exert a force without touching?

- Demonstrate how an object can exert a force on another object without touching it.
- Describe the field that exists around an object (electrical, gravitational, or magnetic).
- Show how the strength of the electric, gravitational, and magnetic forces are related to distance and mass.
- Demonstrate how a field can cause changes in the motion of an object.
- Given a simple interaction between two objects that are not touching (e.g., a ball falling to the ground, a magnet and a steel cabinet, hair and a brush experiencing static), identify the objects involved in the interaction and give the direction of the force on each object.
- Identify the forces acting on various objects (e.g., a skydiver, a hanging mass, a chair resting on the floor) and draw force diagrams for the objects.

What roles does gravity play in our everyday lives?

- Compare and contrast weight and mass.
- Explain how the force of gravity can be acting on a book at rest on a table and yet the book does not move.
- Explain how gravity and inertia keep things in orbit around another object.

How can magnets and electricity be used together in everyday objects?

- Recognize that the electrical force increases as the electrical charges increase.
- Recognize that the electrical force decreases when the distance between the charges increases.
- Use the concept of electrical force to explain various phenomena (e.g., making hair stand up, how a dryer sheet functions)
- Differentiate between electric charges and magnetic poles.
- Explain that the magnetic force exerted on other objects located in a magnetic field increases as the strength of the magnet increases and decreases as the distance from the magnet increases. Observe and document the patterns of magnetic fields around pairs of magnets (include examples of repulsion and attraction).
- Compare the interactions of two charged objects, two magnets, and two uncharged objects with mass.
- Construct an electromagnet and explain the relationship between electricity and magnetism.
- Design an electric generator/motor and explain the relationship between electricity and magnetism.

Essential Vocabulary:
attract, electric charge, electrical field, electromagnet, electrostatic field, field, force, gravity (acceleration of), gravitational field, magnetic field, magnetism, mass, Newton, noncontact force, repel, weight

Instructional Materials and Strategies:

- Suggested Readings → Fusion Unit 7 Forces and Motion
  - Lesson 1: Forces
  - Lesson 2: Gravity and Motion
  - Lesson 3: Electric Charge and Static Electricity
  - Lesson 4: Magnets and Magnetism

- Lesson 5: Electromagnetism

- Potential Simulations
  - **Explore Learning:** Charge Launcher, Coulomb Force, Electromagnetic Induction, Free Fall Laboratory, Free Fall Tower, Gravitational Force
  - **PhET**: Balloons and Static Electricity, Charges and Fields, Electric Field Hockey, Energy Skate Park Basics, Faraday's Electromagnetic Lab, Faraday's Law, Gravity Force Lab, John Travoltage, Magnets and Electromagnets

- Potential Instructional Strategies
  - Plan and implement a scientific investigation to determine the relationship between either distance and force or charge and force for two charges. Analyze the data to determine patterns and trends. Formulate a conclusion about the relationship.
  - Investigate the direction of the magnetic field around a variety of objects using compasses, iron filings, and/or magnetic.
  - Design an experiment to test factors that affect the strength of an electromagnet (e.g. number and tightness of coils, size and type of core, current and voltage of circuit, wire type).
  - Construct an electromagnet and explain the relationship between electricity and magnetism.

- Assessment Resources
  - Item Analysis and Question Alignment

Earth's Interior

8.ESS.1 The composition and properties of Earth's interior are identified by the behavior of seismic waves.

The refraction and reflection of seismic waves as they move through one type of material to another is used to differentiate the layers of Earth's interior. Earth has a core, a mantle, and a crust.

Impacts during planetary formation generated heat. These impacts converted gravitational potential energy to heat. Earth's core is also able to generate its own thermal energy because of decaying atoms. This continuously releases thermal energy. Thermal energy generated from Earth's core drives convection currents in the asthenosphere.

Content Elaboration:
It is important to provide the background knowledge regarding how scientists know about the structure and composition of the interior of Earth (without being able to see it). Seismic data, graphics, charts, digital displays and cross sections can be used to study Earth's interior. Earth is differentiated into distinct chemical and physical layers. They correspond in the following way [the chemical layer is stated first, followed by the physical layers in parentheses]: the crust (upper lithosphere), the mantle (lower lithosphere, asthenosphere, mesosphere) and the core (inner and outer). Primordial heat left over from planetary accretion, and heat produced in the Earth's core, contribute to mantle convection. The refraction and reflection of seismic waves as they travel through the lithosphere, to the inner core, is used to identify the different physical layers of Earth's interior. The thicknesses of each layer of Earth can vary and be transitional, depending on composition, density, temperature and pressure, rather than uniform and distinct as often depicted in textbooks.

Earth and other planets in the solar system formed as heavier elements (primarily iron and nickel) coalesced in their centers and formed planetary cores. The less dense, lighter elements (potassium and sodium for example) remained closer to the planetary surface. This is the process of planetary differentiation, a process through which distinct layers with characteristic chemical and/or physical properties are formed. A major period of planetary differentiation occurred in our solar system approximately 4.6 billion years ago. In addition to the composition of Earth's interior, the history of the formation of Earth and the relationship of energy transfer, transformation and convection currents within the mantle and crust are essential in understanding sources of energy.

