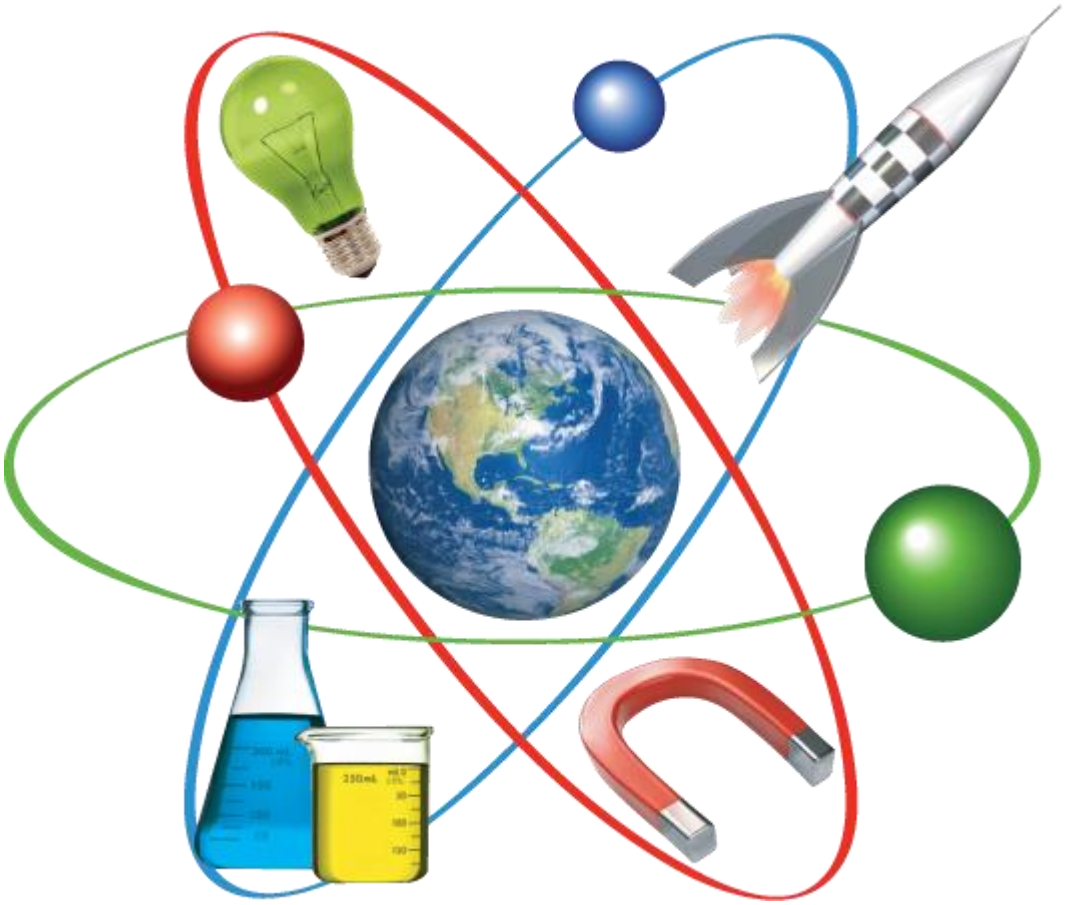
Mrs. Respers
Summer Science Packet
Grade 6



Student Name: _____

Grade: _____

Date: _____

Middle School Science Teacher/ Middle School Science Fair Coordinator

Due Friday, September 10, 2021

Greetings, Parents and Scholars,

I am glad summer break is finally here!

As we reflect on this academic year and segue into the summer; science is all around us. I have prepared the Middle School Science packets so that learning may continue during summer break. This packet includes a study guide and review questions. Completed packets are due on or before September 10, 2021.

We will conduct a Science Fair check-in on September 09, 2021. Students are to complete his/her Science Fair Project Proposal prior to this date. For the 2021-2022 academic year, students in sixth, seventh, and eighth grade will concentrate on engineering and the following areas, respectively: Earth's Place in the Universe, Earth's Systems, Earth and Human Activity; Structure and Function of Organisms, Inheritance and Variation of Traits, Ecosystems: Interactions, and Dynamics; Matter and its Interactions, Motion and Forces, and Energy and Waves.

If you have any questions or concerns, please feel free to contact me via email at starrerespers@gmail.com.

I wish you a safe and fun summer!

Sincerely,

Mrs. Respers,
Middle School Science Teacher
Middle School Science Fair Coordinator

Grade 6 Study Guide

Evolution

Evolution is a theory that describes the changes that living things have undergone over time. If scientists are correct in their measurements and calculations that the earth is at least 4.5 billion years old, that the oceans are 3 billion years old, and that multicellular life is 750 million years old, the present day environment appears much different than it did billions of years ago. The earth's life forms have evolved in this changing environment over millions of years. Students should understand the concepts that make up the theory of evolution.

As living things are affected by changes in the environment around them, they adapt to survive in the new environmental conditions. Adaptations are characteristics that help organisms survive in their environment. Evolution is a change in genes that favors successful adaptations. Adaptations that are favorable may stay in the population, while those that are less favorable will cause the organism to be less fit in its environment and will not likely be passed on for very long, if at all.

As living things adapt, they, in turn, change their environment in an ongoing cycle. As a result, nothing in the cycle stays the same and, according to the theory, everything on the earth has evolved. Extinction, which means the end of a species' existence on the planet, is as much a part of evolution as adaptation. Both are necessary for life on the earth to continue to exist and change. Extinction is a result of a failure to adapt.

Scientists learn about the earth's past from fossils, which are the remains of plants and animals solidified in rock. In the fossil record, there is evidence that many organisms still alive today look different than they did millions of years ago. Furthermore, there were many living things that existed on the earth millions of years ago that are now extinct. The most well known extinct animals are the dinosaurs, but many other animals and plants, also identified in fossils, are extinct as well. There is also evidence of evolution in different species of organisms with similar internal structures and genetic patterns. For example some members of a population adapt, while others do not. This can eventually result in two new species of organisms that look different externally, but have similar internal structures.

The theory of evolution is used to explain how life on earth has changed over time. When fossils are discovered that show differences in animal and plant structure, evolution helps to explain how environmental changes caused these adaptations. As changes in the environment continue to be recorded today, evolution is used to explain what the impact of those changes may be for all life in the future.

To help students understand the theory of evolution, they can find pictures of dinosaurs and other organisms that lived long ago and make a list of which animals and plants of today look like extinct organisms. In the list, they should include notes as to which characteristics are similar and the reasons why the ancient organism may have evolved into the current organism. Also, to increase students' understanding of fossils, they can make their own "fossils" using clay, shells, leaves, and plaster of Paris. Have them firmly press a shell or leaf into a flattened ball of clay to make an impression. Remove the shell or leaf, then spoon some plaster of Paris into the impression. After the plaster has dried, the student can remove the clay and a "fossil" will remain.

Acid Rain

Acid rain is a term used to describe precipitation that contains acids. Acids are corrosive liquids and have a pH value of less than 6 on a scale from 1 to 14. The pH scale is used to measure the acidity of liquids, where neutral water has a value of 7. Students should understand what causes acid rain and what its effects are.

Pollutants in the air, such as sulfur dioxide and nitrogen oxide, combine with water in the atmosphere to form acids. These acids fall to the earth as precipitation, such as rain, snow, or fog. The cause of this air pollution is the burning of fossil fuels, including coal, oil, and natural gas. Since automobiles, power plants, and even outdoor grills burn fossil fuels, they all contribute to air pollution. In the United States, power plants are the leading contributors to this type of air pollution.

Acid rain causes many problems. Many plants can only grow in soils within a certain pH range. Acid in the soil removes the nutrients plants need. This can slow a plant's growth or kill it. In addition, acid rain can damage a plant's leaves, causing the plant to turn yellow or brown and die. Organisms that live in or near water bodies, such as lakes, rivers, and wetlands, are also affected by acid rain. Many aquatic organisms are very sensitive to the pH of the water and certain fish, insects, and algae will die in acidic water. Also, animals that depend on these organisms will suffer a decline in their food source. Finally, acid rain can damage buildings, statues, and other structures that are exposed to the weather. These structures can change colors or deteriorate because of acid rain's corrosive nature.

To learn more about the causes and effects of acid rain, students can test the acidity of the rain in their area. A pH test kit can be purchased from a swimming pool supply store or a discount store that sells swimming pool supplies. Have them collect some rainwater and use the test kit to determine the water's pH by following the kit's instructions. After collecting and testing the water's pH, students can add an acid, such as lemon juice, and test the pH once again. This will show how the pH has changed due to the addition of an acid to the water. Finally, students can water a plant with a mixture of water and lemon juice for several weeks to see the effects of "acid rain."

Photosynthesis and Respiration

Photosynthesis and respiration are processes that all living things depend on for survival. Students should understand the basic processes and chemical reactions of respiration and photosynthesis, the relationship between these two reactions, and the similarities and differences between photosynthesis and cellular respiration.

Cellular respiration is a process that converts stored energy in glucose, a sugar, into useable energy for cells. All organisms undergo cellular respiration to obtain useable energy so that their cells can function. Organisms obtain glucose in different ways. Animals get glucose from eating food, whereas plants make glucose using a process called photosynthesis, which is explained later in this study guide. In respiration, glucose is broken down with oxygen from the air to produce carbon dioxide, water, and release energy. The energy released is in the form of a molecule called ATP. The chemical equation for cellular respiration is as follows:

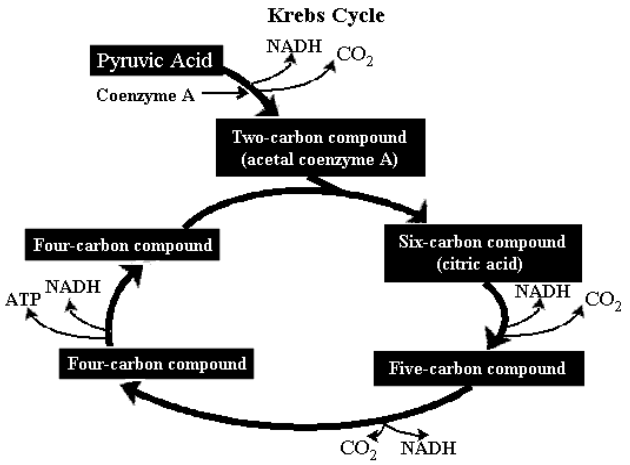
$$\underset{\text{(glucose)}}{C_6H_{12}O_6} + \underset{\text{(oxygen)}}{6O_2} \rightarrow \underset{\text{(carbon dioxide)}}{6CO_2} + \underset{\text{(water)}}{6H_20} + \underset{\text{(energy)}}{2ATP}$$

Cellular Respiration

There are two types of cellular respiration, aerobic and anaerobic. Aerobic respiration occurs in the presence of oxygen and anaerobic respiration occurs when oxygen is not present.

