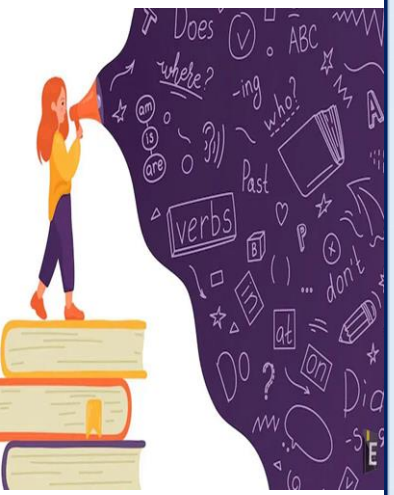
EOT 1

Science

Grade 8 General

2023-2024

الأسئلة الموضوعية MCQ



MCQ - الأسئلة الموضوعية

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6	List and explain the principles and methods that geologists use to assign the relative age to rocks layers and features	textbook, figures	10, 11

Principle of Uniformitarianism Before the late 1700s, most people thought that Earth was only a few thousand years old. James Hutton rejected this idea. He was one of the first scientists to think of Earth as very old. Hutton was a naturalist and a farmer in Scotland. He observed how the landscape on his farm gradually changed over the years. Hutton thought that the processes responsible for changing the landscape on his farm could also shape Earth's surface. For example, he thought that erosion caused by streams on his farm could also wear down mountains or carve deep canyons. Because he realized that this would take a long time, Hutton proposed that Earth is much older than a few thousand years.

Hutton's ideas are the foundation of a principle called uniformitarianism. The principle of **uniformitarianism** states that geologic processes that occur today are similar to those that have occurred in the past. In other words, the same processes that we see today have been occurring since Earth formed.

THREE-DIMENSIONAL THINKING
Scientists use the principle of uniformitarianism to **interpret** Earth's history. Suppose you discover a rock from an ancient beach. Now imagine you are standing on that ancient beach. What do you think you would you see? **Explain** how your answer relates to the principle of uniformitarianism.

If you stand on a shore of an ocean and watch the waves come in, you are observing a process that has not changed since the oceans formed. Using the principle of uniformitarianism, you can infer that you would see waves eroding the shore of the beach just as they do today.

Because of uniformitarianism, scientists can learn about Earth's past by studying the present. One way to do this is by studying the order in which geologic events occurred using a method called relative-age dating. This does not allow scientists to determine the **absolute age,** or the actual age of the events. But it gives scientists a clearer understanding about geologic events in Earth's history.

What is the basis for understanding Earth's past?

Early ideas about Earth's age and geologic history were usually placed in the context of time spans that a person could understand relative to his or her own life. This changed as people began to explore Earth and Earth processes in scientific ways. Today, scientists know that Earth's history stretches back 4.6 billion years. When did this change of thought occur, and how?

INVESTIGATION

The Present Is the Key to the Past

Compare the images of erosion below.

1. Do you think the processes that form and shape the small stream bed are similar to those that form and shape the Grand Canyon? Why or why not?

Yes. The water erosion that is wearing away the banks of the stream is the same as the erosion that is carving the Grand Canyon.

2. How long do you think it would take to create a canyon as deep as the Grand Canyon? Explain your reasoning.

Sample answer: Millions of years. Much longer than the lifetimes of humans or the entire history of humanity.

Want more information?
Go online to read more about how scientists analyze the rock and fossil records.

FOLDABLES
Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

7	Analyze a rock sequence to predict the principle used to assign the relative age for the rock	textbook, figures, 3D	17, 18

The Principles of Relative-Age Dating As you just discovered in the *Relatively Speaking* investigation, there are five principles that geologists use to assign relative ages to rocks and features.

- **Superposition** is the principle that in undisturbed rock layers, the oldest rocks are on the bottom.
- According to the principle of **original horizontality,** most rock-forming materials are deposited in horizontal layers.
- **Lateral continuity** is the principle that sediments are deposited in large, continuous sheets in all lateral directions.
- According to the principle of **inclusions,** if one rock contains pieces of another rock, the rock containing the pieces is younger than the pieces.
- According to the principle of **cross-cutting relationships,** if one geologic feature cuts across another feature, the feature that it cuts across is older.

THREE-DIMENSIONAL THINKING

Models are often used to study and represent **large-scale** time and space phenomena. Using what you have learned about the principles of relative-age dating, create a sketch modeling each principle below.

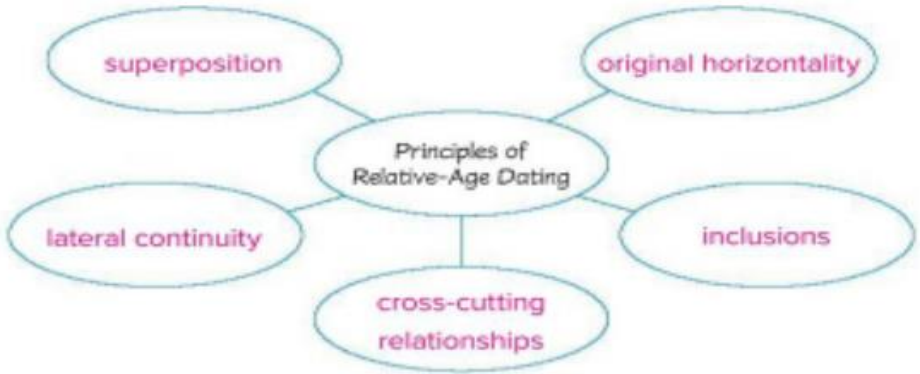
Students' sketches will vary but should demonstrate an understanding of superposition, original horizontality, lateral continuity, inclusions, and cross-cutting relationships. Check students' sketches for accuracy.

COLLECT EVIDENCE

How do the principles of relative-age dating help scientists "read" rocks? Record your evidence (A) in the chart at the beginning of the lesson.

GO ONLINE Finally, watch the animation *Relative-Age Dating*. Then answer the questions that follow.

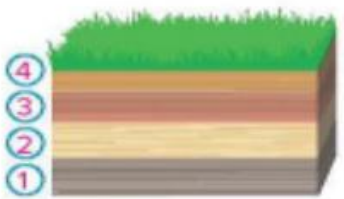
7. What are the principles of relative-age dating?



8. Which principle did you apply in Step 2 of the investigation?

superposition

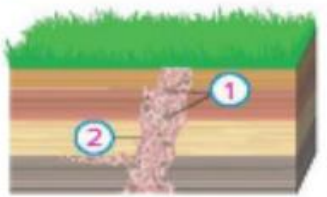
Using this principle, assign the rock layers in the diagram to the right their relative ages from oldest (*1*) to youngest (*4*).



9. Which principle did you apply in Step 4 of the investigation?

inclusions

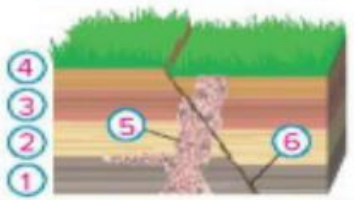
Using this principle, label the older feature *1*, and the younger feature *2* on the diagram to the right.



10. Which principle did you use in Step 6 of the investigation?

cross-cutting relationships

Using this principle, label the rock layers and features from oldest (*1*) to youngest (*6*).



8	Compare and contrast between types of unconformity using examples and diagrams	textbook, figures	32, 33

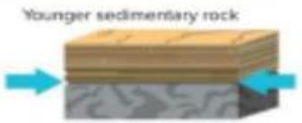
2. The arrows in the images on the previous page point to the surfaces where rock has eroded away, producing breaks, or gaps, in the rock record, called **unconformities** (un kun FOR muh tees). There are three types of unconformities, described below. Can you identify which photo from the previous page each type of unconformity describes? Label the figures *A*, *B*, or *C* to correspond with the matching photos.

B

When horizontal layers of sedimentary rock are deformed during mountain building or other geologic events, they are usually uplifted and tilted. During this process, the layers are exposed to weathering and erosion. If horizontal layers of sedimentary rock are later laid down on top of the tilted, eroded layers, the resulting unconformity is called an angular unconformity.

A

When a horizontal layer of sedimentary rock overlies another horizontal layer of sedimentary rock that has been eroded, the eroded surface is called a disconformity. Disconformities can be easy to identify when the eroded surface is uneven. When the eroded surface is smooth, disconformities are often hard to see.



C

When a layer of sedimentary rock overlies a layer of igneous or metamorphic rock, such as granite or marble, the eroded surface is easier to identify. This kind of eroded surface is called a nonconformity. A nonconformity indicates a gap in the rock record during which igneous or metamorphic rock layers were uplifted, eroded at Earth's surface, and new layers of sedimentary rock formed on top.

Unconformities As you just discovered, when new sediment is deposited on top of old, eroded rock layers, the eroded surface represents a gap in the rock record. Unconformities could represent a few hundred years, a million years, or even billions of years.

So how can geologists organize Earth's history using the rock and fossil records when parts are buried or missing? Let's investigate.

What happens when the rock and fossil records are not complete?

You learned in Lesson 1 that geologists use rock layers and the fossils within to build a record of Earth's geologic history. A complete rock record in one place, however, does not exist. Weathering, erosion, volcanism, and other processes are constantly changing Earth's surface. This makes it difficult to find a sequence of rock layers that haven't been disturbed. Sometimes, the record of a past event or time is completely eroded away! Let's dig in.