Essential Questions:
- How can we understand what Earth's interior is composed of without ever seeing it directly?
- To what extent does the exchange of energy within the Earth drive geologic events on the surface?

Enduring Understandings:
- Technology has allowed us to understand the structure of and activities within Earth's interior.
- Energy flow and movement of material from the Earth's interior causes geologic events on the Earth's surface.

Learning Targets:
- Interpret characteristics of Earth's interior using a variety of resources (e.g., seismic data, maps, diagrams, models, charts, cross sections).

How do we know about the composition of Earth's interior?

- Use prior knowledge to develop a hypothesis of earth's formation and the conditions of early earth.
- Demonstrate the different seismic wave motions and speeds using a Slinky®.
- Explain how seismic wave behavior(reflection and refraction) helps scientists determine where Earth's interior layers are located.
- Identify P and S waves on three-component seismograms.
- Differentiate between the characteristics of P waves and S waves.
- Prove that Earth is not homogenous by comparing a seismic record section to predicted arrivals from a homogeneous Earth model.

What do we know about the composition of and processes within Earth's interior?

- Identify the different composition and consistency of each layer of Earth's interior (inner and outer core, upper and lower mantle, crust).
- Describe and label a diagram of the interior layers of Earth.
- Interpret a cross section of Earth.
- Explain the roles of gravity and density in the formation and position of Earth's different layers.
- Use seismic data to determine the composition of the interior of Earth.
- Compare the Earth's compositional layers with the physical layers, their properties, and how they interact.
- Describe the origin of heat generated within Earth.
- Explain how convection currents in the mantle and crust result in the transfer of energy.

Essential Vocabulary:
asthenosphere, convection current, crust, inner core, lithosphere, mantle, mesosphere, outer core, P wave, planetary differentiation, primordial heat, reflection, refraction, S wave, seismic wave

Instructional Materials and Strategies:

- Suggested Readings → Fusion Unit 3 The Restless Earth
  - Lesson 1: Earth's Interior

- Potential Instructional Strategies
  - Use a density column to illustrate how Earth's layers differentiated during formation.
  - Create a model that identifies the earth's four main layers (inner core, outer core, mantle, crust).
  - Narrate a journey to Earth's core. Features of the journey could include mode of transportation, length of time in each layer, sights seen and other aspects.

- Assessment Resources
  - Item Analysis and Question Alignment

Earth's Lithosphere

8.ESS.2 Earth's lithosphere consists of major and minor tectonic plates that move relative to each other.

Historical data and observations such as fossil distribution, paleomagnetism, continental drift and seafloor spreading contributed to the theory of plate tectonics. The rigid tectonic plates move with the molten rock and magma beneath them in the upper mantle.

Convection currents in the asthenosphere cause the movement of the lithospheric plates.The energy that forms convection currents comes from deep within the Earth.

There are three main types of plate boundaries: divergent, convergent and transform. Each type of boundary results in specific motion and causes events (such as earthquakes or volcanic activity) or features (such as mountains or trenches) that are indicative of the type of boundary.

Content Elaboration:
Historical data related to the modern-day theory of plate tectonics which led to theories of continental drift (Wegener), convection theory (Holmes) and seafloor spreading (Hess, Deitz) is introduced. The data supporting these theories includes paleontological data, paleoclimate data, paleomagnetic data and the continental "puzzle-like-fit" noticed as early as Magellan and by other mapmakers and explorers. Contemporary data is introduced, including seismic data, GPS/GIS data (documenting plate movement and rates of movement), robotic studies of the sea floor and further exploration of Earth's interior. Physical world maps, cross sections, models (virtual or 3D) and data are used to identify plate boundaries, movement at the boundary and the resulting feature or event.

The relationship between heat from Earth's core, convection in the magma and plate movement can be explored. World distribution of tectonic activity of possible interest should be investigated (e.g., Ring of Fire, San Andreas Fault, Mid-Atlantic Ridge, Mariana Trench, Hawaiian Islands, New Madrid Fault System). Volcanic activity, earthquakes, tsunamis, geysers, hot springs, faults, oceanic vents, island arcs, hot spots and rift valleys are included in the identification of plates and plate boundaries.

Plate boundary identification (convergent, divergent, transform) is based on the resulting features or events. The focus is on the cause of plate movement, the type and direction of plate movement and the result of the plate movement, not on memorizing plate names.

Essential Questions:
- How do changes in one part of the Earth system affect other parts of the system? (overarching)
- How has our understanding of plate movement changed over time and influenced what we now know?
- What's happening at plate boundaries and why?
- How does plate motion affect features on Earth's surface?