In the first type of respiration, aerobic respiration, there are three series of reactions: glycolysis, the Krebs cycle, and the electron transport chain. During glycolysis, two ATP molecules are combined with glucose to form the compounds pyruvic acid and NADH, as well as four ATP molecules. The pyruvic acid produced in glycolysis is then broken down by the compound NAD+ into a chemical called acetyl-coenzyme A.

During the Krebs cycle, acetyl-coenzyme A joins oxaloacetic acid, a four carbon compound, to form citric acid, a six carbon compound. Citric acid then changes back into a four carbon compound again and the cycle repeats. Carbon dioxide and NADH are given off and one molecule of ATP is produced each cycle. The following is an illustration of the Krebs cycle.



During the final stage, the electron transport chain, most of the ATP is produced. This is the same process that occurs in photosynthesis. Here, NADH gives off a proton (a positively charged particle) and an electron that bind with hydrogen and oxygen to form water molecules and ATP.

The second type of respiration is anaerobic respiration, also called <u>fermentation</u>. This type of respiration also begins with glycolysis. However, once ATP and pyruvic acid are produced, the pyruvic acid is converted to either carbon dioxide and alcohol during alcoholic fermentation, or a compound called lactic acid during lactic acid fermentation. Alcoholic fermentation is used in the production of alcohol. Lactic acid fermentation sometimes occurs in the human body and causes soreness in muscles. The chemical equations for alcoholic fermentation and lactic acid fermentation are shown below.

$$\underset{\text{(glucose)}}{C_6H_{12}O_6} \rightarrow \underset{\text{(ethyl alcohol)}}{2\,C_2H_5OH} + \underset{\text{(carbon dioxide)}}{2\,CO_2} + \underset{\text{(energy)}}{2\,ATP}$$

Alcoholic Fermentation

$$\underset{\text{(glucose)}}{C_6H_{12}O_6} \rightarrow \underset{\text{(lactic acid)}}{2\,CH_3CHOHCOOH} + \underset{\text{(energy)}}{2\,ATP}$$

Lactic Acid Fermentation

<u>Photosynthesis</u> is the process in which plants use sunlight and carbon dioxide to produce glucose. This process is important because it not only provides plants with the sugar they need to grow, but it also produces oxygen that animals need for cellular respiration. The reactants, or materials that are needed for this process to begin, are water and carbon dioxide. During photosynthesis, sunlight hits the leaf of a plant and enters the cells. The plant cells contain a green pigment called chlorophyll, which gives plants a green color. Chlorophyll captures the energy in sunlight to help convert water and carbon dioxide into glucose and oxygen. The glucose is stored in the plant and can be used for respiration while the oxygen is released into the air. The photosynthesis reaction is shown below.

$$\underset{\text{(water)}}{6H_20} + \underset{\text{(carbon dioxide)}}{6CO_2} + \underset{\text{(energy)}}{\text{sunlight}} \longrightarrow \underset{\text{(glucose)}}{C_6H_{12}O_6} + \underset{\text{(oxygen)}}{6O_2}$$

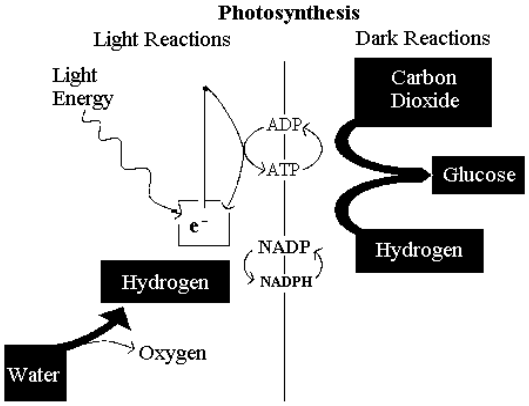
Photosynthesis

Photosynthesis occurs in two stages, the light reactions (also called light dependent reactions), and the dark reactions (light independent reactions). The light reactions require light energy and dark reactions do not.

The light reactions begin with light energy from the sun being absorbed into the chloroplasts. Chloroplasts are structures inside of plant cells that contain chlorophyll and are where photosynthesis occurs. The energy from the sun excites the electrons in the chlorophyll. Electrons are negatively charged particles in atoms. Excited electrons are electrons with extra energy. The excited electrons cannot keep the excess energy, so they undergo a process called the electron transport chain. The electron transport chain is the process by which excited electrons give off energy, one by one, down a chain of molecules, to return to their normal, unexcited state. The energy given off is ATP.

Another reaction that takes place during the light reactions is the splitting of water molecules. A water molecule is composed of two hydrogen atoms and one oxygen atom. Water molecules present in the leaf cells separate into hydrogen and oxygen. The hydrogen atoms combine with electrons from the electron transport chain to form a compound called NADPH. The oxygen atoms are released into the air as a waste product of photosynthesis.

The dark reactions of photosynthesis do not require sunlight. The ATP and the NADPH produced during the light reactions are used in the Calvin Cycle, which is part of the dark reactions. During the Calvin Cycle, carbon dioxide in the air is absorbed by cells in the leaves and forms a compound called PGA. PGA combines with ATP and NADPH to form the compound PGAL. PGAL is then converted to glucose. Plants use glucose for energy. The following is an illustration of the light and dark reactions of photosynthesis.



There are many similarities between photosynthesis and respiration. They are both important processes that produce ATP, they both use the electron transport chain, and they are both are part of the ongoing cycle between plants and animals.

There are, however, three main differences between photosynthesis and aerobic respiration. First, the products of one reaction are the reactants of the other. The water and carbon dioxide created during cellular respiration are used in photosynthesis. The glucose and oxygen created during photosynthesis are used in cellular respiration. As shown in the following diagram, their equations are reversed.

$$\underset{\text{(water)}}{6H_20} + \underset{\text{(carbon dioxide)}}{6CO_2} + \underset{\text{(energy)}}{\text{sunlight}} \longrightarrow \underset{\text{(glucose)}}{C_6H_{12}O_6} + \underset{\text{(oxygen)}}{6O_2}$$

Photosynthesis

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_20 + 2ATP$

(glucose) (oxygen) (carbon dioxide) (water) (energy)

Cellular Respiration

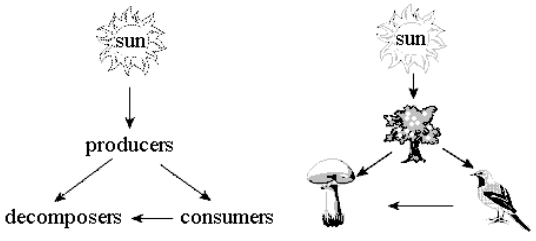
Secondly, not all organisms undergo both processes. All organisms undergo cellular respiration, but only autotrophs undergo photosynthesis. Autotrophs are organisms that can make their own food, like plants. Heterotrophs cannot make their own food; they must obtain energy from an outside source by eating. Thirdly, the location where the two processes occur in the cell are different. Photosynthesis occurs in the chloroplasts, while cellular respiration occurs in the mitochondria.

To help students understand the processes of photosynthesis and cellular respiration, as well as how these two are dependent upon each other, they can create a terrarium. A terrarium is a closed container that holds plants and animals. They can find information on how to set up a terrarium in books or on the Internet. The terrarium should contain plants, soil, some water, and small animals such as snails. Even though the terrarium stays completely closed at all times, the plants and animals inside can survive if it is set up correctly, because the photosynthesis and cellular respiration cycles allow the organisms to meet all of their needs. Also, to learn the chemical reactions of photosynthesis and cellular respiration, have the students write each of the components of these reactions on an index card. Then, mix them up and have the students reassemble them correctly to form the photosynthesis and cellular respiration reactions. Another activity that will help students study the differences and similarities between these two processes is having them make a table. They should include different characteristics, steps, and reactions of each process, and then highlight the ones that occur in both photosynthesis and cellular respiration.

Flow of Energy in Ecosystems

Producers are organisms, mainly plants, that make their own food from the sun's energy. A consumer is an organism that cannot make its own food, so it eats producers or other living things. Decomposers are organisms that break down the tissues of dead organisms for energy. Mushrooms, molds, yeasts, and certain types of bacteria are all decomposers. Students should understand the flow of energy in an ecosystem, among producers, consumers, and decomposers.

Producers get their energy directly from the sun. They use this energy to live and grow. As consumers eat producers, the energy from the producer is passed on to them. Consumers that eat other consumers get their energy from the animals they eat. Decomposers are an important part of the environment because as they help decay, or break down, dead organisms, they return the nutrients back to the environment. This relationship is illustrated in the diagrams below. The arrows represent energy being transferred, or passed on, from one component to another.



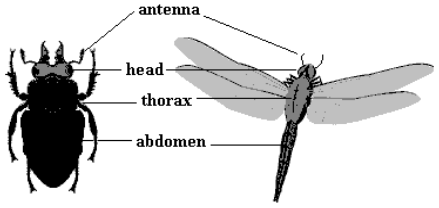
To help students understand the flow of energy in an ecosystem between producers, consumers, and decomposers, have them make several diagrams like the ones shown above. They can use pictures of a different producer, consumer, and decomposer for each diagram, and can include their favorite animal or themselves.

Insects
More than half of all of the animals known in the world are insects. Insects are special animals that have unique characteristics. Students should understand these distinguishing characteristics and be able to identify insects.

There are several characteristics that all adult insects possess. They are listed below.

- They are invertebrates.
- They have an exoskeleton.
- They have a segmented body with three main parts (head, thorax, and abdomen).
- They have six jointed legs.
- They have antennae.