Want more information?
Go online to read more about the development of the geologic time scale.

FOLDABLES
Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

INVESTIGATION

Gaps in the Rock Record

1. Analyze the three photos below. Notice how the arrows point to a line between different rocks. How would you describe the rock below the arrows versus the rock above? Write your descriptions next to each image.

A

horizontal sedimentary layer overlies horizontal sedimentary layer

B

horizontal sedimentary layer overlies tilted sedimentary layer

C

horizontal sedimentary layer overlies nonsedimentary layer

9	Compare and contrast between the structure and function of DNA and RNA, and Define key terms associated with the structure of DNA	textbook, figures	64, 68

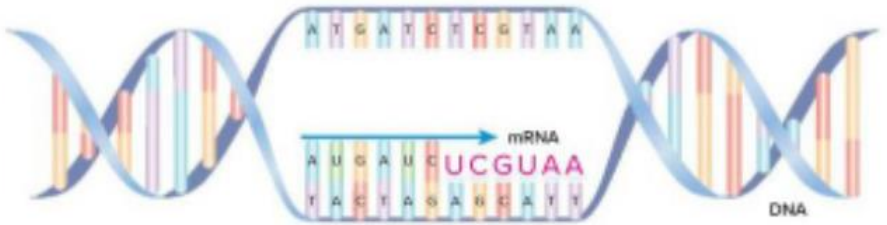
Transcription RNA, like DNA, is made of nucleotides. However, there are key differences between DNA and RNA. DNA is double-stranded, but RNA is single-stranded. RNA has the nitrogen base uracil (U) instead of thymine (T) and the sugar ribose instead of deoxyribose. The first step in making a protein is to make messenger RNA (mRNA) from DNA. Messenger RNA transfers the genetic code from DNA in the cell's nucleus to ribosomes in the cytoplasm for protein synthesis. The process of making mRNA from DNA is called **transcription.** How does this happen? Let's find out.

INVESTIGATION

Transcription

GO ONLINE Watch the animation *Transcription*. Then examine the figure below.

Based on the animation and the figure, complete the DNA to mRNA transcription below. Use the blue lines to write your answer.



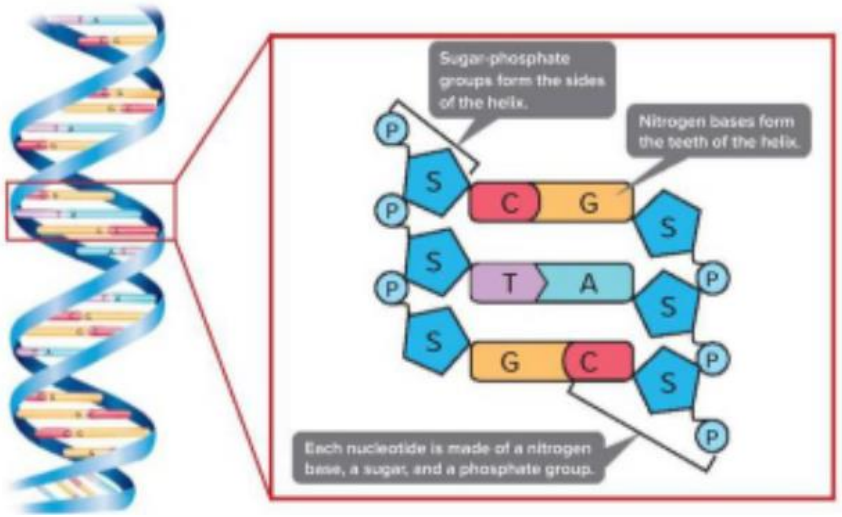
A Complex Molecule DNA is like a twisted zipper. This twisted zipper shape is called a double helix. A model of DNA's double helix structure is shown below.

HISTORY Connection How did scientists discover the shape of DNA? Rosalind Franklin and Maurice Wilkins were two scientists in London who used X-rays to study DNA. Some of the X-ray data indicated that DNA has a helix shape.

American scientist James Watson visited Franklin and Wilkins and saw one of the X-rays of DNA. Watson realized that the X-ray gave valuable clues about the structure of DNA. Watson worked with an English scientist, Francis Crick, to build a model of DNA.

Watson and Crick based their work on information from Franklin's and Wilkins's X-rays. They also used chemical information about DNA discovered by another scientist, Erwin Chargaff. After several tries, Watson and Crick built a model that showed how the smaller molecules of DNA bond together and form a double helix.

Four Nucleotides Shape DNA DNA's twisted-zipper shape is because of molecules called nucleotides. A **nucleotide** is a molecule made of a nitrogen base, a sugar (called deoxyribose in DNA), and a phosphate group. There are four nitrogen bases: adenine (A), cytosine (C), thymine (T), and guanine (G). A and T always bond together, and C and G always bond together. Examine the figure below to see how DNA is composed.



10	Define adaptation, Identify different types of adaptation, and Explain why organism that unable to adapt, it becomes extinct	textbook, figures	94

What are adaptations?

Adaptations The accumulation of many similar variations can lead to an adaptation. An **adaptation** is an inherited trait that helps a species survive in its environment. Giraffes have different spot patterns, but each has spots. The spots help the giraffes blend in with their environment. As a result, predators of giraffes cannot see them as easily. The spotted coat of giraffes is an adaptation.

Types of Adaptations Every species has many adaptations. Scientists classify adaptations into three categories: structural, behavioral, and functional. Structural adaptations involve color, shape, and other physical characteristics. The length of a tortoise's neck is a structural adaptation. Behavioral adaptations involve the way an organism behaves or acts. Hunting at night and moving in herds are examples of behavioral adaptations. Functional adaptations involve internal body systems that affect biochemistry. A drop in body temperature during hibernation is an example of a functional adaptation.

◀ **Structural Adaptation** The jackrabbit's powerful legs help it run fast to escape from predators.

▲ **Functional Adaptation** The blood vessels in the jackrabbit's ears expand to enable the blood to cool before reentering the body.

Behavioral Adaptation ▶ The jackrabbit stays still during the hottest part of the day, helping it conserve energy.

THREE-DIMENSIONAL THINKING

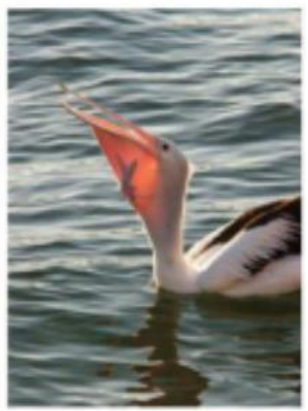
Primates such as humans and chimpanzees have opposable thumbs, which means that the thumb can move around to touch the other fingers on that hand. What type of adaptation is this? **Explain** why opposable thumbs are a beneficial adaptation. Record your response in your Science Notebook.

11	Define adaptation, Identify different types of adaptation, and Explain why organism that unable to adapt, it becomes extinct	textbook, figures	97

Environmental Interactions Have you ever wanted to be invisible? Many species have evolved adaptations that make them nearly invisible. The snake in the photo on the left is the same color as the leaves it is resting on. This is a structural adaptation called camouflage (KAM uh flah(j)). **Camouflage** is an adaptation that enables a species to blend in with its environment.

Some species have adaptations that draw attention to them. The caterpillar in the center photo resembles a snake. Predators see it and are scared away. The resemblance of one species to another species is **mimicry** (MIH mih kree). Camouflage and mimicry are adaptations that help species avoid being eaten. Many other adaptations help species eat. The pelican in the photo on the right has a beak and mouth uniquely adapted to its food source—fish.





Environments are complex. Species must adapt to an environment's living parts as well as to an environment's nonliving parts. Nonliving things include temperature, habitat, nutrients in the soil, and climate. Deciduous trees shed their leaves due to changes in climate. Camouflage, mimicry, and mouth shape are adaptations mostly to an environment's living parts.

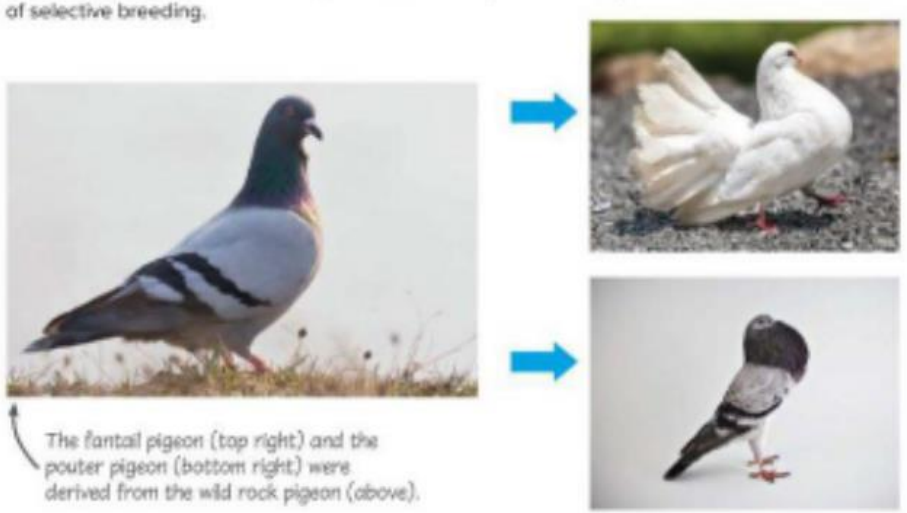
Living and nonliving factors are always changing. Even slight environmental changes affect how species adapt. If a species is unable to adapt, it becomes extinct. The fossil record contains many fossils of species unable to adapt to change.