Enduring Understandings:
- Historical data and observations such as fossil distribution, paleomagnetism, continental drift and sea-floor spreading contributed to the theory of plate tectonics.
- Processes in Earth's interior influence actions and features on its surface.
- Plate tectonics, earthquakes, volcanoes and other natural phenomena continuously shape and reshape Earth's surface.

Learning Targets:

How has our understanding of plate movement changed over time and influenced what we now know?

- Describe the historical evidence for plate tectonics, including the early observations, discoveries and ideas that combined to eventually lead to the modern theory of plate tectonics.
- Explain the cause of seafloor spreading and continental drift.
- Use paleomagnetic data to show evidence of seafloor spreading.
- Differentiate between the concepts of plate tectonics and continental drift.
- Use rock and fossil data to recreate the position of the continents at various points in history.
- Apply knowledge of geography and plate tectonics to assemble a 'best fit' map of the world's major plates.
- Argue for the current theory of plate movement and opposition to Wegner's theory of continental drift.

What's happening at plate boundaries and why?

- Compare the characteristics of oceanic crust to the continental lithosphere.
- Use current events and data to support the idea of converging, transforming, and diverging boundaries (Google Earth, StrataLogica, satellite imagery, ocean maps).
- Identify the standard geologic features or events that occur at each of the boundaries (e.gOceanic trenches are formed at convergent plate boundaries, oceanic ridges form at diverging plate boundaries).
- Determine types of plate boundaries based on geologic data (location and magnitude of earthquakes and volcanoes, elevation, and age of ocean crust).

How does plate motion affect features on Earth's surface?

- Identify plate motion as a cause for construction and destruction of landforms and surface features on Earth's crust.
- Explain how plate movement causes the following physical characteristics: volcanic activity, earthquakes, tsunamis, geysers, hot springs, faults, oceanic vents, island arcs, hot spots, and rift valleys.
- Correlate locations of volcanoes and earthquakes with plate boundaries.
- Interpret longitude and latitude coordinates of volcanic and earthquake activity and analyze locations of these occurrences throughout the world.
- Describe where most volcanic and earthquake activity occurs on earth.
- Evaluate how volcanic and earthquake activity impact humans and their environment.

Essential Vocabulary:
asthenosphere, continental drift, convergent boundary, divergent boundary, fault, folding, geyser, hot spot, island arc, mid-ocean ridge, paleomagnetism, plate tectonics, rift valley, Ring of Fire, sea floor spreading, stress, subduction, transform boundary, trench, tsunami

Instructional Materials and Strategies:

- Suggested Readings → Fusion Unit 3: The Restless Earth
  - Lesson 2: The Theory of Plate Tectonics
  - Lesson 3: Plate Tectonics and Landforms

- Lesson 4: Earthquakes

- Potential Simulations
  - **Explore Learning**: Building Pangaea, Plate Tectonics
  - **PhET:** Plate Tectonics

- Potential Instructional Strategies

  How has our understanding of plate movement changed over time and influenced what we now know?
  - Make a timeline to show the development of our current theory of plate tectonics.
  - Create a model demonstrating how paleomagnetic stripes on the seafloor provided clues to magnetic reversals of the planet.
  - Assemble a puzzle based on Pangaea and use it to explain the processes that separated Pangaea and project future plate movement.
  - Research the most recent measurements of North America. Using this data and the movement of North America throughout geologic time, predict where North America will be in 600 million years or more. Create a model to demonstrate that movement.

  What's happening at plate boundaries and why?
  - Model movements at different plate boundaries (convergent, divergent, and transform) and lithospheric interactions (continental-continental, continental-oceanic, and oceanic-oceanic) using manipulatives.
  - Graph the age of the Hawaiian Islands and other seamounts and their distance from Kilauea to determine the speed and direction the Pacific Plate is moving due to plate tectonics.
  - Using a world map, mark the locations of all earthquakes and volcanoes that are recorded each week for one month (or longer). Use a different color or pattern so that earthquakes and volcanoes can be differentiated. Outline the boundaries of where the concentrations are located. Compare/contrast this map with a map of plate boundaries. Ask: What types of boundaries are found in the volcano areas? What types are found in earthquake areas? Discuss findings with the class.
  - Collect real-time data to document tectonic activity in the United States. Highlight the areas of greatest activity and compare them to Ohio activity.

  How does plate motion affect features on Earth's surface?
  - Create a marketing pamphlet describing features of an earthquake resistant building/structure.

- Assessment Resources
  - Item Analysis and Question Alignment

Erosion and Deposition

8.ESS.3 A combination of constructive and destructive geologic processes formed Earth's surface.

Earth's surface is formed from a variety of different geologic processes, including but not limited to plate tectonics.

Content Elaboration:
The interactions between the hydrosphere and lithosphere are studied as they relate to erosional events (e.g., flooding, mass movement). The characteristics of rocks and soil, climate, location, topography and geologic process are studied. Learning should focus on distinguishing between major geologic processes (e.g., tectonic activity, erosion, deposition) and the resulting feature on the surface of Earth. It is important to build on what was included in the elementary grades (recognizing features), enabling students to describe conditions for formation. Factors that affect the patterns and features associated with streams and floodplains (e.g., discharge rates, gradients, velocity, erosion, deposition), glaciers (e.g., moraines, outwash, tills, erratics, kettles, eskers), tectonic activity (includes the features listed in the previous content statement), coastlines, flooding and deserts should be studied.