An invertebrate is an animal without a backbone. There are other animals that are invertebrates, but are not insects because they do not possess all of the characteristics that are listed above. Insects do not have soft bodies. They have a hard outer covering called an exoskeleton. The body of an insect contains three main parts: the head, the thorax, and the abdomen. A pair of antennae, which are sensory structures, are located on the head of an insect. The thorax is where the legs and wings of an insect are attached. The abdomen is the body segment in which the digestive and reproductive organs are located. Insects have six jointed legs, which means the legs are able to bend at certain points. Also, most insects have wings. Ants, bees, beetles, butterflies, moths, flies, and crickets are all insects. Spiders, which have eight legs instead of six, are not insects. The picture below shows the parts of two different insects.

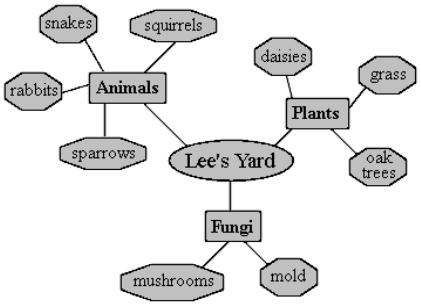


Many young insects look different than adult insects. For example, the first stage of life of a butterfly is a caterpillar. Caterpillars do not have the characteristics of adult insects as described above. They eventually grow, mature, and change forms through a process called metamorphosis during which they become adult butterflies. If you would like to learn more about metamorphosis, refer to the study guide entitled "Life Cycles - B."

To help students understand the characteristics of insects so they can identify them, have the students search their yards for different animals. They can use a magnifying glass to examine the smaller characteristics of the animals they find. Using the information they have learned about the characteristics of insects, they can identify which animals are insects and which are not. For each animal observed, students should discuss the reasons why the animal is or is not an insect.

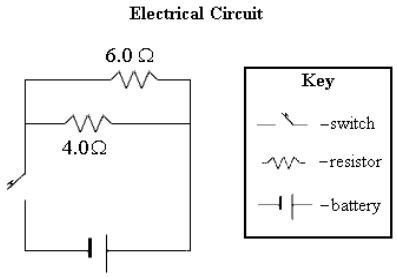
Interpreting Concept Maps and Diagrams
In many subject areas, including science, visual representations, such as concept maps, models, drawings, blueprints, and other diagrams, are often used to convey or explain information. Students should be able to interpret concept maps and diagrams.

A concept map usually consists of shapes connected by lines or arrows. The shapes contain ideas or headings, and they are connected by lines to show how each shape is related to the others. The concept map below shows the different types of organisms that live in Lee's back yard.



The oval in the center connects to three types of organisms: animals, plants and fungi. Each type of organism connects to specific living things in its own category. For instance, oak trees, grass, and daisies are the plants in Lee's yard. One can also tell by this concept map that mold is a type of fungus that is found in Lee's back yard. Even though there is no title for this concept map, it is clear that the map is displaying the different types of living things found in Lee's yard.

Diagrams, such as blueprints and drawings of models, are another type of graphical representation. Like concept maps, they can also show relationships between different parts or ideas. In addition, diagrams can show sizes, scale, shapes, locations, distances, or processes. The diagram below is of an electrical circuit. It shows the parts of a particular circuit and their locations.



This diagram includes a key, which is common in diagrams. A key describes or defines symbols found in the diagram. In this diagram, the key shows what each symbol means.

Example: Use the diagram of the electrical circuit shown above to answer the following question. How many resistors does this circuit have?

A. 4
B. 6
C. 2
D. 1

Answer: C. The key shows that the symbol for a resistor is a jagged line. There are two of these symbols in the circuit, so there are two resistors.

To help students understand concept maps, have them make concept maps of their families. Their concept maps should be similar to family trees with grandparents or great-grandparents in a central

location, branches out to each of their children, more branches representing their children's children, and so on. So that students may better understand diagrams, have each student draw a simple diagram of his or her bedroom. The student can draw what the bedroom looks like from above, using symbols for the different types of furniture and items in the room. Make sure students include a key that defines each symbol in the diagram. Finally, have them write the distances between different pieces of furniture in the room.

Linear Relationships in Data

A linear relationship between two sets of numbers in data is a pattern of increasing or decreasing values in one set of numbers that matches an increasing or decreasing pattern in another set of numbers. These relationships can often be used to make predictions and conclusions about the data being analyzed. Students should be able to identify linear relationships in data.

When two sets of numbers in a chart appear to be increasing or decreasing in a relatively uniform manner, and the increments are generally consistent, the data can be considered linear. The possible combinations of changes that can occur in linear relationships between two sets of data are as follows: both sets of numbers increase, both sets of numbers decrease, one set of numbers increases while the other set decreases, one set of numbers increases while the other stays exactly the same, or one set of numbers decreases while the other stays exactly the same. Perfectly linear relationships, where the increments between values are exactly the same each time, are rare in data, but relationships that are close to linear are often just as useful and still considered linear.

The following charts include data that show linear relationships. As one set of numbers increases or decreases, the matching set of numbers also increases or decreases

Week	Height
1	2 in.
2	3 in.
3	5 in.
4	7 in.

(both sets increase)

Amount of Fertilizer	Final Height of Grass
8 oz.	6 in.
7 oz.	5 in.
4 oz.	3 in.
2 oz.	2 in.

(both sets decrease)

Depth	Temp.
2 m	27°C
4 m	23°C
7 m	21°C
12 m	19°C
20 m	16°C

(one set increases one set decreases)

The charts below include data that does not show linear relationships. One of the number sets in each chart does not uniformly increase or decrease.

Water Temp.	Air Temp.
64°F	84°F
64°F	82°F
66°F	73°F
64°F	70°F

Weight	Speed
2 oz.	12 in/sec
3 oz.	30 in/sec
4 oz.	10 in/sec
5 oz.	8 in/sec
6 oz.	35 in/sec
9 oz.	18 in/sec

Depth	Temp.
2 m	28°C
4 m	22°C
7 m	20°C
12 m	19°C
20 m	14°C

To help students learn to identify linear relationships in data, have them make three charts with data that show a linear relationship and three that do not show a linear relationship. Their charts should look similar to the six shown above. They can make the charts from data they find in graphs, or they can collect data from an actual experiment and record it in a chart.

Animal Structure and Function - B

By looking at various features, such as the skin, feet, and mouths on different animals, and by observing the locations of certain body parts on these animals, students should be able to determine the habitat in which each animal lives and describe how a specific body part or characteristic helps the animal survive within that habitat.

The shapes, locations, and colors of an animal's physical structures help the animal survive and meet its basic needs in the environment. Certain parts of the body help each animal eat, breathe, move, and/or protect itself. For example, most animals that live in cold habitats, like the Arctic, have thick fur or feathers to keep them warm. In a desert where it is hot and dry, animals may have scales instead of fur because having scales helps their bodies conserve water. Animals that live in the water often have scales, fins, shells, or webbed feet to help them swim and protect themselves. Tails, strong toes, and claws are common in animals that live in trees so that they can hold onto branches.

Example 1: Which animal would survive best in a pond?

Answer: The frog. While any one of these animals may live near a pond, the frog has skin that is moist and is adapted to living in water. A frog also has eyes located on the top of its head for seeing above the water in the pond, along with powerful back legs and webbed feet to help it swim in water. A frog would live best in a pond because of its physical structure.

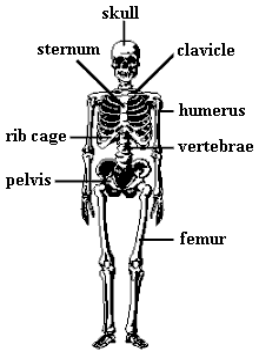
One way an animal improves its chances for survival is by using camouflage. Camouflage results when an animal's skin or fur color, the pattern in which the colors may appear, or the location of certain colors on the animal's body allow the animal to blend into its environment. For example, a lion hunts other animals for food. Camouflage helps the lion sneak up on the animals it eats because its fur blends in with its surroundings and makes the lion hard to see. Students should recognize other physical structures that help various animals survive in their habitats.

To help students learn about how physical structures help animals survive in a particular environment, have them look at pictures of animals in their natural habitats and note the special body parts the animals have that help them to survive in that environment. To help students learn about other animal structures and their functions, have them point out special body parts on animals in their community and in pictures, communicating the ways in which those features help each animal survive. Observing animals at a zoo or in an aquarium will also help students understand animal body parts and their functions.

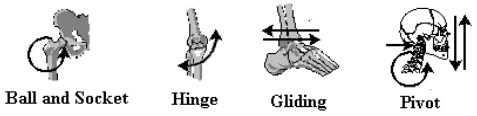
Skeletal and Muscular Systems

The skeletal and muscular systems are the systems of the body that help us move. Students should know the functions of these systems, know their component parts, and understand that they work together.

The skeletal system gives the human body shape, rigidity, and structure. There are over two hundred individual bones that make up the human skeleton. Bones have a hard exterior with a softer center called the bone marrow. A spongy material, called cartilage, cushions the ends of bones. In addition, it is cartilage, not bone, that shapes the ears and the nose on humans. The following diagram shows the location and general shape of some of the major bones in the human body, including the skull, clavicle, vertebrae, humerus, rib cage, sternum, pelvis, and femur bones in the human skeleton.



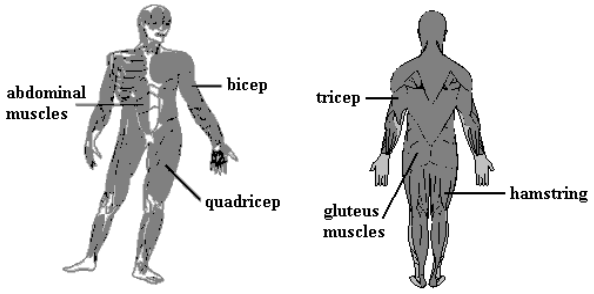
A joint is formed where bones come together. There are four basic types of moveable joints: ball and socket, hinge, pivot, and gliding. Ball and socket joints allow movement in all directions. The shoulder and hip are examples of ball and socket joints. Hinge joints allow bones to move together and apart, like in the knee and the elbow. The skull and vertebrae come together and form a pivot joint. Pivot joints allow movement up and down and rotation from side to side, like the bones in your neck. Gliding joints can be found in the ankles and wrists, where bones move back and forth, and from side to side. Stretchy, rubber band-like ligaments hold the bones together at the joints. The following diagrams show the four types of joints, with arrows indicating the directions of their movement.