COLLECT EVIDENCE

How do adaptations affect organisms, such as orchid plants? Record your evidence (C) in the chart at the beginning of the lesson.

12	Compare natural and artificial selection in terms of time spans, genetic variation, and level of human interference, suggest characteristics that may be selected for in given examples of animal or plant species, describe some advantages of artificial selection, including the production of desired animals	textbook, lab	106, 108

Selective Breeding Watching natural selection in action is like watching mountains grow taller. It occurs over so many generations that it usually cannot be seen. It is easier to observe a type of selection practiced by humans. When humans breed organisms for food or for companionship, they are selecting variations that occur naturally in populations. The selection and breeding of organisms with desired traits is **selective breeding.** Selective breeding, sometimes referred to as artificial selection, is similar to natural selection except that humans, instead of nature, do the selecting. By breeding organisms with desired traits, humans change traits just as natural selection does. Cows with increased levels of milk production, dogs of different sizes, and roses of unique colors are products of selective breeding.



The fantail pigeon (top right) and the pouter pigeon (bottom right) were derived from the wild rock pigeon (above).

THREE-DIMENSIONAL THINKING

Can traits of organisms always be predicted with selective breeding? **Explain** how multiple **causes** can influence the traits of an organism.

Students should identify that traits are not always predictable due to mutations. Students may list environmental and genetic factors as multiple causes that influence an organism's traits.

COLLECT EVIDENCE

How can humans influence traits of organisms, such as the dogs at the beginning of the lesson, through selective breeding? Record your evidence (A) in the chart at the beginning of the lesson.

How can traits be directly influenced?

Adaptations provide evidence of how closely Earth's species match their environments. This is exactly what Darwin's theory of evolution by natural selection predicted. Darwin also had a hobby of breeding domestic pigeons where he found his rules of natural selection also applied in situations he controlled. When humans influence traits in other organisms, it is called artificial selection.

LAB Developing Dogs

Safety

Materials

penny
colored pencils

Procedure

1. Read and complete a lab safety form.
2. In your Science Notebook, draw a dog with your desired traits. Include either long or short hair, pointed or floppy ears, light fur or dark fur, solid coloration or spotted coloration, and playful or tame. Circle your selections below:

   long hair/short hair
   pointed ears/floppy ears
   light fur/dark fur
   solid coloration/spotted coloration
   playful/tame

3. Find a partner. Imagine your dog and your partner's dog have three puppies. Choose one dog to be the mother and one to be the father.
4. Flip a coin to determine whether a puppy will inherit each of the traits from the mother (heads) or the father (tails). Repeat for all three puppies.
5. Illustrate the puppies in your Science Notebook.

13	Define genetic engineering and genetically modified organisms or GMOs, and their advantage and disadvantage, Define the process used genetic engineering to produce insulin or other chemicals to treat cancer	textbook, figures	109, 110

What is a genetically modified organism?

Genetic engineering can produce improvements in crop plants, such as corn, wheat, and rice. Food products that have been genetically engineered are commonly referred to as genetically modified organisms, or GMOs. Scientists have made genetically engineered tomatoes with a gene that allows tomatoes to be picked while green and transported great distances before they ripen completely. Ripe, firm tomatoes are then available in the local market. Some crops are even engineered to be toxic to particular insects and pests.

Read a Scientific Text

Because some people might prefer foods that are not changed genetically, some stores label such items. Many people worry about possible health risks that may be present with the consumption of genetically modified crops. Others worry about the effects that altered plants might have on the environment. However, the scientific consensus is that GMOs are safe.

CLOSE READING

Inspect

Read the passage *Consumer Info About Food from Genetically Engineered Plants.*

Find Evidence

Reread the passage. Highlight the definition of genetic engineering, then underline the desirable traits resulting from genetic engineering.

Make Connections

Communicate Choose a fruit, then pair with a partner who has selected a different fruit. Design a genetically engineered fruit that could be developed from traits belonging to the two fruits you have chosen.

PRIMARY SOURCE

Consumer Info About Food from Genetically Engineered Plants

FDA regulates the safety of food for humans and animals, including foods produced from genetically engineered (GE) plants. Foods from GE plants must meet the same food safety requirements as foods derived from traditionally bred plants.

[...]

Crop improvement happens all the time, and genetic engineering is just one form of it. We use the term "genetic engineering" to refer to genetic modification practices that utilize modern biotechnology. In this process, scientists make targeted changes to a plant's genetic makeup to give the plant a new desirable trait. For example, two new apple varieties have been genetically engineered to resist browning associated with cuts and bruises by reducing levels of enzymes that can cause browning.

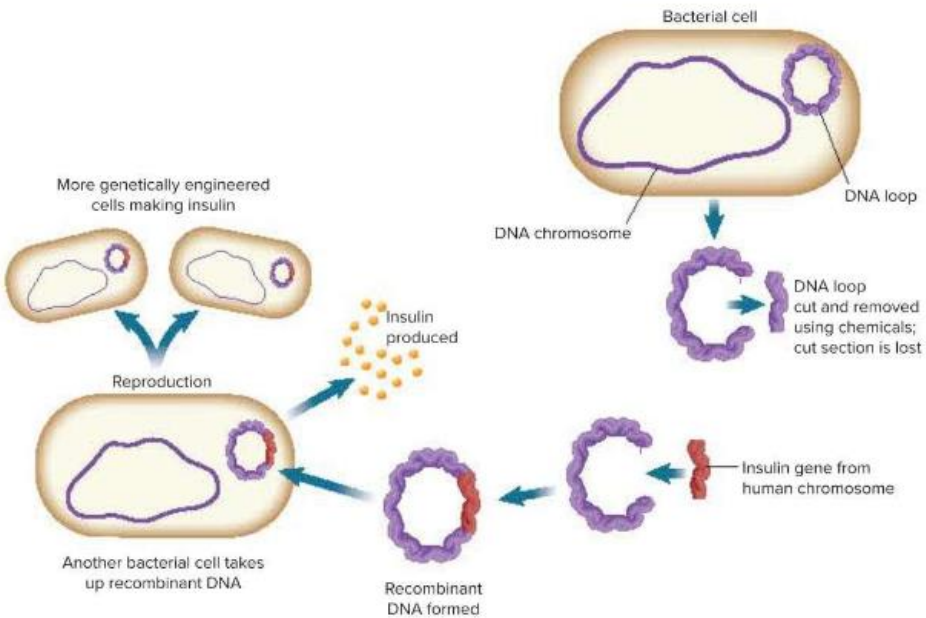
Humans have been modifying crops for thousands of years through selective breeding. Early farmers developed cross breeding methods to grow numerous corn varieties with a range of colors, sizes, and uses. For example, the garden strawberries that consumers buy today resulted from a cross between a strawberry species native to North America and a strawberry species native to South America.

Source: U.S. Food & Drug Administration

What is genetic engineering?

Recall that chromosomes are made of DNA and are in the nucleus of a cell. Sections of DNA in chromosomes that direct cell activities are called genes. Scientists are experimenting with **genetic engineering,** which refers to the biological and chemical methods that change the arrangement of DNA that makes up a gene. Genetic engineering already is used to help produce large volumes of medicine. Genes also can be inserted into cells to change how those cells perform their normal functions, as shown in the figure below.

Recombinant DNA Making recombinant DNA is one method of genetic engineering. Recombinant DNA is made by inserting a useful segment of DNA from one organism into a bacterium, as shown below. Large quantities of human insulin are made by some genetically engineered organisms. People with Type 1 diabetes need this insulin because their pancreases produce little to no insulin. Another use includes the production of chemicals to treat cancer.



14	List the five types of fossils, Describe each type and recognise a figure example on it	Textbook, table	135

Three-Dimensional Thinking

A student prepared this chart comparing examples of natural selection with artificial selection.

Natural Selection Traits That Benefit the Species	Artificial Selection Traits That Directly Benefit Humans
• Ability to escape predators • Ability to resist droughts	• •

2. Which can the student add in the column under artificial selection to complete the chart?

1. ability to grow large kernels of corn
2. ability to grow fruit that can be stored for long periods
3. ability to catch larger prey
4. ability to produce milk for offspring

A 1 and 3
B 1 and 2
C 2 and 3
D 3 and 4

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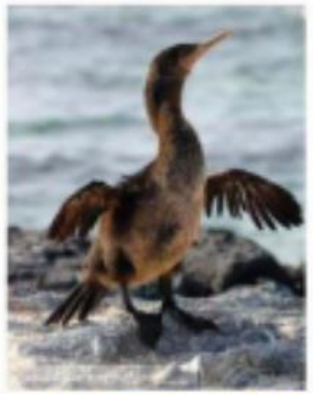
3. Golden rice is a type of rice that has been altered to contain vitamin A. This yellow rice is beneficial to populations that typically do not receive enough vitamin A from other sources. How is golden rice classified?