Topographic, physical and aerial maps, cross-sections, field trips and virtual settings are methods of demonstrating the structure and formation of each type of feature. The use of technology (remote sensing, satellite data, LANDSAT) can be used to access real-time photographs and graphics related to landforms and features.

Essential Questions:
- In what ways can Earth processes be explained as interactions between the hydrosphere and lithosphere? (overarching)
- Why is Earth's crust considered to be in a constant state of change?
- What are the impacts of erosion and deposition?

Enduring Understandings:
- Earth's components form systems. These systems continually interact at different rates of time, affecting the Earth locally and globally.
- Erosion and deposition continuously shape and reshape Earth's surface.

Learning Targets:

Why is Earth's crust considered to be in a constant state of change?
- Label sets of images as erosion and deposition.
- Describe the forces of water as major causes of erosion and apply to local surroundings.
- Identify patterns associated with streams, flood plains, glaciers, tectonic activity, coastlines and deserts.
- Illustrate and explain, using real world examples, how weathering ,erosion, and deposition work together to change earth's surface features.

What are the impacts of erosion and deposition?
- Demonstrate that surface features on Earth are a result of erosion, deposition, and tectonic motion.
- Identify types of mass movement (rock fall, mud flow, landslide) that are present in the local area.
- Describe the steps of desertification and identify areas on a globe that represent each of the transitions.

- Using a topographic map or simulation, identify and explain the processes that created glacial features (e.g., moraines, outwash, till, erratics, kettles, eskers, glaciated and unglaciated areas, rivers and streams).
- Using aerial photographs, LANDSAT data, surficial geology maps or topographic maps, recognize and identify different types of glaciers and glacier features.

Essential Vocabulary:
cut banks, delta, deposition, discharge rate, erratic, erosion, esker, floodplain, glacier, gradient, hydrosphere, kettle, lithosphere, mass movement, meandering, moraine, outwash, point bar, sediment, till, topography

Instructional Materials and Strategies:

- Suggested Readings → Fusion Unit 2: Earth's Surface
  - Lesson 1: Erosion and Deposition by Water
  - Lesson 2: Erosion and Deposition by Wind, Ice, and Gravity
    Lesson 3: Topographic Maps

- Potential Simulations
  - **Explore Learning**: Building Topographic Maps, Erosion Rates, Reading Topographic Maps, River Erosion, Weathering
  - **PhET:** Glaciers

- Potential Instructional Strategies

  <u>Why is Earth's crust considered to be in a constant state of change?</u>
  - Use technology to access real-time photographs and graphics related to landforms and features to describe conditions for formation (remote sensing, satellite data, LANDSAT).
  - Construct a topographic map to identify land features.
  - Manipulate Earth's surface to create a variety of surface features (i.e., kettle lakes, delta, moraines, sand dunes).
  - Use current event articles to find examples of gradual and catastrophic destructive processes (e.g., erosion vs. landslide).
  - Construct a model to explore how soil type (e.g., sand, gravel, lava rock), water content and slope affect severity of landslides.
  - Use a stream table to model factors (e.g., glacial activity, tectonic activity, gradient, discharge rate, load) and test rates of erosion and deposition in a stream meander over time.

  <u>What are the impacts of erosion and deposition?</u>
  - Research and develop a regional solution to minimize the impacts of mass movement events (e.g. flooding, landslides, mudflows, sinkholes, rockfalls).
  - Develop a model to reconstruct glacial history (e.g., U shaped valleys, moraines, tills, kettles, eskers, erratics, outwash) and use it to explain the processes.
  - Examine a glacial map of Ohio to compare the northern counties with the southern counties. What features would you expect to find in each location?

- Assessment Resources

- Item Analysis and Question Alignment

Earth's History

8.ESS.4 Evidence of the dynamic changes of Earth's surface through time is found in the geologic record.

Earth is approximately 4.6 billion years old. Earth history is based on observations of the geologic record and the understanding that processes observed at present day are similar to those that occurred in the past (uniformitarianism). There are different methods to determine relative and absolute age of some rock layers in the geologic record. Within a sequence of undisturbed sedimentary rocks, the oldest rocks are at the bottom (superposition). The geologic record can help identify past environmental and climate conditions.

Content Elaboration:
Representations of the age of the Earth should include a graphic demonstration of the immensity of geologic time, as this is a very difficult concept to grasp. The different methods used to determine the age of the Earth are an important factor in this concept. In elementary grades, fossils are used to compare what once lived to what lives now, but the concept of Earth's age and the age of the fossils were not included (the concept of billions or millions of years was not age-appropriate). In grade 8, the concept of index fossils is a way to build toward understanding relative dating. Superposition, crosscutting relationships and index fossils play an important role in determining relative age. Radiometric dating plays an important role in absolute age. The inclusion of new advances and studies (mainly due to developing technological advances) is important in learning about the geologic record.