The skeletal and muscular systems are dependent on one another. Muscles are attached to the skeleton in many places because the muscles of the body help the skeleton move. They are attached to bones by bands of tissue called tendons. Without muscles, the body could not move.

Muscle tissue contracts, or squeezes together, and relaxes in order to move the parts of the body. An example of this is the relationship between the bicep muscles in the front of your arm and the tricep muscles opposite to the biceps. When you touch your right shoulder with your right hand, your biceps contract, while the triceps on the other side relax. To stretch the arm back out and hold it flat, the triceps must contract while the biceps relax. Many muscle groups throughout the body share this same type of relationship.

The following diagram shows the location of the abdominal muscles, the bicep, the quadricep, the tricep, the hamstring, and the gluteus muscles in the human body.



There are three different types of muscle tissue. They are smooth muscle, cardiac muscle, and skeletal, or striated, muscle. The muscles shown in the diagram above are all skeletal muscles. Skeletal muscles are attached to bones and help move the skeleton. They are voluntary muscles, meaning you

can consciously make them move. Smooth muscle is found in internal organs. These muscles are involuntary, which means that you are not able to consciously control their movement; they help organs perform certain functions. For example, the smooth muscles of the stomach churns food during digestion. Finally, cardiac muscle is only found in the heart. This type of muscle also moves involuntarily.

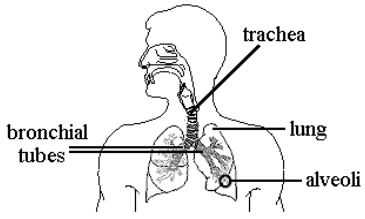
To help students understand the skeletal system, have them try to find items around the house or at school that look or work like the different types of joints. A door hinge (hinge joint) and a nut and bolt (pivot joint) are two examples. Another activity students can complete, to help them learn muscles and bones in the muscular and skeletal systems, is to draw a picture of a person. On the picture, they should label the major bones and muscles. Finally, students can make different movements and try to guess which bones, muscles, and joints are moving.

Circulatory and Respiratory Systems

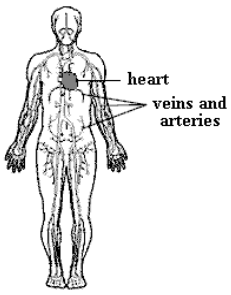
The circulatory and respiratory systems work together to provide the body with the oxygen and nutrients it needs to survive. Students should understand the relationship between these two systems, as well as the systems' responses to different situations.

The circulatory and respiratory systems are dependent on one another. The respiratory system brings oxygen into the body. Oxygen is a gas in the air that the human body must have to live and grow. When humans breathe, they are using the respiratory system to get the oxygen they need. Then, the circulatory system moves the oxygen to all parts of the body. It also moves carbon dioxide, a waste product that the body needs to get rid of, from all parts of the body back to the lungs. To learn about these processes, one must first understand the parts of the respiratory and circulatory systems.

The respiratory system is composed of several parts. The trachea is a tube located in the middle of the chest, near the heart. This tube branches into two separate parts, called bronchial tubes. Each bronchial tube branches even further, into an organ called a lung. In the respiratory system, the lungs are the main organs. The human body has two lungs, one located on either side of the chest. The lungs are made of a material that can expand as air enters. Finally, there are millions of tiny sacs called alveoli inside the lungs. The diagram below shows the parts of the respiratory system.



The main organ of the circulatory system is the heart. The heart is a muscle located near the center of the chest. The heart pumps a liquid called blood through the body using contractions and relaxations. Small, tube-like "roads," called veins, arteries, and blood vessels, carry the blood to different parts of the body. Circulation is the transportation of materials in the blood throughout the body. The diagram below shows the parts of the circulatory system.



When a person inhales, air from the nose and mouth moves into the trachea, through the bronchial tubes, and into the lungs. Then, the air enters into the tiny alveoli. This is where the oxygen from the air is transferred into the circulatory system. Carbon dioxide from the blood is transferred into the alveoli at the same time. Tiny blood vessels called capillaries cover the alveoli in the lungs, and the blood in the capillaries picks up the oxygen there. The blood then travels into the heart to get a "push" so it can move to the other parts of the body. Next, the blood is pumped out of the heart to all parts of the body to deliver oxygen to the cells. When cells pick up oxygen from the blood, they exchange the oxygen for carbon dioxide. The blood then takes the carbon dioxide, moves back into the heart for another push, and travels to the lungs once again. In the lungs, the blood will get rid of the carbon dioxide and pick up new oxygen. After the carbon dioxide is deposited in the alveoli, it travels back through lungs and out of the mouth, where it is exhaled. Breathing out is called exhalation, while breathing in is called inhalation.

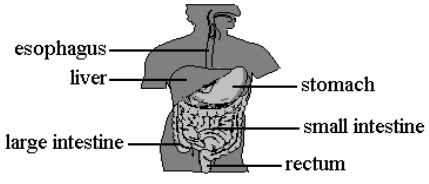
Certain activities will cause these processes to speed up or slow down. When the body needs more oxygen, the respiratory system must take air in faster, causing a person's breathing rate, or respiration, to increase. Also, the circulatory system must move the blood around the body faster to provide cells with the extra oxygen they need, so the heart must beat faster. This increase occurs when someone is involved in physical activities like running, swimming, and biking. It can also occur when someone is afraid or surprised. This is why a person may feel "out of breath" when he or she is startled or is exercising. When a person is resting or sleeping, his or her body does not need as much oxygen, so the person's breathing and heart rate are slower.

To help students learn about the circulatory and respiratory systems, have them trace the outlines of their bodies on butcher or bulletin board paper. Inside the outlines, students can draw the organs of the circulatory and respiratory systems. Then, with a different colored marker or crayon, draw arrows tracing the pathway of air from the time it is inhaled, through the respiratory system, into the circulatory system, to all parts of the body, then back out when it is exhaled.

Digestive System

The purpose of the digestive system is to break down the food we eat into nutrients that the body can use to live and grow. Students should understand the purpose of the digestive system and know the functions and locations of the main organs involved.

The locations of the main organs of the digestive system are shown in the following diagram.



Digestion starts in the mouth. The teeth chew food, mechanically breaking it down into smaller pieces. Saliva contains chemicals that also begin breaking down the food. In addition, saliva coats the food so it can travel through the rest of the digestive system and break down more easily. Once the food leaves the mouth, it moves into the esophagus, a tube leading into the stomach. The esophagus has muscles in its walls that push the food into the stomach. Once in the stomach, the food is coated with stomach acids that help liquify the nutrients in the food. From the stomach, the liquid food moves into the small intestine. There, the nutrients from the food are further digested. The liver is an organ that secretes bile. Bile in the small intestines helps break down the food even more. Then, the nutrients are absorbed into the blood through the wall of the small intestine. Whatever is not absorbed into the bloodstream goes into the large intestine. The large intestine absorbs the water from the remaining food; this water will be used by the body. Whatever remains in the large intestine is considered "waste" and exits the body through the rectum.

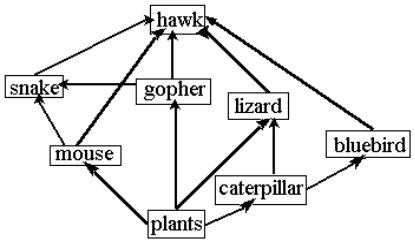
To help students learn about the digestive system, its organs, and their locations, ask them to trace the outlines of their bodies on butcher or bulletin board paper. Inside the outline, students can draw and label the organs of the digestive system in their correct locations. Also, students can make a flow chart tracking the pathway of food from the time it enters the mouth until it exits the body.

Food Webs

A food chain is a diagram that shows how the energy in food is passed from one organism to another. Most food chains start with a plant. The next "link" in the chain is an animal that eats that plant, and the following "link" is an animal that eats the previous animal. The arrows in a food chain indicate the direction in which the energy is passed between the organisms. For example, a forest food chain might look like this:

A food web is a series of interconnecting food chains, showing how organisms get energy within their environment. The food web expands the idea of a food chain by showing that animals get energy from a variety of foods and that many animals share the same food sources. The relationship between predator and prey is also shown in a food web. Animals that hunt and eat other animals are called predators. Animals that are hunted by other animals are called prey. Some animals are both predators and prey because they hunt other animals and are hunted themselves.

Example 1: The diagram below shows a food web in a meadow.



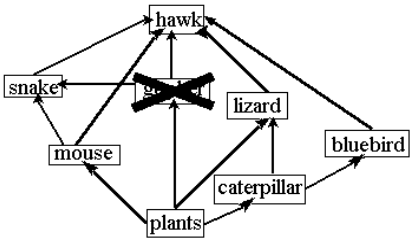
Which animals are **predators** in the meadow? Which animals are **prey**?

Answer: The snake, hawk, lizard, and bluebird are all predators in the meadow because they eat other

animals. The gopher, mouse, and caterpillar eat plants; they do not hunt other animals for food. The gopher, mouse, and caterpillar are all prey, since the predators in the meadow hunt and eat them. All of the animals in the meadow are prey for the hawk.

All the organisms in a food web are very important to all other organisms in that food web. If the population, or number of a certain species of living thing, changes by getting bigger or smaller, the other populations in the food web are affected. For example, if the number of a certain predator in a food web increases, then the number of prey it hunts will most likely decrease, since more predators are hunting them. Or, if there is not enough prey to sustain the higher predator population, some of the predators will not survive. On the other hand, if the number of a certain predator decreases, its prey will increase in number, since fewer animals are hunting and eating them. Sometimes, the populations in a food web change because new animals are added to the environment. In other cases, populations may change because humans have over-hunted a species, leaving the other living things in the environment that depend on that species to suffer.

Example 2: If gophers disappeared from the meadow, which of the following would be true?



A. There would be more hawks.
B. There would be fewer caterpillars.
C. The snake would have less food.
D. The bluebird would leave the meadow.