A genetically engineered
B genetically modified organism
C altered through gene therapy
D A and B

15	Explain how natural selection support the theory of evolution, study relatedness of organisms traits, use the comparative anatomy to relate species to their common ancestor	textbook, figures, investigation	153, 154

Analogous Structures Both wings shown to the right are used for flight. But bird wings are covered with feathers. Fly wings are covered with tiny hairs. Body parts that perform a similar function but differ in structure are **analogous** (uh NAH luh gus) **structures.** Analogous structures evolved separately from one another and organisms with the structures do not share a closely related common ancestor. Differences in the structure of bird and fly wings indicate that birds and flies are not closely related.

Vestigial Structures The flightless cormorant in the photo has short, stubby wings. Yet, as its name suggests, it cannot fly. The bird's wings are an example of vestigial structures. **Vestigial** (veh STIH jee ul) **structures** are body parts that have lost their original function through evolution. The best explanation for vestigial structures is that the species with a vestigial structure is related to an ancestral species that used the structure for a specific purpose. The flightless cormorant, for example, evolved in an isolated ecosystem—the Galápagos Islands—that did not have any predators on land. In that ecosystem, wings and the ability to fly no longer gave individuals an increased chance of survival and reproduction. Eventually, the flightless cormorant lost its ability to fly due to a wing size that is far too small to support a bird of its proportions.



INVESTIGATION

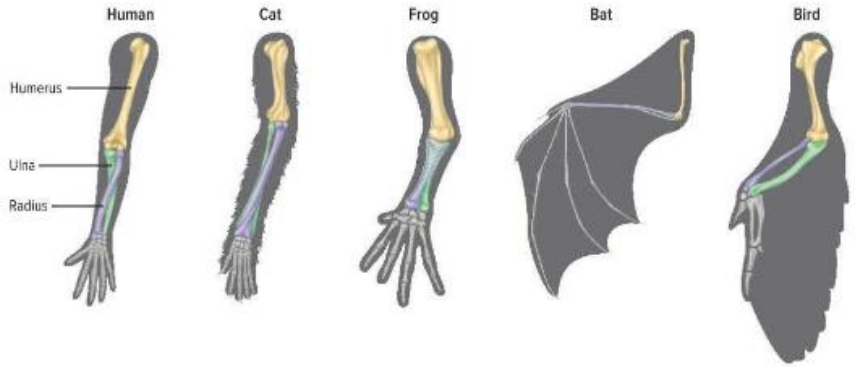
Missing in Action

Research a vestigial structure present in a living organism. Explain how the vestigial structure arose while detailing how its function relates to its structure.

Answers will vary. Students should research a present-day organism and describe the vestigial structure in question. Students will want to trace where the structure first arose. Students will want to describe how the structure was used then, as well as how it may be used by the present-day organism.

Comparative Anatomy As you just observed, spoons that look different from one another still have some structural and functional similarities. Like spoons, animals also have similarities, even when they appear very different. Observations of structural and functional similarities and differences in species that do not look alike are possible through comparative anatomy. **Comparative anatomy** is the study of similarities and differences among structures of living and fossil species.

Homologous Structures Humans and birds look different and move in different ways. Humans use their arms for balance and their hands to grasp objects. Birds use their forelimbs as wings for flying. However, the forelimb bones of these species exhibit similar patterns. **Homologous** (huh MAH luh gus) **structures** are body parts or structures that were inherited by two or more species from a common ancestor.



As shown in the figure, homologous structures, such as the forelimbs of humans, cats, frogs, bats, and birds, are evidence that these species are related. The more similar two structures are to each other, the more likely it is that the species have evolved from a recent common ancestor.

THREE-DIMENSIONAL THINKING

Think about patterns in structures, other than the arm, that can be found across different groups of animals. In your Science Notebook, quickly sketch your structures as shown in the figure above.

COLLECT EVIDENCE

How does comparative anatomy help you understand the evolutionary relationship between bats and birds? Record your evidence (A) in the chart at the beginning of the lesson.

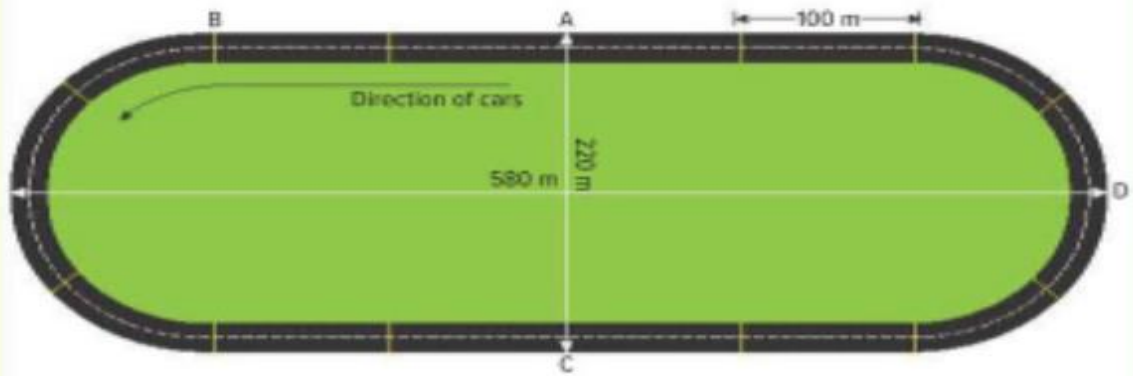
16	Compare between distance and displacement, and give the value for each for an object movment	Textbook, figures	19

previous page, the player runs 41.2 m from position D to position C. Then she runs 10 m to position B. Her path is shown by the green dotted lines. The total distance the player travels is 41.2 m + 10 m = 51.2 m.

The solid purple arrow in the figure shows the player's displacement. **Displacement** is the difference between the initial, or starting, position and the final position. The player starts at point D and finishes at point B. Her displacement is 40 m in front of her initial position. Displacement is the shortest distance between where the player started and the player's final position. An object's displacement and the distance it travels are not always equal. If the player runs directly from point D to point A, then both the player's distance and displacement are the same quantity—10 m. If the player's final position is the same as her starting position, her displacement is 0 m.

THREE-DIMENSIONAL THINKING

Use the race track **model** below to determine the distance traveled and the displacement of a car from point A to when it reached point D on the first lap.



The distance the car traveled is 1,200 m. The displacement is 310 m toward the southeast. This is calculated using the Pythagorean theorum using 110 m and 290 m as the sides of the right angle and solving for the hypotenuse.

COLLECT EVIDENCE

How can you describe the motion of the trains from the beginning of the lesson? Record your evidence (B) in the chart at the beginning of the lesson.

17	Calculate accelaration using Newton's second law of motion	Textbook, Example	44

Mathematical Model Isaac Newton, an English scientist and mathematician, developed laws of motion. **Newton's second law of motion** states that the acceleration of an object equals the net force on the object divided by the object's mass. With a mathematical model, scientists can make predictions about how objects will accelerate with a given force. This can be shown by the mathematical model, the acceleration equation.

Acceleration Equation

$$\text{acceleration (in m/s}^2\text{)} = \frac{\text{force (in N)}}{\text{mass (in kg)}}$$

$$a = \frac{F}{m}$$

MATH Connection In the PhET interactive simulation, a force of 100 N is applied to the wrapped present, giving it an acceleration of 2 m/s^2. What is the mass of the object?

50 kg

What is the acceleration when a force of 2.0 N is applied to a ball that has a mass of 0.60 kg?

3.3 m/s^2

COLLECT EVIDENCE

How do the changes in motion help explain what happens when you push or pull a water tube? Record your evidence (A) in the chart at the beginning of the lesson.

18	Explain Newton's second and third law, identify the action and reaction in forces, identify force pairs from giving scenario examples	Textbook, figure, 3D	64, 66, 73

Opposing Forces In the activity at the beginning of the lesson, you moved because the wall exerted a force on you. This force exists because you were pushing against the wall. If you push only a little amount against the wall, the wall will push only a little against you. If you push against the wall with a lot of force, the wall will push against you a lot. Newton also noticed this phenomenon and described it by saying that for every action, there is an equal and opposite reaction. It is now known as the third law of motion.

Newton's third law of motion states that when an object applies a force on another object, the second object applies a force of the same strength on the first object, but the force is in the opposite direction. This idea explains how helicopters and drones work. When a drone pushes the air down, the air pushes the drone up. Air particles may be small and not very massive, but pushing a large amount of air can lead to a large push back.

THREE-DIMENSIONAL THINKING

What patterns exist between all forces that you apply to objects or systems of objects?

When you push an object, the object will push back with the same amount of force. This is true for all forces.

COLLECT EVIDENCE

How do the forces that are present when you push on an object explain what happens when the airboat pushes on the air? Record your evidence (A) in the chart at the beginning of the lesson.

FOLDABLES

Go to the Foldables® library to make a Foldable® that will help you take notes while reading this lesson.

2. Will the boat work as claimed? Explain, using the diagram to support your answer.

No. The boat will not work. The fan will push the boat to the right with the same amount of force that the sail will push the boat to the left. The net force on the boat will be zero.

3. What could be done to improve the student's boat design?

Answers will vary. Sample answers: The student could remove the sail from the boat. Then the boat would push the air and move in the opposite direction. The student could remove the fan, then sail with the natural wind.