Uniformitarianism can be an important key in understanding how scientists have interpreted the environmental conditions that existed throughout Earth's history. Fossil evidence also can indicate specific environments and climate conditions that help interpret the geologic record. Environmental and climate conditions also can be documented through the cryosphere as seen through ice cores. Relating Earth's climate history to present-day climate issues should include evidence from ice core sampling as well as evidence from the geologic record. Using actual data to generate geologic maps of local or statewide formations can connect to the real world. Field studies or geologic research (virtual/digital) can help identify local formations and interpret the environment that existed at the time of the formation. Analyzing and interpreting the data to draw conclusions about geologic history is an important part of this content statement.

Essential Questions:
- How do scientists figure out that the Earth and life on Earth have changed over time? (overarching)
- What methods are used to determine Earth's geological age?
- How have fossils helped us determine the credibility of Earth's geological age?
- How does Earth's geologic record tell us about past environments?

Enduring Understandings:
- Earth history is based on observations of the geologic record and the understanding that processes observed at present day are similar to those that occurred in the past (uniformitarianism).
- Different methods are used to determine relative and absolute age of some rock layers in the geologic record.
- The geologic record can help identify past environmental and climate conditions.

Learning Targets:

What methods are used to determine Earth's geological age?

- Explain how uniformitarianism and superposition are key to understanding Earth's history.
- Explain exceptions to the law of superposition (i.e., unconformities, faults, igneous intrusions, inclusions).
- Explain how folding, faulting and uplifting rearrange rock layers so the youngest rock is not always on top.

How have fossils helped us determine the credibility of Earth's geological age?

- Use a model to identify the relative ages of various fossils or rock layers using index fossils.
- Define and give examples of index fossils.
- Arrange rock layers based on index fossils.
- Predict the relative age of a fossil using index fossils.
- Describe how to determine the relative age of fossils found in sedimentary rock.
- Create a timeline that illustrates the relative ages of fossils of a particular organism in sedimentary rock layers.
- Determine which radiometric dating method would be best to use for a given fossil and determine that fossil's age.
- Use fossil data to describe the geologic history of an area.

How does Earth's geologic record tell us about past environments?

- Use a geologic cross-section (or conduct a field investigation) for a specific location to analyze/interpret geologic history (e.g., rock type, formation, fossils or minerals present) and environmental conditions.
- Analyze ice core data to reconstruct a region's past environmental and climate conditions.

Essential Vocabulary:
absolute age, cross-cutting, cryosphere, faults, half-life, index fossil, igneous intrusions, inclusions, isotope, radiometric dating, relative age, relative dating, superposition, unconformities, uniformitarianism

Instructional Materials and Strategies:

- Suggested Readings → Fusion Unit 4: Earth's History
  - Lesson 1: Geologic Changes over Time
  - Lesson 2: Relative Dating
  - Lesson 3: Absolute Dating
  - Lesson 4: The Geologic Time Scale

- Potential Simulations
  - **PhET:** Radioactive Dating Game

- Potential Instructional Strategies

  What methods are used to determine Earth's geological age?
  - Develop a 3D model that shows the geologic layers of an area using data published by scientists.
  - Calculate, given the half-life and relative amounts of original isotope and daughter product in a rock sample, the estimated age of the sample.

How have fossils helped us determine the credibility of Earth's geological age?

- Represent the geologic time period graphically (e.g. Football Field, Clock Representation). Include specific formation and fossil information.

- Assessment Resources
  - Item Analysis and Question Alignment

Species Diversity

8.LS.1 Diversification of species, a result of variation of traits, occurs through the process of evolution and extinction over many generations. The fossil records provide evidence that changes have occurred in number and types of species.

Fossils provide important evidence of how life and environmental conditions have changed.

Throughout Earth's history, extinction of a species has occurred when the environment changes and the individual organisms of that species do not have the traits necessary to survive and reproduce in the changed environment. Most species (approximately 99 percent) that have lived on Earth are now extinct.

Changes in environmental conditions can affect how beneficial a trait will be for the survival and reproductive success of an organism or an entire species.

Content Elaboration:
The fossil record documents the variation in a species that may have resulted from changes in the environment. The fossil record is contained within the geologic record (ESS grade 8). Combining data from the geologic record and the fossil record, Earth's living history can be interpreted. Data and evidence from the fossil record can be used to further develop the concepts of extinction, biodiversity and the diversity of species. The term "transitional form" is used to describe intermediate organisms between ancestral forms and their descendants. Some examples of transitional forms were fossilized and found in the fossil record. Other transitional forms are missing from the fossil record. Evidence from the geologic and fossil record can be used to infer what the environment was like at the time of deposition.