Answer: C. The snake would have less food if there were no gophers, since the food web shows that mice and gophers are the main energy source for snakes in the meadow. If there were fewer gophers, there would be no reason that the hawk population should grow or that the caterpillar population should decrease. The bluebird is not relying on the gopher for food, so there would be no reason for it to leave the meadow if gophers disappear.

To better understand food webs, students can create their own food webs, using pictures of living things from magazines and drawing energy arrows between the organisms to show where they get their energy. Have students discuss what would happen to the organisms in their food webs, if an organism from another food web is added. Students can also choose an organism to take away from another student's food web and then discuss how the organisms that remain would be affected.

Arthropods

Arthropods are animals that have hard shells, called exoskeletons, covering their soft bodies and jointed legs. As they grow, they molt, shedding their hard outer covering. Arthropods have special sense organs, called antennae, attached to their heads, and modified feet at the end of their jointed legs. Some of these modifications include claw-like hands that allow arthropods to grab prey or surfaces for climbing. All arthropods lay eggs to reproduce. Students should know the basic features of all arthropods, and be able to distinguish between the three types of arthropods: crustaceans, arachnids, and insects.

Crustaceans, such as barnacles, crabs, lobsters, crawfish, and shrimp, are arthropods that are usually found in water. Their bodies are divided into two or more sections, and they have ten legs, five on each side of their body. The front legs have claws for grabbing prey or surfaces.

Arachnids are spiders, ticks, and scorpions that have eight jointed legs, four on each side of the body. Their bodies are divided into two parts. The front part has a mouth with fang-like structures. Arachnids have venom, or poison, that they use on their prey.

Insects are the most plentiful arthropod. Insects have three pairs of legs, and three distinct body parts. Most insects also have two pairs of wings. Many insects live in colonies and have mouths built for piercing or sucking.

Example 1: Which of these living things is an arthropod?

Answer: The crab. The dolphin and snake are not arthropods since they do not have hard exoskeletons or jointed legs. The seaweed is a plant, not an animal. The crab has an exoskeleton and jointed legs which are characteristics of arthropods.

Example 2: Which of these is an arachnid?

snake **tarantula** **barnacle** **hermit crab**

Answer: The tarantula. The barnacle and hermit crab are crustaceans. The snake is not an arthropod, but is a reptile.

To help students learn about the variety of arthropods and their characteristics, students can cut out pictures of different arthropods and group them according to their characteristics. Students can research some of the arthropods native to their environment and observe them, being careful not to harm themselves or the animals.

Fish, Reptiles, Amphibians

Fish, reptiles, and amphibians are cold-blooded animals. This means their bodies do not maintain a regular body temperature. They must rely on the surrounding environment to warm up or cool down. Students should know the basic characteristics of fish, reptiles, and amphibians, and be able to distinguish among them.

Fish are animals that live in fresh or salt water. There are many species of fish, but all fish share certain characteristics. All fish breathe underwater using gills on the sides of their bodies, and all fish have fins, which help them move about in the water. Sharks are fish and the whale shark is the largest fish in the ocean. Most fish reproduce by laying eggs, but some give birth to live offspring.

Reptiles are a very diverse group of animals that includes snakes, lizards, alligators, crocodiles, and turtles. All reptiles have scaly, dry skin and tails. Turtles have very hard scales that form a shell on their body. As they grow, reptiles molt, or shed, their outer skin, replacing old scales with new ones. Most reptiles have legs, but snakes do not. All reptiles breathe using lungs. Most reptiles lay leathery-shelled eggs to reproduce, but some reptiles give birth to live offspring.

Amphibians are animals such as frogs, toads, and salamanders. The skin of these animals is smooth and moist. All amphibians are born from eggs laid underwater. They hatch first as fish, complete with fins and gills. In their next stage of growth, they grow legs. Finally, the fins disappear, lungs replace the gills, and the amphibian emerges from the water to live on land and breathe air. Adult amphibians continue to live near watery areas as they get older.

Example: Which of these living things is a reptile?

alligator whale frog goldfish

Answer: The alligator. The frog is an amphibian because of its skin texture and the way it was born. The goldfish is a fish due to its body structure and the fact that it breathes underwater with gills. The whale is a mammal, having no characteristics of reptiles at all. The alligator has the rough, dry skin of a reptile and began its life in a leathery-shelled egg. The alligator is the only reptile in the group.

To help learn about these animals and their different characteristics, students can cut out pictures of different fish, reptiles, and amphibians and group them according to their characteristics. Students can research some of the fish, reptiles and amphibians native to their environment and study them, being careful not to harm themselves or the animals.

Birds and Mammals

Birds and mammals are warm-blooded animals. This means their bodies keep a regular temperature by cooling or heating themselves from the inside. Mammals and birds breathe air using lungs. Air enters their bodies through a nose or blowhole, and lungs help the animal get the oxygen it needs from the air it breathes. Students should know the basic characteristics of birds and mammals and be able to distinguish between them.

Birds are animals that have feathers covering most of their body. They also have wings, usually for flight. Certain birds, like the ostrich, cannot fly because their bodies are too large and their wings are too small. Feathers provide covering for the bird's body and are somewhat water repellent and insulating. Feathers also help with flight. The bones in the skeleton of a bird are light, making flight easier. All birds have hard beaks in front of their mouths that they use to feed themselves, as well as special adaptations on their feet to help them walk, wade, perch, or grab prey. All birds reproduce by laying eggs.

Mammals are animals that have fur, or hair, covering the outside of their bodies. Fur provides warmth for the animals. Bears, cats, dogs, rodents, deer, elephants, apes, and monkeys are some examples of mammals. Mammals usually have live births and nurse (feed) their young with milk made within their bodies. Humans are mammals because we share these characteristics with other mammals. Whales and dolphins are mammals that live in the ocean. The duck-billed platypus and the spiny anteater from Australia are mammals that have fur and nurse their young, but they give birth by laying eggs.

Example: Which of these animals is NOT a bird?

Answer: The butterfly. The songbird, hawk, and ostrich are all birds since they have feathers. The

butterfly has wings, but has no feathers. The butterfly is an insect, not a bird.

To help students learn about these animals and their characteristics, students can cut out pictures of different birds and mammals and group them according to their characteristics. Students can research some of the birds and mammals native to their environment and observe them, being careful not to harm themselves or the animals.

Life Cycles - B

Animals reproduce, or make more of their kind, at different rates and in different ways. Some animals have live births while other animals lay eggs. All birds, most reptiles, amphibians, insects, arachnids, mollusks, and fish lay eggs to reproduce. Their eggs come in many shapes, colors, and sizes, and the way animals lay and care for their eggs varies. Spiders wrap their eggs in silky web sacks. Birds build nests to hold their eggs and cover them with their bodies to help keep them warm. Some fish and insects lay their eggs attached to plants or rocks, while other fish and insects scatter their eggs in many places. Some insects, like bees, build nests, called hives, where they lay their eggs. Amphibians always lay their eggs underwater, while reptiles lay leathery-shelled eggs on land. Students should be able to identify animals that lay eggs to reproduce, as well as where and how those eggs are laid.

Example 1: Which of these animals does NOT reproduce by laying eggs?

birds bees butterflies bears

Answer: Bears. Birds lay eggs to reproduce. Bees and butterflies are insects, which also lay eggs to reproduce. Bears are mammals, and they have live births rather than lay eggs.

When insects and amphibians hatch from eggs, they go through stages of growth during which their bodies change dramatically. This process of change is called metamorphosis. Each of the stages of metamorphosis has a name. Students should know the stages of metamorphosis and be able to sequence the stages in their proper order.

When young insects first emerge, they look like a soft worm, called a larva. The larva needs food that is easy to get, because the larva cannot move around very much. Many insects surround their larvae with food, like bees do with honey, so that each larva is protected and can eat when it wants. When the larva enters the next stage, it becomes a pupa. As a pupa, the young insect grows body parts necessary to protect it. With butterflies, the pupa is covered with a hard coating, or cocoon. Not all insects have a cocoon at the pupa stage. When the insect emerges from the pupa stage, it becomes an adult and is able to reproduce.

Amphibians, such as frogs, toads, and salamanders, have different names for their stages of metamorphosis. When amphibians emerge from the egg they are tadpoles, and resemble fish. Then, they grow legs and lungs in their next stage before emerging from the water as adults.

Example 2: Put these stages of insect metamorphosis in order:

1 - pupa
2 - adult
3 - larva
4 - egg

Answer: 4 - 3 - 1 - 2. First the insect hatches from the egg (4), then it is a larva (3), then becomes a pupa (1),

and finally, an adult (2).

These activities will help students learn about the stages of metamorphosis:

Activity 1: Have students make flashcards with the stages of insect or amphibian metamorphosis drawn on one side, and the name of the stage on the other. Students should be able to sequence the stages of metamorphosis, associate the stage with its name, and know what types of animals undergo metamorphosis.

Activity 2: Encourage students to watch metamorphic changes in insects and amphibians in the wild, in a tank, or in a bug box, being careful not to harm themselves or the animals.

Activity 3: Using pictures of animals, have students sort them into the two ways they reproduce: by live birth, or by egg.

Invertebrates and Vertebrates

Students should understand that animals are organized into two categories, vertebrates and invertebrates. Vertebrates are animals that have a backbone and invertebrates are animals that do not have a backbone.

Vertebrates have an endoskeleton, which is an internal skeleton that supports and protects the organism's body. Vertebrates, such as humans, dogs, snakes, fish, and birds, can be further categorized as warm-blooded or cold-blooded vertebrates. A warm-blooded animal maintains its own body temperature. Humans and dogs have a specific body temperature because their own energy is used to keep it constant. Cold-blooded animals have a body temperature that is controlled by the temperature of their surroundings. Snakes and fish are both cold-blooded vertebrates. To keep their bodies warm, they must live in warm environments or bask (lay) in the sun.

Invertebrates do not have an internal skeleton. Many invertebrates have a shell, or exoskeleton, that protects the organism's soft body. Many types of invertebrates live in the ocean, such as sponges, coral, starfish, sea anemone, jellyfish, crabs, octopi, clams, and snails. The largest and most common group of invertebrates is the insects.

Example: Which of the following is an invertebrate?