Force Pairs The forces described by Newton's third law depend on each other. A **force pair** is the forces two objects apply to each other. Recall that you can add forces to calculate the net force. If the forces of a force pair always act in opposite directions and are always the same strength, why don't they cancel each other? Force pairs are not the same as balanced forces. Balanced forces act on the same object. The force from gravity and the force from the floor act on the same object—you—and are balanced. In force pairs, each force acts on a different object. Look at the ball and the tennis racket below. The ball has the force of the racket pushing it. The racket has the force of the ball pushing on it. The forces do not result in a net force of zero because they act on different objects. Adding forces can only result in a net force of zero if the forces act on the same object.

Normal Force The force that pushes back is sometimes called the normal force. The **normal force** is the force that pushes perpendicular to the object's surface. When you push on the wall, the wall has a normal force that is pushing straight out from the wall. When a tennis ball hits a tennis racket, the racket applies a normal force perpendicular to the racket. This is why a tennis player will turn her racket when she wants to turn the ball to the left or right. The racket applies a normal force in the direction that the player wants the ball to go.

18	Explain Newton's second and third law, identify the action and reaction in forces, identify force pairs from giving scenario examples	Textbook, figure, 3D	64, 66, 73

Three-Dimensional Thinking

A person is applying a force to the right on an object as shown.
Use the model below to answer questions 2 and 3.

2. What forces are acting on the person?

A a slightly smaller force to the left because the object is accelerating

B a force equal to the force applied going to the left

C a force to the right to apply the force to the object

D a force to the right because the object is accelerating

3. The person is standing on ice with little to no friction. What will be the motion of the person applying the force to the object?

A begin to move to the right because that is the direction of the push

B no change in motion because the person is pushing the object

C begin to move to the left because the object pushes on the person

D begin to move to the right with the object

---

4. Which of the following systems does NOT represent a force pair?

A When you push on a bike's brakes, the friction between the tires and the road increases.

B When a diver jumps off a diving board, the board pushes the diver up.

C When an ice skater pushes off a wall, the wall pushes the skater off of the wall.

D When a boy pulls a wagon, the wagon pulls back on the boy.

19	Construct and present arguments using evidence to support the claim that gravitional interactions are attractive and depend on the masses of interacting objects and their diatance	textbook, figures, 3D	83 - 86, 93

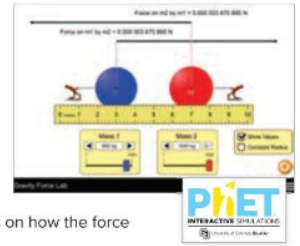
What factors affect the strength of a gravitational force?

A pencil has less mass than Earth. Do they exert the same amount of force on each other? What if there was a pencil on the *International Space Station*? Would Earth exert the same amount of force on it as the pencil on Earth's surface?

INVESTIGATION

The Force of Gravity

How could you increase the force of gravity?



GO ONLINE Explore the PhET interactive simulation *Gravity Force Lab*.

After exploring the simulation on your own, reset the simulation and follow the instructions below.

1. Determine how to change the force of gravity on the object on the right. In the graphic organizer below, circle the words that best describe your observations on how the force of gravity on the object on the left changes.

When the force of gravity changes on one object, the force of gravity on the second object always changes by

(the same amount.) a different amount.

2. Move the object on the right closer to and farther away from the object on the left.

3. Complete the graphic organizer below using *increases* or *decreases* to explain how changing distance affects the force of gravity on the two objects.

Decreasing the distance between the two objects	increases the force of gravity on the first object. increases the force of gravity on the second object.
Increasing the distance between the two objects	decreases the force of gravity on the first object. decreases the force of gravity on the second object.

4. Next, increase the mass of the object on the right. Then decrease the mass of the object on the right.

5. Complete the graphic organizer using *increases* or *decreases* to explain how changing mass affects the force of gravity on the two objects.

Decreasing the mass of one of the two objects	decreases the force of gravity on the first object. decreases the force of gravity on the second object.
Increasing the mass of one of the two objects	increases the force of gravity on the first object. increases the force of gravity on the second object.

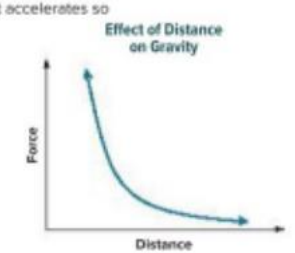
6. Which law of motion explains why the force of gravity between two objects is the same for each object regardless of its mass? Explain.

Newton's third law of motion states that when one object exerts a force on a second object, the second object exerts an equal force in the opposite direction on the first object. This law applies to gravity, too.

Gravitational Force and Mass When the mass of one or both objects increases, the gravitational force between them also increases. This is a direct proportional relationship. Each object exerts the same attraction on the other object.

If both objects exert the same attraction on each other, why does it look like the pencil falls toward Earth? The effect of mass on the force of gravity is most noticeable when one object is very massive, such as a planet, and the other object has much less mass, such as a pencil. Even though the force of gravity acts equally on both objects, the less massive object accelerates more quickly due to its smaller mass. Because the planet accelerates so slowly, all you observe is the object with less mass "falling" toward the object with greater mass.

Gravitational Force and Distance As the distance between objects increases, the attraction between objects decreases. This is an inverse proportional relationship as seen in the graph on the right. For example, if your mass is 45 kg, the gravitational force between you and Earth is about 440 N. On the Moon, about 384,000 km away, the gravitational force between you and Earth would only be about 0.12 N.



19	Construct and present arguments using evidence to support the claim that gravitional interactions are attractive and depend on the masses of interacting objects and their diatance	textbook, figures, 3D	83 - 86, 93

Read a Scientific Text

HISTORY Connection In the late 1600s, Sir Isaac Newton, an English scientist and mathematician, studied the effects of gravity on objects on Earth and in space. From these studies he wrote *Newton's Principia. The Mathematical Principles of Natural Philosophy.* In the text he summarized the three laws that govern all motion and the law of universal gravitation.

CLOSE READING

Inspect

Read the passage *Newton's Principia. The Mathematical Principles of Natural Philosophy.*

Find Evidence

Reread the passage. Underline the evidence Newton presented for his concept of gravity.

Make Connections

Communicate With your partner, discuss if this evidence would be enough to convince you that gravity exists between all objects.

PRIMARY SOURCE

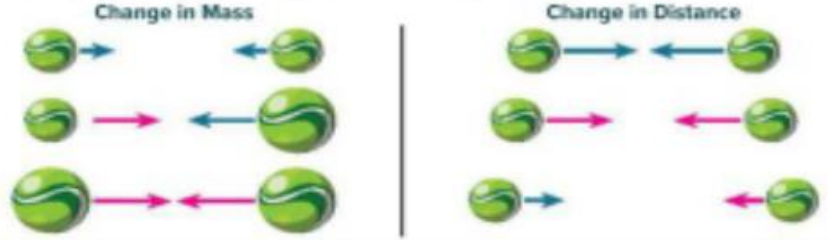
Passage from: Newton's Principia. The Mathematical Principles of Natural Philosophy by Sir Isaac Newton

Lastly, if it universally appears, by experiments and astronomical observations, that all bodies about the earth gravitate towards the earth, and that in proportion to the quantity of matter which they severally contain, that the moon likewise, according to the quantity of its matter, gravitates towards the earth; that, on the other hand, our sea gravitates towards the moon; and all the planets mutually one towards another; and the comets in like manner towards the sun; we must, in consequence of this rule, universally allow that all bodies whatsoever are endowed with a principle of mutual gravitation. For the argument from the appearances concludes with more force for the universal gravitation of all bodies than for their impenetrability; of which, among those in the celestial regions, we have no experiments, nor any manner of observation. Not that I affirm gravity to be essential to bodies: by their *vis insita* [power implanted or inertia] I mean nothing but their *vis inertiae* [weak force]. This is immutable. Their gravity is diminished as they recede from the earth.

Source: Newton's Principia. The Mathematical Principles of Natural Philosophy by Sir Isaac Newton

THREE-DIMENSIONAL THINKING

On the figure below, add arrows to **model** the size and direction of the force of gravity for the missing forces in each **system** below.



Three-Dimensional Thinking

The model below represents a star orbited by two planets—Planet A and Planet B. The star is also orbited by a mysterious object, Object X, which entered into the star's gravitational field. The star is the most massive object, followed by Planet B, Planet A, and Object X. Use the model to answer questions 3–4.

3. In the model above, how is the mass of the objects represented?

   A The mass is represented by the size of the objects.
   B The mass is represented by the distance between the objects.
   C The mass is represented by the color of the objects.
   D The mass is not represented.

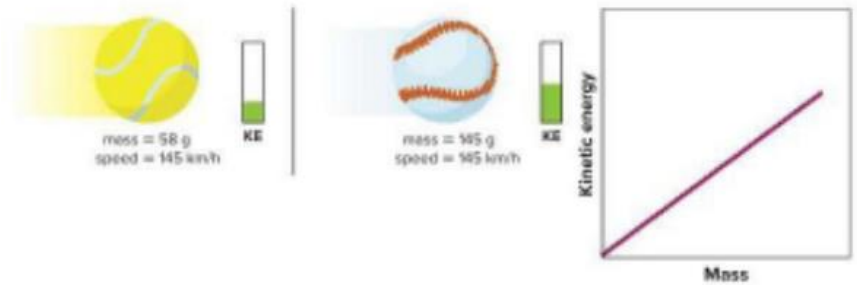
4. The gravitational force from Planet A on the star is shown in the model. How should the arrow that represents the gravitational force from the star on Planet A be represented?