Essential Questions:

- How do organisms change over time in response to changes in the environment? (overarching)
- How can comparing fossils to related specimens (species) today provide an understanding of environmental and genetic changes?
- How does natural selection encourage diversity over time?
- How do adaptations and genetic variations lead to evolution?

Enduring Understandings:

- Fossils provide important evidence of how life and environmental conditions have changed.
- Changes in environmental conditions can affect how beneficial a trait will be for the survival and reproductive success of an organism or an entire species.
- The diversity and changing of life forms over many generations is the result of natural selection, in which organisms with advantageous traits survive, reproduce, and pass those traits to offspring.
- Throughout Earth's history, extinction of a species has occurred when the environment changes and the individual organisms of that species do not have the traits necessary to survive and reproduce in the changed environment.

Learning Targets:

How can comparing fossils to related specimens (species) today provide an understanding of environmental and genetic changes?

- Use evidence from geologic and fossil records to infer what the environment was like at the time a specific organism lived.
- Investigate structural differences in past and present organisms that have enabled some species to survive while others have become extinct due to sudden or gradual environmental changes (e.g., peppered moths, crayfish fossils found in Antarctica).
- Use the fossil record to explain the genetic variation of a species over time.

How does natural selection encourage diversity over time?

- Explain why variation within a population can be advantageous for a population of organisms.
- Use manipulatives to model and analyze how selection pressures influence a population.

How do adaptations and genetic variations lead to evolution?

- Explain how the rate of environmental change impacts an organism's response (evolution to extinction).
- Predict the survival and reproductive success of an organism when given an environmental condition.
- Compare the ability of organisms to survive under different environmental conditions.
- Map the multiple mass extinction events have occurred throughout the Earth's history.
- Explain why 99% of all species that have ever existed on Earth are extinct.

Essential Vocabulary:
adaptation, biodiversity, diversity, evolution, extinction, mass extinction, natural selection, species, transitional form

Instructional Materials and Strategies:

- Suggested Readings → Fusion Unit 4: Earth's History
  - Lesson 4: The Geologic Time Scale
- Suggested Readings → Fusion Unit 6: Life over Time
  - Lesson 1: Theory of Evolution by Natural Selection
  - Lesson 2: Evidence of Evolution
  - Lesson 3: The History of Life on Earth

- Potential Instructional Strategies
  - Graph data that indicates how the biodiversity in a particular biome or continent have changed over time.
  - Research organisms that are found in a variety of environments and others that have very specific habitats. Compare and contrast the ability of these organisms to survive under different environmental conditions.
  - Research an extinct organism. Focus on the cause of the extinction and suggest adaptations that would have given the organism a better chance of survival.

- Assessment Resources
  - Item Analysis and Question Alignment

Species Reproduction

8.LS.2 Every organism alive today comes from a long line of ancestors who reproduced successfully every generation.

Reproduction is the transfer of genetic information from one generation to the next. It can occur with mixing of genes from two individuals (sexual reproduction). It can occur with the transfer of genes from one individual to the next generation (asexual reproduction). The ability to reproduce defines living things.

Content Elaboration:
Organisms reproduce either sexually or asexually. Some organisms are capable of both. In asexual reproduction, all genes come from a single parent, resulting in offspring genetically identical to their parent. Mitosis was introduced in grade 6. The end products of mitotic and meiotic cell divisions are compared as they relate to asexual and sexual reproduction. Mitosis and meiosis are addressed in preparation for the study of Mendelian genetics.

In sexual reproduction, a single specialized cell from a female (egg) merges with a specialized cell from a male (sperm). Half of the nuclear genes come from each parent. The fertilized cell, carrying genetic information from each parent, multiplies forming the genetically complete organism. Each cell of an organism contains the same genetic information. As opposed to asexual reproduction, sexual reproduction results in offspring with new combinations of traits which may increase or decrease their chances for survival.

Essential Questions:
- How do living organisms pass traits from one generation to the next?
- What are the advantages and disadvantages of different reproductive strategies?

Enduring Understandings:
- Reproduction is the transfer of genetic information from one generation to the next.
- Sexual reproduction occurs with mixing of genes from two individuals.
- Asexual reproduction occurs with the transfer of identical genes from one individual to the next generation.

Learning Targets:
- Describe the features of sexual and asexual reproduction related to the transfer of genetic information from parent to offspring.
- Compare and contrast the processes of asexual and sexual reproduction.
- Compare and contrast the genetic advantages and disadvantages of sexual and asexual reproduction.
- Compare the general processes and end products of mitosis and meiosis.
- Explain why genetic variation is a survival advantage.

Essential Vocabulary:
asexual reproduction, chromosome, crossing over, cytokinesis, egg, fertilization, gene, generation, inheritance, meiosis, mitosis, offspring, sexual reproduction, sperm, trait, zygote

Instructional Materials and Strategies:

- Suggested Readings → Fusion Unit 5: Reproduction and Heredity
  - Lesson 1: Mitosis
  - Lesson 2: Meiosis
  - Lesson 3: Sexual and Asexual Reproduction

- Potential Simulations
  - **Explore Learning**: Inheritance, Cell Division, Meiosis

- Potential Instructional Strategies
  - Use microscopes, web-based video or simulations to observe microscopic organisms that reproduce asexually and/or sexually (e.g., paramecium, hydra, aphids, yeast, planaria).