A. snake
B. bird
C. octopus
D. fish

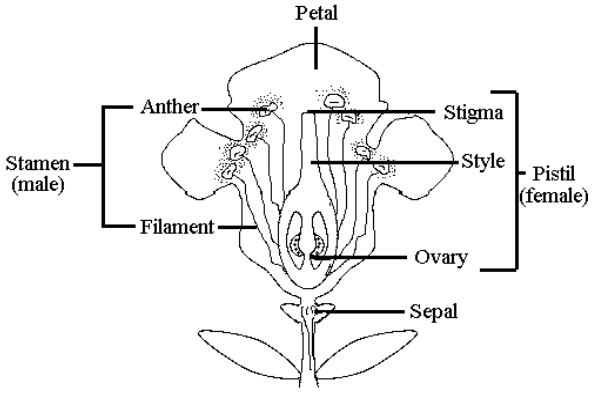
Answer: C. The octopus does not have a backbone, so it is an invertebrate. The snake, bird, and fish all have backbones so they are vertebrates.

To learn more about vertebrates and invertebrates, students can find pictures of animals in books and magazines and classify them as vertebrates or invertebrates, and cold-blooded or warm-blooded.

Flower Parts and Functions

Students should understand the process of reproduction in flowering plants, including the flower parts necessary for reproduction.

The following diagram shows the general shape and location of the parts of a flower.



The petals protect the interior flower parts and attract insects.
The sepal is a small leaf-like part on the bottom of the flower that protects the young flower (bud).
The stamen is the male reproductive structure of the flower and is made up of the anther and filament. It produces powdery pollen grains which are the male sex cells of the flower.
The filament holds up the anther.
The anther produces and holds pollen.
The pistil is the female reproductive structure of the flower and is where seeds are produced. It is made up of three parts: the stigma, style, and ovary.
The stigma is the opening of the ovary.
The style is a tube connecting the stigma to the ovary.
The ovary is where the eggs, the female sex cells of the flower, and seeds are produced.

Flowering plant reproduction begins with a process called pollination, during which pollen is carried to the stigma by wind, insects, or other means. Insects and other animals often carry pollen between flowers. They are attracted to the petals' bright colors and perfumes. After pollination, the pollen grain makes its way down the style into the ovary. Once in the ovary, the pollen grain will unite with the egg. This union is called fertilization. After fertilization, seeds begin to develop inside the ovary. As the seeds grow, the ovary swells and hardens to protect the seeds.

To study the process of plant reproduction, students can make a flow chart showing the steps of reproduction, including the parts of the flower involved. Also, students can find various flower samples and identify their parts. The interior parts of a flower can be observed by removing one or two petals. Different flowers have different forms of flower structures. After identifying the structures inside the flowers, students should discuss each structure's role in reproduction.

Energy Pyramid

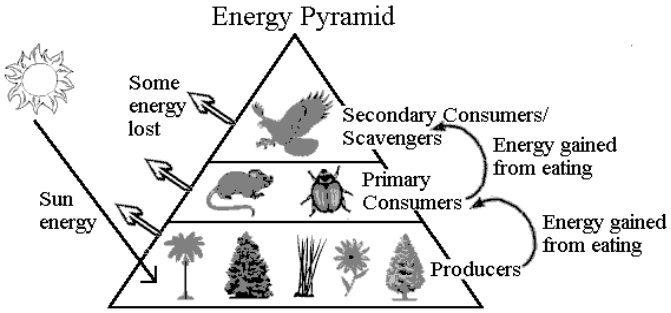
The energy pyramid is a model that shows the relationships between trophic levels in an environment and the amount of energy that is passed from organism to organism. A trophic level is a group of organisms performing a specific role in an environment. The trophic levels are producers, primary and secondary consumers, and scavengers.

Students should know the definitions and apply an understanding of the energy relationships between primary and secondary consumers, producers, and scavengers.

Producers are plants; they make their own food from the sun. A consumer is an organism that cannot make its own food, so it feeds on plants or other animals. Primary consumers eat only producers and secondary consumers eat other consumers. A scavenger is a secondary consumer that feeds on dead or decaying organisms. Here are some examples of the interactions between these trophic levels:

A sparrow (secondary consumer) eats a seed (producer).
A vulture (scavenger) eats a dead lion (secondary consumer).
An owl (secondary consumer) eats a mouse (primary consumer).
A mouse (primary consumer) eats grass (producer).

An energy pyramid shows most of these relationships in pyramid form. Producers are on the bottom of the energy pyramid. They get all of their energy from the sun. The next level is the primary consumers. They get their energy from eating the producers, but there is less energy at this level because some energy was lost in the exchange as heat. Secondary consumers get energy from eating primary consumers. There is the least amount of energy at the top level of the pyramid because energy is lost in each exchange. As you can see in the following diagram, the higher you go in the pyramid, the less the amount of energy.



To study energy pyramids, students can cut out pictures of plants and animals from magazines and classify them as producers, primary consumers, secondary consumers, or scavengers. On a piece of blank paper, they can create their own energy pyramid by pasting the organisms in the proper trophic level and labeling the trophic levels on the pyramid.

Producers, Consumers, and Decomposers

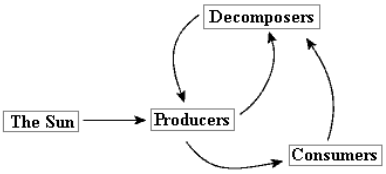
Students should apply an understanding of producers, consumers, and decomposers, including the three types of consumers.

Plants are known as producers since they get energy from the sun to produce their own food. Animals cannot make their own food, and therefore must eat other animals or plants for energy, which makes them consumers. Hawks, snakes, birds, caterpillars, and mice are all consumers because they must eat other organisms to get the energy they need to live. There are three types of consumers, and they can be distinguished by the kinds of foods they eat. These types are herbivores, carnivores, and omnivores. If an organism eats only plants, it is called an herbivore. Deer, cows, elephants, and most insects are herbivores. Organisms that eat only animals are called carnivores. Lions, cheetahs, sharks, wolves, hawks, and owls are carnivores. If an organism eats both plants and animals, it is an omnivore. Humans, bears, and chimpanzees are omnivores.

Decomposers are organisms that get their energy from dead plants and animals. They decay, or break down, dead organisms and then return nutrients to the environment. As decomposers break down the

tissues of dead plants and animals, which contain nitrogen, they return the nitrogen to the soil as nitrates, a form of nitrogen that can be used by plants. Plants need nitrates to grow and they get the nitrates they need out of the soil. Moist, dark soil is rich in organic material, so it is where most decomposers live and where nitrate content is high. When dead organisms decay, they also release carbon dioxide back into the atmosphere. This is very beneficial to plants because they use carbon dioxide to make food. Mushrooms, molds, yeasts, and certain types of bacteria are all decomposers.

This energy relationship in an ecosystem is illustrated in the diagram below.



To learn about producers, consumers, decomposers, herbivores, omnivores, and carnivores, students can find examples of various organisms in textbooks or magazines and discuss which are producers, which are consumers, which are decomposers, and explain why. Also, students can make a chart listing the names of some animals. After researching the foods each animal eats, have students list next to each animal whether it is an herbivore, carnivore, or omnivore.

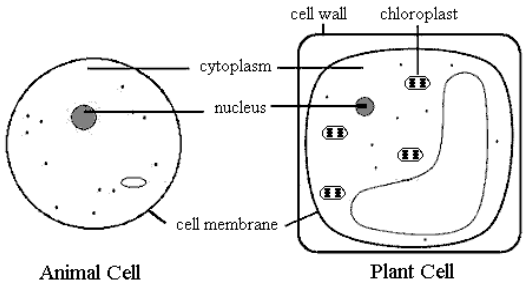
Basic Cells

Students should be able to identify cell parts, including the nucleus, cell membrane, cell wall, chloroplasts, and cytoplasm, to know each of their functions, and to understand the differences between plant and animal cells.

A cell is the basic, smallest unit of life. All living things are composed of cells, though some are composed of only one cell and others have millions of cells. Unicellular organisms are composed of only one cell. Protists like diatoms, amoebae, and paramecia are unicellular. Multicellular organisms have many cells. Plants, fungi, and animals are multicellular organisms.

Cells reproduce by dividing. Cell division is the process by which cells split to create more cells. During cell division, genetic information is copied inside cells and passed along to new cells. In multicellular organisms, cells reproduce in order to grow and repair themselves. Unicellular organisms reproduce in order to make more of their kind.

All cells contain parts that have specific functions. Plant cells and animal cells contain basically the same parts, with a few exceptions. Since plant cells photosynthesize, they contain chloroplasts, while animal cells do not. Plant cells also have cell walls to help give the plant support. These two types of cells are labeled in the following diagrams.



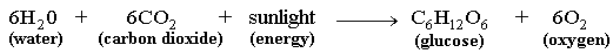
The cell membrane is the outer layer of the cell that protects the cell and allows some materials to pass

in and out of it.
The cell wall is an extra layer on the outside of a plant cell that is thick to give the plant support.
The nucleus is on the inside of the cell, controls the functions of the cell, and holds the genetic information.
The cytoplasm is a thick, jelly-like substance inside the cell in which all of the cell parts are suspended.
Chloroplasts are found in plant cells. They are where photosynthesis occurs. Photosynthesis is a process by which plants make sugars using the sun's energy.

One way to study unicellular and multicellular organisms is to make a table of names and descriptions of some unicellular organisms and some multicellular organisms. Students can study cell parts and their functions by drawing a plant cell and an animal cell and labeling the parts. A short description of the function of each can be written next to the name of each cell part.

Photosynthesis - A
Students should understand the purpose as well as the products and reactants of photosynthesis, what chlorophyll is, and how photosynthesis is beneficial to other organisms.

Photosynthesis is the process where plants convert sunlight into food. This process is very important because it not only provides plants with energy, it also produces most of the oxygen animals need to breathe. The reactants, or materials that are needed for this process to begin, are water and carbon dioxide. Sunlight hits the leaf of a plant and enters the cells. Inside plant cells is a green pigment called chlorophyll. Plants appear green because of the presence of chlorophyll. Chlorophyll captures the energy in sunlight to help convert water and carbon dioxide into glucose (sugar) and oxygen. The glucose is stored in the plant and used for energy while the oxygen is released into the air. The reaction of photosynthesis is shown in the following diagram.



Photosynthesis

To study photosynthesis, students can make a diagram or flow chart of the process, including all of the substances and structures involved.