   A It should point from Planet A toward the star and will be longer because the star has more mass.
   B It should point from Planet A toward the star and will be the same size because it is an equal and opposite force.
   C It should point from Planet A toward the star and will be shorter because Planet A has less mass.
   D There is no arrow to represent because gravitational force is only in one direction.

20	Define kinetic energy as the energy of motion, Describe the relationship between mass and velocity in determining the amount of kinetic energy.	textbook, figures, 3D	116, 123

Kinetic Energy and Mass Did you notice in the Lab *Mass Matters* that the sphere with the largest mass created the largest crater? As it fell it had kinetic energy. When it hit the clay it created a larger crater because it had more kinetic energy than the spheres with less mass. A moving object's kinetic energy depends on its mass. If a baseball and a tennis ball move at the same speed, the ball with more mass has more kinetic energy.

Look at the figure below. Note the vertical bars. These are energy bars. Energy bars show relative amounts of energy. The more full the bar, the more energy the object has. The tennis ball and the baseball are traveling at the same speed, but the baseball has a greater mass. For objects traveling at the same speed, the more mass an object has, the greater its kinetic energy.



The relationship between mass and kinetic energy is a proportional, linear relationship that can be described mathematically.

$$KE \propto m$$

THREE-DIMENSIONAL THINKING

For each system determine how the quantity of kinetic energy would increase or decrease.

1. If the mass of an object is increased by a factor of 4, kinetic energy increases by a factor of 4
2. If the mass of an object is decreased by a factor of $\frac{1}{2}$, kinetic energy decreases by a factor of $\frac{1}{2}$

COLLECT EVIDENCE

How does the mass of the ball determine how far the ball will travel? Record your evidence (A) in the chart at the beginning of the lesson.

Three-Dimensional Thinking

2. Aiden collected canned goods for a neighborhood service project. He pulled a plastic wagon behind him to put the items in. From the time Aiden began until he finished collecting, the mass of the wagon tripled. The walk back to Aiden's house was downhill and the speed of the wagon tripled. What happened to the kinetic energy when the mass tripled? What happened to the kinetic energy when the speed tripled?

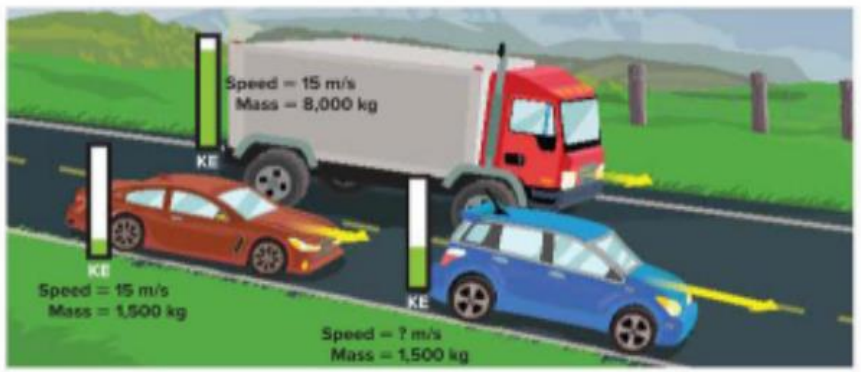
   A When the mass tripled, the kinetic energy increased by a factor of 3. When the speed tripled, the kinetic energy increased by a factor of 3.

   B When the mass tripled, the kinetic energy increased by a factor of 3. When the speed tripled, the kinetic energy increased by a factor of 9.

   C When the mass tripled, the kinetic energy increased by a factor of 9. When the speed tripled, the kinetic energy increased by a factor of 3.

   D When the mass tripled, the kinetic energy increased by a factor of 9. When the speed tripled, the kinetic energy increased by a factor of 9.

The figure below shows mass and relative kinetic energy in energy bars for three vehicles.



3. What can you determine about the speed of the blue car?

   A The blue car's speed is the same as the red car's speed.

   B The blue car's speed is less than the truck's speed.

   C The blue car's speed is equal to the truck's speed.

   D The blue car's speed is greater than the red car's speed.

Paper Part أسئلة مقالية

الأسئلة المقالية - Paper part	1	Construct a scienttific explanation based on evidence from rock layers for how the geologic time scale is used to build a timline and organise Earth's history, Define index fossils and recognise	Textbook, figures, 3D	36, 39
	2	Define mutation, Identify different types of mutations, and Explain the cause of mutations and how mutation aafect organisms	Textbook, figures, investigation, 3D	71, 74, 77
	3	Sate the evidence fouund on the Galapagos island and how it supported the claim that variations helped individuals survive in their environment and eventally evolve by Natural selection	Textbook, figures, 3D	89, 90, 91
	4	Compare between relative-age dating and absolute-age dating according to precision and aacuracy given for the fossil age and the proceduer (way) used to determne the age of a fossil	textbook, table	137
	5	1. Analyze distance–time graphs used to represent a journey traveled over a period of time, calculate speed, 2. represent forces on any object and define balanced force and explain why object are stationary, 3. describe and list the estimated values of kinetic and potential energy for projectile objects	textbook, figures, 3D, review	29, 32, 49, 52, 55, 185

1	Construct a scienttific explanation based on evidence from rock layers for how the geologic time scale is used to build a timline and organise Earth's history, Define index fossils and recognise	Textbook, figures, 3D	36, 39

THREE-DIMENSIONAL THINKING

Scientists hypothesize that a meteorite impact might have caused the mass extinction that occurred when dinosaurs became extinct. Evidence for this impact is in a clay layer containing the element iridium in rocks around the world. Iridium is rare in Earth rocks but common in meteorites.

Analyze the image below.

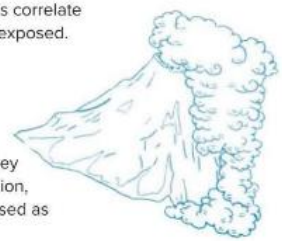
1. Would you expect to find dinosaur fossils in undisturbed rocks that are above the iridium layer? **Explain** your answer.

No. The rock layers above the iridium layer are younger. The iridium layer marks the mass extinction of the dinosaurs.

2. How does the **structure** of a distinctive layer that is used as a marker determine its **function?**

If a layer is distinctive enough, it can be used for correlation, and for dating events above and below it.

Key Beds As you just examined, a large meteorite strike, volcanic eruption, or other major event can leave a unique layer in the rock record. Because these types of layers are easy to recognize, they help geologists correlate rock formations in different geographic areas where layers are exposed. A rock or sediment layer used as a marker in this way is called a **key bed.** Using the principle of superposition, geologists know that the layers above a key bed are younger than the layers below it.



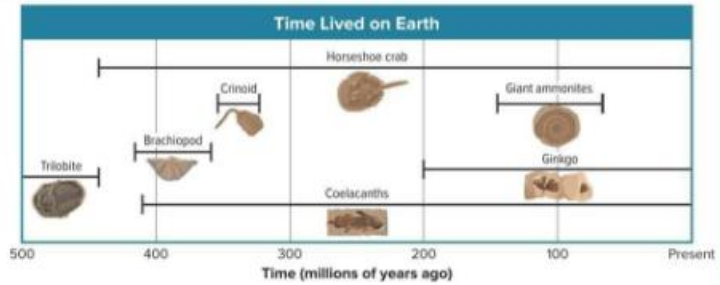
Not all of Earth's major events leave distinctive key beds, but they do leave evidence in the rock record. In the following investigation, you will explore how the type and order of rock layers can be used as evidence for the formation of mountains.

Correlation As you just explored in the *It's a Match* investigation, geologists fill gaps in the rock record through **correlation** (kor uh LAY shun)—the matching of rock layers or fossils exposed in one geographic region to similar layers or fossils exposed in other geographic regions. If the rock formations are very far apart or even on different continents, geologists often rely on fossils. If two or more rock formations contain fossils of about the same age, scientists can infer that the formations are also about the same age.

Not all fossils are useful in determining the relative ages of rock layers. The most useful fossils represent species that existed on Earth for a short length of time, were abundant, and inhabited many locations. These fossils are called **index fossils.**

THREE-DIMENSIONAL THINKING

Analyze the time scales for the following fossils.



Which fossils could be index fossils? **Explain** your choices.

The trilobite, brachiopod, crinoid, and ammonites could be index fossils because they existed for the shortest time periods.

The correlation of fossils and rock layers aids in the relative dating of rock sequences and helps geologists understand the history of larger geographic regions. It is largely through correlation that geologists have constructed Earth's time line.

COLLECT EVIDENCE

How do geologists fill gaps in the rock record? Record your evidence (A) in the chart at the beginning of the lesson.