- Assessment Resources
  - Item Analysis and Question Alignment

Inheritance

8.LS.3 The characteristics of an organism are a result of inherited traits received from parent(s).

Expression of all traits is determined by genes and environmental factors to varying degrees. Many genes influence more than one trait, and many traits are influenced by more than one gene.

During reproduction, genetic information (DNA) is transmitted between parent and offspring. In asexual reproduction, the lone parent contributes DNA to the offspring. In sexual reproduction, both parents contribute DNA to the offspring.

Content Elaboration:
The traits of one or two parents are passed onto the next generation through reproduction. Traits are determined by instructions encoded in deoxyribonucleic acid (DNA), which forms genes. Genes have different forms called alleles. The concepts of dominant and recessive genes are appropriate at this grade level. In codominant traits, such as roan color in horses and cows, both traits are expressed in the resulting offspring. Pedigree analysis is appropriate for this grade level when limited to one trait that is dominant, recessive, or codominant.

The principles of Mendelian genetics are introduced by reviewing Mendel's work. Mendel's two laws provide the theoretical base for future study of modern genetics. Mendel's first law, the Law of Segregation, and his second law, the Law of Independent Assortment, should be demonstrated and illustrated in a variety of organisms. The Law of Independent Assortment should only be explored in simple cases of dominant and recessive traits.

A long-term investigation to analyze and compare characteristics passed on from parent to offspring through sexual and asexual reproduction can be conducted. These investigations can lead to questions about the phenotypes that appear in the resulting generations and what they infer about genotypes of the offspring.

Note: Incomplete dominance is not suggested for this grade level to help avoid the misconception of "blending of traits." Dihybrid crosses and sex-linked traits are also reserved for high school.

Essential Questions:
- How do living organisms pass traits from one generation to the next? (overarching)
- How does the structure of DNA determine our traits?
- How are traits passed from one generation to another?

Enduring Understandings:
- During reproduction, genetic information (DNA) is transmitted between parent and offspring.
- In sexual reproduction, offspring receive the genetic information from both parents.

Learning Targets:

How does the structure of DNA determine our traits?
- Identify the relationship between traits, chromosomes, DNA, alleles, and genes.
- Identify and explain how traits are passed on (dominance, codominance, recessive genes).

- Apply Mendel's laws (Law of Segregation and Law of Independent Assortment) to a variety of organisms.

<u>How are traits passed from one generation to another?</u>

- Differentiate between dominant and recessive alleles.
- Differentiate between heterozygous/hybrid and homozygous/pure.
- Given the genetic characteristics of the parents, use a Punnett square to predict the genetic outcome of the offspring produced.
- Use a Punnett Square to determine the probability of an offspring inheriting a given trait.
- Differentiate between genotype and phenotype.
- Predict the genotypic and phenotypic ratios for a monohybrid cross with Mendelian dominance and codominance patterns through at least two generations.
- Identify the genotypes of parents based on phenotypes of offspring.
- Describe how genetic conditions influence inheritance of autosomal dominant, autosomal recessive, and autosomal codominant genes.
- Analyze and interpret a pedigree with one trait exhibiting complete dominance or codominance. (determine if dominant or recessive)

Essential Vocabulary:
allele, autosomal, chromosome, codominance, complete dominance, DNA, dominant, gene, genotype, Gregor Mendel, heterozygous (hybrid), homozygous (pure), Law of Independent Assortment, Law of Segregation, pedigree, phenotype, Punnett Square, recessive, trait

Instructional Materials and Strategies:

- Suggested Readings → Fusion Unit 5: Reproduction and Heredity
  - Lesson 4: Heredity
  - Lesson 5: Punnett Squares and Pedigrees

- Potential Simulations
  - **Explore Learning**: Chicken Genetics, Inheritance, Mouse Genetics (One Trait)

- Potential Instructional Strategies
  - Design and implement an investigation to predict the genotype and phenotypes of offspring between plants of known heritage.
  - Design and implement an activity to predict the genotype and phenotypes of offspring between fictional characters with specified alleles for both complete dominance and codominant inherited traits (e.g., trolls, potato heads, aliens, Crazy Traits, Crazy Chromosomes).
  - Select a genetic condition and show its inheritance pattern through multiple generations on a pedigree or other graphic representation.
  - Conduct a long-term investigation to analyze and compare characteristics passed on from parents to offspring through sexual and asexual reproduction (pedigree analysis).
  - Research artificial selection (genetic modification, animal husbandry, gene therapy) in society. Select one practice and determine how that practice has changed the way humans influence the inheritance of desired traits in organisms. Justify your position with scientific evidence.