Survival of the Fittest
Students should understand that organisms must adapt to their changing environments to insure their continued survival. "Survival of the fittest" is the idea that only the organisms with characteristics best suited to the environment will survive. Color, body structures, and speed are some of the alterations, or changes, that organisms have developed over time to survive. These adjustments in structures or habits are called adaptations.

If a rabbit is slow, it will not be able to escape an owl that is hunting it. Therefore, fast rabbits have a much better chance of survival and there will eventually be more fast rabbits than slow rabbits. If an area that used to be very dry is now wet and swampy, organisms in that environment, birds for example, must change if they want to continue living there. Having longer legs would help the birds wade in the swamp after food. The birds may adapt over time as the ones with longer legs have a higher survival rate than those with shorter legs. Well-adapted organisms survive and reproduce more of their kind.

Camouflage helps organisms survive. When organisms blend in with their surroundings, predators have

difficulty finding them and killing them. An organism that stands out will be found and hunted more easily and eventually there will be fewer, or none, of that particular kind. Stick bugs, chameleons, and zebras have developed color adaptations to help them escape predators.

To learn about the idea of survival of the fittest, students can look at pictures of a variety of organisms and identify any adaptations they have that help them survive.

Pollution

Students should know the main causes and effects of air, water, and soil pollution.

Air pollution is mainly caused by the burning of fossil fuels for energy. Cars, factories, and electricity plants that use oil, coal, or gas put harmful chemicals into the air. Besides contaminating the air needed to breathe, air pollution has two other major effects: the creation of acid rain and the destruction of the ozone layer. Acid rain is rain that contains harmful chemicals that kill plants, poison water, and eat away at rock, plastic, and metal. The ozone layer is also affected by air pollution. The ozone layer in the upper atmosphere acts like a blanket around the earth, protecting the earth from receiving too much of the sun's radiation. Air polluting chemicals destroy the ozone layer, allowing excess radiation to make its way to the earth's surface. Too much radiation can cause sunburns, skin cancer, and can overheat the earth.

Another type of pollution is water pollution. The water used by humans and other animals can become polluted in many ways. Wastes and chemicals are sometimes spilled or dumped directly into lakes, streams, and rivers. Trash on the ground, called litter, can also wash into water supplies and contaminate the water. Fertilizers and pesticides used on lawns and farms can seep into underground water supplies (groundwater). Many fertilizers and nutrients can also get into ponds and lakes and cause algae to grow. The algae eventually overpopulates the area and uses up much of the oxygen in the water, thereby killing other organisms in the water.

Soil pollution results from litter, landfills (where trash is buried), chemical spills, and any other hazardous waste getting into the soil. Hazardous waste is any waste material that is poisonous, can react with other substances, or can burn easily. If the soil is contaminated with hazardous waste, plants that grow in it absorb the chemicals, and those hazardous chemicals are passed on to humans and other animals when the plants are eaten. Pollution in the soil can become water pollution if the pollutant seeps through the soil into the groundwater.

Students can research areas in their community that may have become polluted, observe the effects of the pollution, and discuss solutions. Students can also make a list all of the litter they see on the ground in one day.

Natural Selection

Students should know that the theory of natural selection was developed by Charles Darwin and be able to explain his ideas on how organisms change over time to survive in a changing environment.

The British scientist, Charles Darwin, argued that an organism has a special trait, or characteristic, that helps it survive, like blending into the surroundings or the ability to run quickly to get away from predators. Because it survives, an organism is able to reproduce and pass on the traits that enabled it to survive to its offspring. Darwin called this process natural selection.

If there is a species of varying brownish-white mice that live in the forest, the individuals that are mostly white will not survive as well as the ones that are primarily brown. The mostly white ones will stand out more in the

dark forest and owls will hunt them more easily. This means that the mostly brown mice will live to reproduce and the white ones will not. The offspring of these mostly brown mice will be mostly brown as well. Eventually, mostly brown mice will exist in this forest and primarily white mice will become rare. The change in a species' characteristics develop over very long periods of time because there are only slight changes in the organisms which must be passed down through many generations.

Fossils are hardened plant or animal remains and prints from long ago. Scientists believe that fossils show that many species of living things have gradually changed over time, or have become extinct, due to natural selection. When an organism becomes extinct, every member of that particular type dies and there are no more left on earth. If a species is unable to survive and produce more offspring, its numbers decrease, while a species better suited to the environment survives to reproduce.

To understand how Darwin applied the theory of natural selection, students can look at pictures of animals and different environments and discuss which would survive the best in each environment. They can also discuss what would happen to animals that are not well suited to their environment.

Population

Students should understand the biotic and abiotic factors that impact population sizes in an environment, including the concepts of sustainability, limiting factors, biotic potential, and carrying capacity.

Living things in an environment, such as trees and animals, are called biotic factors. Non-living parts of an environment, such as amount of sunlight, climate, soil, and cleanliness of the air, are called abiotic factors. A population is a group of the same type of organism in an ecosystem. Populations increase and decrease in number, based on the birth rates as well as how long organisms survive.

A limiting factor is a specific biotic or abiotic factor that stops a population from increasing. Sometimes an area has plenty of water, space, and clean soil, but there are not enough mice for the owls to eat. The lack of food may be the limiting factor for the owl population, because without food, fewer owls will survive and the population will decrease. After a few seasons, the mouse population may increase because there are fewer owls to kill them. The mouse population could reach its biotic potential, where the conditions of the environment are just right for the maximum capacity of mice to survive and reproduce. If too many mice are present though, the population may reach carrying capacity. The carrying capacity is the maximum population size that an ecosystem can support before food, water, shelter, or space begin to run out. These shortages will eventually affect reproduction and survival, and therefore limit the population.

Sustainability is the ability to maintain, support, or provide for something. An environment reaches sustainability when there are enough resources, space, and diversity so that the needs of all organisms are being met. Sustainability in an environment is important because it means an environment can allow many different organisms to survive for a long time. Without sustainability in an environment, population numbers fluctuate greatly or carrying capacity is reached quickly.

Example: Eagles eat fish. If the lake in the eagles' habitat becomes extremely polluted, how will the eagle population be affected?

A. The eagle population will increase.
B. The eagle population will decrease.
C. The eagle population will stay the same.
D. The eagle population will reach their biotic potential.

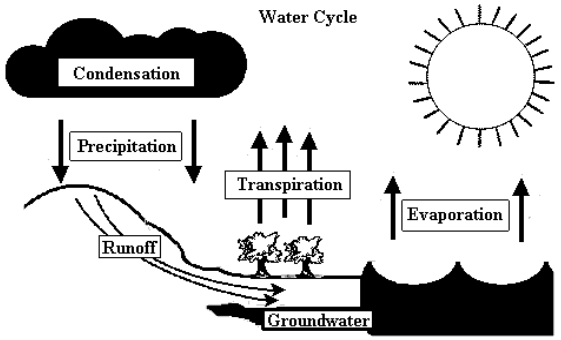
Answer: B. If the lake is extremely polluted, the fish that live there will die. Since the lake is in the eagles' habitat and is where they get fish, the eagles will not have enough food. This will decrease the eagle population.

To understand populations and how they change, students can write a short story about a specific environment and the changes in a population there. They should include details about both biotic and abiotic limiting factors, effects on other organisms in the environment, and when the population may have been at its biotic potential or carrying capacity. Students should try to focus on one or two types of organisms instead of all organisms in the environment.

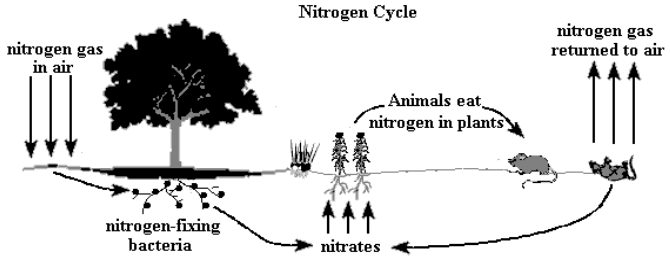
Material Cycles

Students should understand how materials in the environment, such as water, nitrogen, carbon, and oxygen, are distributed, replenished, and cycled. In addition, students should understand the impact of environmental changes on the material cycles.

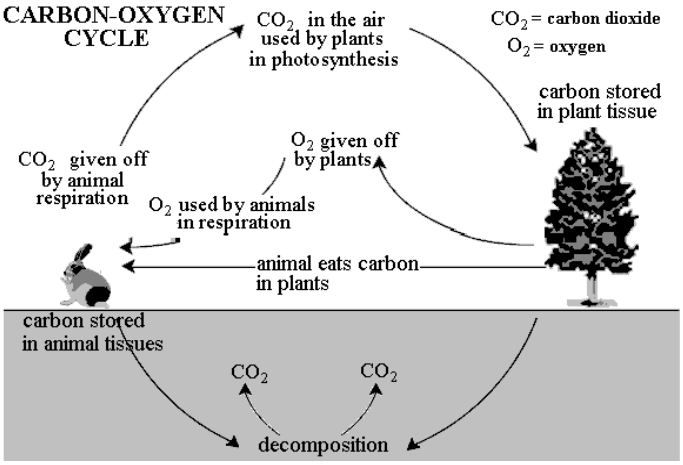
One example of a material cycle is the water cycle. Water from oceans and lakes is heated by the sun and turns into water vapor, a gas, in a process called evaporation. The vapor enters the atmosphere, cools, and turns into droplets, called condensation. Condensation is what forms clouds. The clouds move over land and release snow, hail, or rain, called precipitation. As the water falls to earth, several things can happen. Some of the water runs off the land into streams or rivers, or it seeps into the soil to become groundwater. Groundwater is water that is found underground in spaces between soil particles or rocks. The streams and rivers eventually empty water back into lakes or oceans. Water can also seep into the ground where plants absorb and use it. As water is used by plants, it reenters the atmosphere through transpiration, a process where plants give off water vapor. As water evaporates, the process repeats itself. The following is an illustration of the water cycle.