2	Define mutation, Identify different types of mutations, and Explain the cause of mutations and how mutation aafect organisms	Textbook, figures, investigation, 3D	71, 74, 77

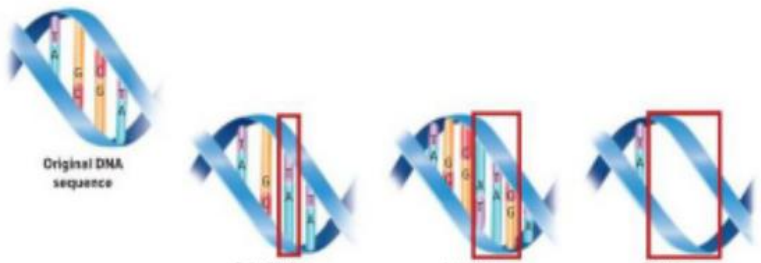
Mutations Recall that genes are located on chromosomes and that each pair of chromosomes contains two variants of a gene. Each gene controls the production of specific proteins, which in turn control traits.

A **mutation** is a permanent change in the sequence of DNA. Changes in genetic material can result in the production of different proteins. This change can alter an organism's traits. Mutations can also be triggered by environmental factors such as exposure to X-rays, ultraviolet light, radioactive materials, and some chemicals.

When an organism's phenotype, how a trait appears or is expressed, changes in response to its environment, the organism's genes are not affected and the change cannot be passed on to the next generation. The only way that a trait can change so that it can be passed to the next generation is by mutation, or changing an organism's genotype.

Although all genes can mutate, only mutated genes in egg or sperm cells are inherited. Some mutations in egg or sperm cells occur if an organism is exposed to harsh chemicals or severe radiation. But most mutations occur randomly.

Types of Mutations There are many types of DNA mutations. In a deletion mutation, one or more nitrogen bases are left out of the DNA sequence. In an insertion mutation, one or more nitrogen bases are added to the DNA. In a substitution mutation, the nitrogen base is replaced by a different nitrogen base.



COLLECT EVIDENCE

How do mutations, such as the mutation that caused the white coloring of the alligator at the beginning of the lesson, occur? Record your evidence (B) in the chart at the beginning of the lesson.

Mutation Classification

A mutation can be negative, positive, or neutral. A positive mutation is beneficial to an organism. A negative mutation is harmful to an organism. A neutral mutation is neither beneficial nor harmful, and may not appear in the phenotype. Classify each of the following mutations as positive, negative, or neutral. Record your answers in the table.

Mutation	Effects	Positive	Negative	Neutral
Eye color	Genes for brown eyes are mutated and the individual has blue eyes.			X
Lactose tolerance	Due to a mutation, human adults are able to process lactose unlike other mammals.	X		
Color blindness	Due to a mutation on the X chromosome, a person cannot see certain colors.		X	

Choose one of the above mutations to research further. Finally, create a short public service announcement, in your Science Notebook, explaining one of the three mutations.

THREE-DIMENSIONAL THINKING

Predict the effect of a mutation which limits the production of pigment in hair.

Students should predict that the animal would have white hair or hair with no color.

COLLECT EVIDENCE

What are the results of a mutation, such as the white coloring of the alligator at the beginning of the lesson? Record your evidence (C) in the chart at the beginning of the lesson.

2	Define mutation, Identify different types of mutations, and Explain the cause of mutations and how mutation aafect organisms	Textbook, figures, investigation, 3D	71, 74, 77

Three-Dimensional Thinking

Use the diagram below to answer the following questions.

2. The diagram above shows a segment of DNA before and after replication. Which could have occurred as a result of this change in structure?

A changes to the genotype of the organism

B changes to the traits of the organism

C changes in the production of proteins

D all of the above

3. The mutation shown above resulted in muscle degeneration. The effect of this mutation is that muscles become progressively weaker. What type of mutation is this?

A positive

B neutral

C negative

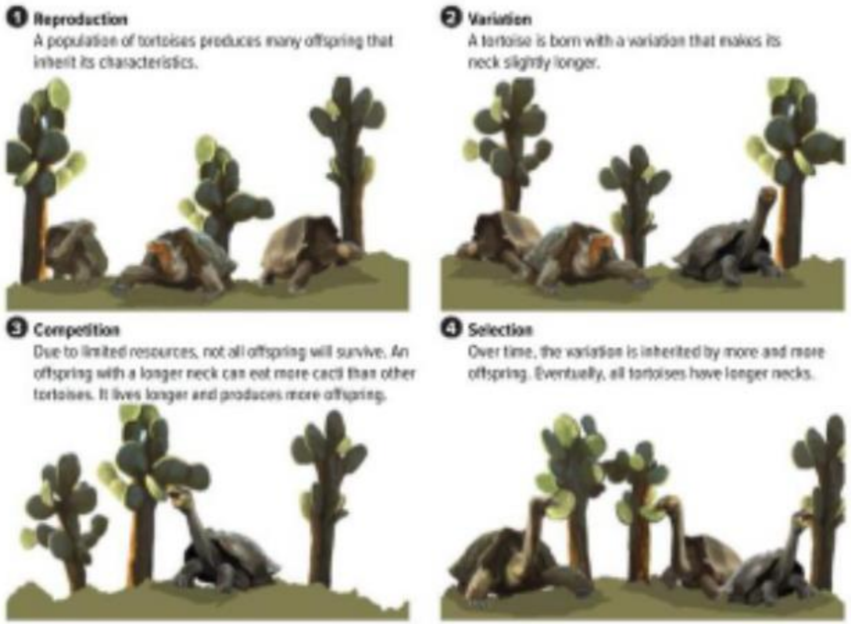
D none of the above

3	Sate the evidence fouund on the Galapagos island and how it supported the claim that variations helped individuals survive in their environment and eventally evolve by Natural selection	Textbook, figures, 3D	89, 90, 91

Common Ancestors Darwin became convinced that all the tortoise species were related. He thought they all shared a common ancestor. He suspected that a storm had carried a small ancestral tortoise population to one of the islands from South America millions of years before. Eventually, the tortoises spread to the other islands. Over many generations, each island's tortoise population developed a neck length and shell shape that made it easier to access their islands' food sources.

Variations and Competition Darwin did not know about genes. But he realized that variations were the key to the puzzle of how populations of tortoises and other organisms evolved. Darwin understood that food is a limiting resource, which means that the food in each island environment could not support every tortoise that was born. Tortoises had to compete with each other for food.

As the tortoises spread to the various islands, some were born with random variations in neck length and shell shape. If a variation benefited a tortoise, allowing it to compete for food better than other tortoises, the tortoise lived longer. Because it lived longer, it reproduced more. It passed on its variation to its offspring.



HISTORY Connection Darwin served as a naturalist on the HMS Beagle, a survey ship of the British navy. During his voyage around the world, Darwin observed and collected many plants and animals. Darwin was especially interested in the organisms he saw on the Galápagos (guh LAH puh gus) Islands. The islands, shown in the figure below, are located 1,000 km off the South American coast in the Pacific Ocean. Darwin saw that each island had a slightly different environment. Some were dry. Some were more humid. Others had mixed environments.

Tortoises look different depending on which island environment they inhabit.

Tortoises Giant tortoises lived on many of the islands. When a resident told Darwin that the tortoises on each island looked different, as shown in the figure above, he became curious.

Finches Darwin also became curious about the variety of birds on the islands. Later, he was surprised to learn that many birds he collected were all species of finches despite their different appearances. Like the tortoises, these finches lived in different island environments.

Traits and Environment Darwin recognized the relationship between each species and the food source on the island it lived on. Tortoises with long necks and a large space between the shell and neck lived on islands with tall cacti. Their unique necks and shells let them reach high to eat the cacti. The tortoises with short necks and shells close to the neck lived on islands with plenty of short grass.

3	Sate the evidence fouund on the Galapagos island and how it supported the claim that variations helped individuals survive in their environment and eventally evolve by Natural selection	Textbook, figures, 3D	89, 90, 91

Theory of Evolution by Natural Selection After years of research, Charles Darwin developed the theory of evolution by natural selection. **Natural selection** is the process by which individuals with variations that help them survive in their environments live longer, compete better, and reproduce more than those that do not have the variations. Natural selection explains how populations change as their environments change. It explains the process by which Galápagos tortoises became matched to their food sources. It also explains the diversity of the Galápagos finches. Birds with beak variations that help them compete for food live longer and reproduce more.

COLLECT EVIDENCE

How does natural selection lead to changes in populations of organisms, such as orchid plants? Record your evidence (B) in the chart at the beginning of the lesson.

Darwin studied the diversity of Galápagos finch beaks.

GO ONLINE for additional opportunities to explore!

Investigate natural selection by performing one of the following activities.

☐ **Interact** with the **PhET Interactive Simulation** *Natural Selection.* **OR** ☐ **Watch** the **Animation** *Natural Selection.*

THREE-DIMENSIONAL THINKING

Explain the conditions that led to the **changes** in the tortoises on the Galápagos Islands.

Sample answer: There were more offspring than could survive, variation in neck length and shell shape, and competition for resources, which led the tortoises with variations in neck length and shell shape to survive and reproduce, and the variations to become more common over time.

4	Compare between relative-age dating and absolute-age dating according to precision and aacuracy given for the fossil age and the proceduer (way) used to determne the age of a fossil	textbook, table	137

The Fossil Record You may have guessed that the fossils at the bottom of the image were much older than the fossils at the top. The fossils at the bottom were left by animals that existed long before the fossils at the top.