- Assessment Resources
    - Item Analysis and Question Alignment

Surviving in a Changing Environment

8.LS.1 Diversification of species, a result of variation of traits, occurs through the process of evolution and extinction over many generations. The fossil records provide evidence that changes have occurred in number and types of species.

Fossils provide important evidence of how life and environmental conditions have changed.

Throughout Earth's history, extinction of a species has occurred when the environment changes and the individual organisms of that species do not have the traits necessary to survive and reproduce in the changed environment. Most species (approximately 99 percent) that have lived on Earth are now extinct.

Changes in environmental conditions can affect how beneficial a trait will be for the survival and reproductive success of an organism or an entire species.

Content Elaboration:
The variations that exist in organisms can accumulate over many generations, so organisms can be very different in appearance and behavior from their distant ancestors. Diversity can result from sexual reproduction. The sorting and combining of genes results in different genetic combinations, which allow offspring to be similar to, yet different from, their parents and each other. (This statement connects to the grade 8 Life Science content statement on reproduction and Mendelian Genetics.) These variations may allow for survival of individuals when the environment changes. Diversity in a species increases the likelihood that some individuals will have characteristics suitable to survive and reproduce when conditions change.

Essential Questions:
- Are the traits carried in our DNA successful traits for survival?
- How does diversity influence survival in a changing environment?

Enduring Understandings:
- In nature, change is possible, inevitable, and sometimes beneficial.
- Diversity in a species increases the likelihood that some individuals will have characteristics suitable to survive and reproduce when conditions change.

Learning Targets:
- Explain why genetic variation is a survival advantage.
- Explain why phenotypic variation within a population can be advantageous for a population of organisms.
- Compare the ability of organisms to survive under different environmental conditions.
- Predict the survival and reproductive success of an organism when given an environmental condition.
- Determine the most suitable environment for an organism based on its traits.
- Explain how the rate of environmental change impacts an organism's response (evolution to extinction).
- Investigate structural differences in past and present organisms that have enabled some species to survive while others have become extinct due to sudden or gradual environmental changes (e.g., peppered moths, crayfish fossils found in Antarctica).

Essential Vocabulary:

adaptation, biodiversity, diversity, evolution, natural selection, selection, variation

Instructional Materials and Strategies:

- Suggested Readings → Fusion Unit 4: Earth's History
  - Lesson 4: The Geologic Time Scale
- Suggested Readings → Fusion Unit 6: Life over Time
  - Lesson 1: Theory of Evolution by Natural Selection

- Potential Simulations
  - **Explore Learning**: Evolution: Natural and Artificial Selection

- Potential Instructional Strategies
  - Graph data that indicates how the biodiversity in a particular biome or continent have changed over time.
  - Design a graphic representation of the evolutionary timeline.
  - Examine organisms that are found in a variety of environments and others that have very specific habitats. Compare and contrast the ability of an organism to survive under different environmental conditions.
  - Research an extinct organism. Focus on the cause of the extinction and suggest adaptations that would have given the organism a better chance of survival.

- Assessment Resources
  - Item Analysis and Question Alignment

Ohio's Learning Standards for Literacy in Science

Teachers should incorporate Ohio's Learning Standards for Literacy and Writing in Science throughout the course.

Reading

By the end of the course, students should be reading, comprehending, and responding to science/technical texts in the appropriate grade level complexity band independently and proficiently.

Key Ideas

1. Cite specific textual evidence to support analysis of science and technical texts.
2. When analyzing content-area-specific text development, determine the central ideas or conclusions of a text and provide an accurate and objective summary that includes the central ideas or conclusions of the text.
3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure

1. 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.
2. Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.
3. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Integration of Knowledge and Ideas

1. 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).
2. Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
3. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Writing

Text Types and Purposes

1. Write arguments focused on discipline-specific content.
    a. Establish a clear thesis statement to present an argument.
    b. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
    c. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
    d. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
    e. Establish and maintain a formal style.
    f. Provide a concluding statement or section that follows from and supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
   a. Establish a thesis statement to present information.
   b. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
   c. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
   d. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
   e. Use precise language and domain-specific vocabulary to inform about or explain the topic.
   f. Establish and maintain a formal style and objective tone.
   g. Provide a concluding statement or section that follows from and supports the information or explanation presented.

Production and Distribution of Writing

1. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
2. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.
3. Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.

Research to Build and Present Knowledge

1. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
2. 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.
3. Draw evidence from informational texts to support analysis, reflection, and research.
4. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Board-Adopted Instructional Materials

Ohio Science Fusion (2015) published by Houghton Mifflin Harcourt

Explore Learning Gizmos

Acknowledgements

Westerville City Schools appreciates the effort and work done by the committee to develop this course.

Blendon MS Science Teacher	Genoa MS Science Teacher	Heritage MS Science Teacher	Walnut Springs MS Science Teacher	Secondary Science Curriculum Specialist
Angie Crego	Scott Delligatti	Chad Brisentine	John McCoy	Lyndsey Manzo