Pygmy mammoth fossils have been found only in California.

These fossils help make up the fossil record. The fossil record is made up of all the fossils ever discovered on Earth. It contains millions of fossils that represent thousands of species. Most of these species are no longer alive on Earth. The fossil record documents the existence, diversity, extinction, and change of life forms throughout the history of life on Earth.

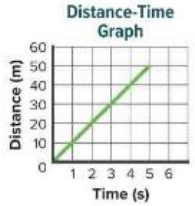
Scientists cannot date most fossils directly. Instead, they date the rocks the fossils are embedded inside. Rocks erode or are recycled over time. However, scientists can determine ages for most of Earth's rocks. Examine the table below to learn how scientists determine the age of fossils.

Relative-Age Dating	Absolute-Age Dating
• In relative-age dating, scientists determine the relative order in which rock layers were deposited. In an undisturbed rock formation, they know that the bottom layers are oldest and the top layers are youngest. • Relative-age dating helps scientists determine the relative order in which species have appeared on Earth over time.	• Absolute-age dating is more precise than relative-age dating. Scientists take advantage of radioactive decay, a natural clock-like process in rocks, to learn a rock's absolute age, or its age in years. • In radioactive decay, unstable isotopes in rocks change into stable isotopes over time. Scientists measure the ratio of unstable isotopes to stable isotopes to find the age of a rock.

Geologic Time It is hard to keep track of time that is billions of years long. Evidence of microscopic, unicellular organisms has been found in rocks 3.7 billion years old. Scientists organize Earth's history into a time line called the geologic time scale. The **geologic time scale** is a chart that divides Earth's history into different time units. The longest time units in the geological time scale are eons. Earth's history is divided into four eons. Earth's most recent eon—the Phanerozoic (fa nuh ruh ZOH ihk) eon—is subdivided into three eras. Examine the geologic time scale on the next page.

5	1. Analyze distance–time graphs used to represent a journey traveled over a period of time, calculate speed, 2. represent forces on any object and define balanced force and explain why object are stationary, 3. describe and list the estimated values of kinetic and potential energy for projectile objects	textbook, figures, 3D, review	29, 32, 49, 52, 55, 185

Distance-Time Graphs The plot you made in the Investigation *Plot It* is a distance-time graph. This type of graph shows how an object's position changes during each time interval. A distance-time graph does not show you the actual path the object took.



Did you notice that the line through the points in the investigation wasn't completely straight? When an object is moving at a constant speed, the line will be straight. The steeper the line, the greater the slope, which means the greater the speed of the object.

If the slope of the line changes, this means the speed of the object has changed. Even if the speed has changed, the average speed can still be calculated.

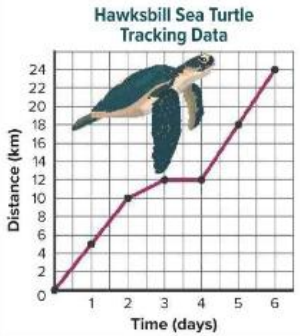
GO ONLINE for additional opportunities to explore!

Investigate position and motion by performing one of the following activities.

☐ **Use models** in the **PhET Interactive Simulation** *The Moving Man.* **OR** ☐ Find **patterns** by examining changes over time in the **Lab** *Calculate Average Speed from a Graph.*

THREE-DIMENSIONAL THINKING

Analyze the data on the plot below. Determine the speed of the hawksbill sea turtle during each interval listed below.



Day 0 to day 2: 5 km/day

Day 2 to day 3: 2 km/day

Day 3 to day 4: 0 km/day

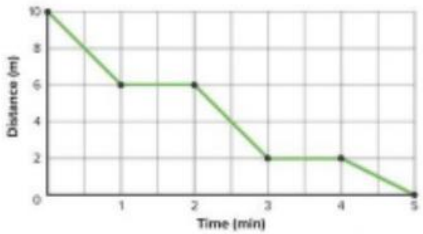
Day 4 to day 6: 6 km/day

COLLECT EVIDENCE

How do time-distance graphs help you understand the motion of the train? Record your evidence (D) in the chart at the beginning of the lesson.

Real-World Connection

4. Interpret Data The plot below shows the motion of an elevator. Explain its motion.



The elevator went down 4 m at a constant speed for 1 min. It then stopped for 1 min. It went down 4 m in 1 min, stopped for 1 min, and went down 2 m in the final minute.

5. Calculate A driver travels 55 km in 1 hour. He then drives at a speed of 35 km/h for 2 hours. Next, he drives 175 km in 3 hours. What was his average speed?

50 km/h

Still have questions?
Go online to check your understanding about position and motion.

REVISIT PAGE KEELEY SCIENCE PROBES

Do you still agree with the statement you chose at the beginning of the lesson? Return to the Science Probe at the beginning of the lesson. Explain why you agree or disagree with that statement now.

EXPLAIN THE PHENOMENON

Revisit your claim about how you can describe position and motion of a train. Review the evidence you collected. Explain how your evidence supports your claim.

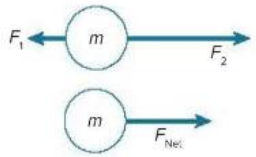
START PLANNING

STEM Module Project Engineering Challenge

Now that you understand the differences between position and motion, go to your Module Project to determine the criteria and constraints of your design. Keep in mind any societal or environmental impacts.

5	1. Analyze distance–time graphs used to represent a journey traveled over a period of time, calculate speed, 2. represent forces on any object and define balanced force and explain why object are stationary, 3. describe and list the estimated values of kinetic and potential energy for projectile objects	textbook, figures, 3D, review	29, 32, 49, 52, 55, 185

When all the arrows are added together, the result it is called the net force. The **net force** is the sum of all the forces acting on an object. To model the net force, simply add together the forces in the same direction and subtract the forces in the opposite direction. The sizes of the arrows show how much is added or removed. Then draw a free-body diagram of the net force.



3. Make a free-body diagram for the net force on the object shown below. The object is sliding across a surface with friction.

Sketch should show a free-body diagram with net force to the right but less than *F*.

4. An object is pushed to the right with 10 Newtons of force, and pulled to the left with 20 Newtons. Sketch a free-body diagram of this system, and draw a diagram with the net force. Ignoring friction, identify the direction and motion of the object.

Sketch should show a free-body diagram with a force to the left that is twice as large as the force to the right. The net force will then be depicted as an arrow to the left that is half of its original size.

When multiple forces act on an object, the forces will add together and act as a force in one direction. In many cases, the change in motion is in one direction but is a result of many forces. 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.

Balanced and Unbalanced Forces In the figure to the right, students are playing tug of war. Both sides are pulling with the same force, so neither side is winning. If the forces acting on an object are balanced, the object's motion does not change. Balanced forces are forces that cancel each other. The only way for a team to win is to have unbalanced forces, when one team pulls harder than the other team. When the forces are unbalanced, the rope and everyone holding it will accelerate in the direction of the net force.

Balanced forces can act on objects that are moving as well. Recall that for an object to change its motion, a net force must be acting on it. As a boat pulls the water tube at a constant speed, the net force must be zero. According to Newton's first law of motion, balanced forces cause no change in an object's velocity. This is true when an object is at rest or in motion. The skiers in the figure to the right are being pulled up the mountain at a constant velocity. Even when they are moving and pulling on the rope, the net force is zero.

THREE-DIMENSIONAL THINKING

In what ways does Newton's second law of motion describe **stability and change** of any **system** that has forces acting on it?

Answers will vary. Sample answer: Stability can be obtained by balanced forces. This stability can only be changed by an imbalance in the forces acting on an object.

COLLECT EVIDENCE

How do multiple forces help explain what happens when you push or pull a water tube? Record your evidence (C) in the chart at the beginning of the lesson.

5	1. Analyze distance–time graphs used to represent a journey traveled over a period of time, calculate speed, 2. represent forces on any object and define balanced force and explain why object are stationary, 3. describe and list the estimated values of kinetic and potential energy for projectile objects	textbook, figures, 3D, review	29, 32, 49, 52, 55, 185

Three-Dimensional Thinking

An object has a force acting on it to the right and has a frictional force to the left as shown below. Use the model below to answer questions 2 and 3.

2. What change in motion will result from the forces modeled?

A There will be no change in motion because the forces are in opposite directions.

B The object will slow down because of the friction force.

C The object will accelerate to the right.

D The object will accelerate to the left.

3. What would a model of the net force look like?

A The arrow would be to the right at the same length as before, because friction is a different force.

B The arrow would be to the right but shorter than before to account for the friction force.

C There would be no net force because the two forces are in opposite directions.

D The arrow would be to the left because friction is slowing the object down.

4. A train moves at a constant speed down a straight track. Which of the following scientific explanations is true?

A No forces act on the train as it moves.

B The train moves because no forces are acting against it.

C The forces of the train's engine balance the force of friction opposing it.

D An unbalanced force keeps the train moving.

LESSON 2

Review

Summarize It!

1. **Model** Create a model to illustrate the interactions that affect the amount of potential energy an object might have.

The model should include that mass and distance from Earth's surface affect the amount of potential energy an object might have. The model should include that changing the shape of an elastic object increases the amount of elastic potential energy an object might have (such as stretching a rubber band)