All living things need nitrogen to live. Though our atmosphere is about 78% nitrogen, it is not in a form useable to many organisms. In the nitrogen cycle, nitrogen gas in the air is converted to useable nitrogen. This process begins with bacteria in the soil and on the roots of plants. These bacteria, called nitrogen-fixing bacteria, use the nitrogen in the air and convert it to nitrates in the soil. Nitrates are nitrogen compounds that can be used by plants. Plants absorb the nitrates from the soil to use in photosynthesis, a process by which plants make their own food. Animals get the nitrogen they need from the plants that they eat. When plants and animals die or produce waste, decomposers in the soil break down the material and convert it to nitrates. Some of the nitrates are broken down further by other bacteria, which release nitrogen gas back into the atmosphere. The following is an illustration of the nitrogen cycle.



The carbon and oxygen cycles work together because both elements are combined in our air as carbon dioxide. The carbon from carbon dioxide is used by plants in photosynthesis, and oxygen is given off during the process. Oxygen is used by animals and plants in respiration, or breathing, and carbon dioxide is released. Respiration is the process where the cells exchange gasses with the environment. Like nitrogen, carbon is also stored in plant tissues, which are then eaten by animals. After organisms die, their decomposed tissues release carbon dioxide into the atmosphere. The following is an illustration of the carbon and oxygen cycle.



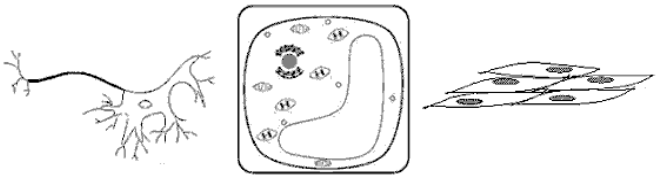
Any change that effects the materials involved in these cycles can in turn affect the environment in some way. For instance, if all of the plants in an area were removed due to clear cutting or development, the water cycle would be affected. Transpiration, an integral part of the water cycle, would not take place in that area. The nitrogen cycle would be affected because there would be no plant roots to convert nitrogen in the air to useable nitrogen in the soil. Also, animals in the area would not have plants to eat in order to obtain the nitrogen they need. Finally, the carbon and oxygen cycle would be disrupted in that area. Since there is no photosynthesizing plants, there is no oxygen production.

To understand material cycles, students can draw a diagram of each of the cycles, showing all materials and where they originate. All the underlined terms discussed here should be included.

Hierarchy of Body Systems

Cells are the smallest units of life. Though it contains even smaller parts, a cell is the smallest unit of life that undergoes all life processes. Students should know that multicellular organisms (organisms with many cells) are made up of various types of cells with specific functions. The structures of each type of cell help them to perform their functions. Cell adaptation to a specific role in the organism is called specialization. Specialized cells are the basic unit that form other structures in the body, including tissues, organs, systems, and organisms. Students should understand these structures and how they are organized.

The following cells look different because they are specialized to perform different roles:



Nerve Cell Plant Cell Muscle Cells

Nerve cells must pick up signals from the senses and carry them to other parts of the body. Nerve cells have long filaments that help them spread throughout a larger area, reaching all parts of the body. This lets the nerve cell pick up signals. Plant cells must make food or energy for the plant and give the plant structure to stand upright. Plant cells contain chloroplasts, which are green structures that allow them to make sugars, giving the plant energy. Plant cells are surrounded by a cell wall, a rigid layer of strong material that helps give the plant more support. Muscle cells contain many special structures that allow them to use a lot of energy. Muscle cells lie close together, in long fibers, in order to work together more effectively.

Similar cells that perform the same functions organize to form tissues. Different types of cells form different tissues. For example, muscle tissue is made of muscle cells, and root tissue in a plant is made of root cells. Although it is in liquid form, blood is considered a tissue because it is made up of blood cells. Different types of tissues are organized to form organs, which have specific functions. The stomach, eye, heart, and lungs are all organs that contain more than one type of tissue. When two or more organs work together for a greater function, they form a system. The brain, spinal cord, eyes, nose, ears, and tongue are all organs that work together to make up the nervous system. Some other systems of the human body are the digestive, muscular, circulatory, and respiratory systems. When a group of systems work together, they form a whole organism.

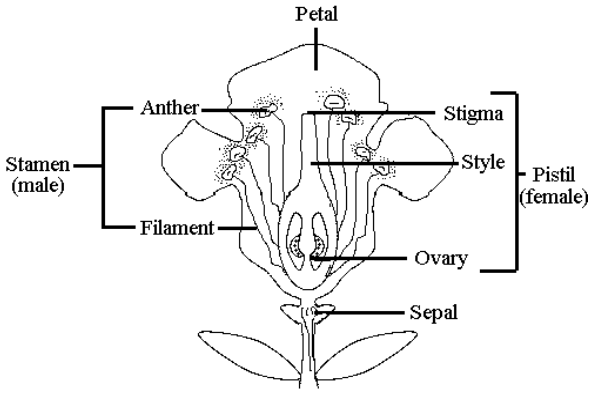
These are two examples of the levels of organization:
Muscle cells make muscle tissue that forms the calf muscle (organ), which is part of the muscular system, a system in a human (organism).
Skin cells make covering tissue that forms the intestines (organ), which is part of the digestive system, a system in a dog (organism).

To learn about cell specialization, students can look at pictures of cells, note their special characteristics, and discuss how those characteristics can help the cell perform certain functions. To learn about the hierarchy of body systems, students can make flow charts showing the relationship between the levels of organization in an organism.

Plant Reproduction

Students should understand that plants reproduce by making seeds or spores. Flowering plants produce seeds through a process involving pollination. Some organisms that do not have flowers, like mushrooms and ferns, reproduce with cells called spores. Students should understand the process and flower parts necessary for plant reproduction, as well as how environmental changes can affect the life cycle of a flowering plant.

The following diagram shows the parts of a flower involved in plant reproduction and seed production:



The stamen produces pollen, the male sex cells of the flower. The anther and filament make up the stamen, the male reproductive structure of the flower. The anther holds the pollen, while the filament holds up the anther. The pistil, which is the female reproductive structure of the flower, has three parts: the stigma, style, and ovary. Reproduction begins with a process called pollination, where pollen is carried to the stigma by wind, insects, or by other means, and makes its way down the style into the ovary. The ovary is where the egg, the female sex cell of the flower, is produced. Once in the ovary, the pollen grain will unite with the egg. This union is called fertilization. After fertilization, seeds begin to develop inside the ovary. As the seeds grow, the ovary swells and hardens to protect the seeds. The petals of a flower protect the reproductive structures inside the flower and attract animals that help in pollination. Insects and other animals that carry pollen between flowers are attracted to the petals' bright colors and perfumes.

Any environmental change that affects a flower's ability to pollinate, distribute seeds, or otherwise reproduce, will affect the plant's life cycle. Certain environmental conditions must be right for a flowering plant to reproduce. For instance, if the weather is very cold and there are no insects or other pollinators in the area, a flowering plant may not be able to pollinate. This means the plant will not be able to reproduce. It may be springtime before insects return and pollinate the flower, allowing it to reproduce.

To study the process of plant reproduction, students can make a flow chart of the steps of reproduction, including the parts of the flower involved. Also, students can find various flower samples and identify their parts. The interior parts of a flower can be observed by removing one or two petals. Different flowers have different forms of the flower structures. After identifying the structures inside the flowers, students should discuss their functions in reproduction.

Organism Interactions

Students should know the definition of symbiosis and apply an understanding of these symbiotic relationships: mutualism, parasitism, and commensalism. Students should also be able to recognize acts of cooperation, predation, and competition among animals.

Organisms in a habitat interact constantly. Sometimes these interactions are helpful to a particular organism, sometimes they are harmful, and sometimes the organism is not affected at all, but these interactions are all an important part of keeping an ecosystem functioning. When two organisms of a different species interact with each other it is called symbiosis. There are three types of symbiotic relationships: mutualism, parasitism, and commensalism.

Mutualism is a relationship that benefits both organisms involved. Birds sit on the backs of water buffalo and

eat insects off of them. This allows the birds to get food, and protects the water buffalo from getting insect bites. When one organism benefits from a relationship but the other organism is harmed, it is called parasitism. Mistletoe is a parasitic plant because it grows on a tree and takes the tree's water and nutrients. Eventually, the tree may weaken and die because it doesn't get enough water and nutrients. Commensalism is when one organism benefits from the relationship while the other organism is not affected. Remora are fish that attach themselves to the fins of sharks. This is good for the remora because they get food scraps from the shark and they get carried through the ocean, but they don't affect the shark at all.

Cooperation can occur in ecosystems when two or more organisms of possibly the same species act in order to get benefits from one another. For example, fish swim together in schools to protect themselves against predators. Another way organisms interact is through competition. Since many organisms may have the same needs and there may only be a limited amount of material in the ecosystem, they must compete for food, water, shelter, or space. Both organisms are adversely affected. Acts of predation, when a predator hunts prey, sometimes bring about competition among organisms. An example of this is when a lion catches and eats an antelope. Many other lions, or scavengers like hyenas and vultures, will try to eat the same antelope that was killed by the lion.

Example: A leech attaches itself to a human to drink his blood. What type of relationship is this?

A. mutualism
B. commensalism
C. cooperative
D. parasitism

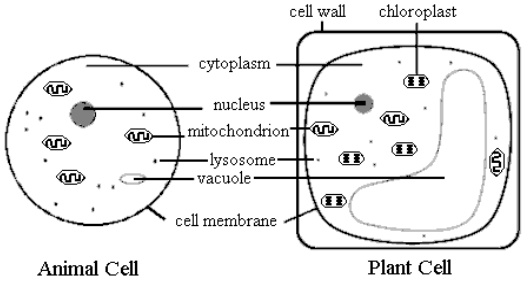
Answer: D. This is a parasitic relationship because the leech benefits by getting food, but the human is harmed because the leech is taking valuable blood away from the human.

Students can study organism interactions by making a table of the above underlined terms and finding examples of these relationships in the community, on television, or on the Internet.

Cell Parts - A

Students should be able to differentiate between a plant and animal cell and know the location and function of the following cell parts: nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosomes, vacuoles, and mitochondria.

The following diagram shows the cell parts, or organelles:



The cell membrane is the layer that surrounds the cell, protects it, and allows some materials to pass in and out of the cell.
The cell wall is an extra layer on the outside of plant cells that is rigid to give the plant support and prevent loss of moisture.

The cytoplasm is a thick jelly-like substance inside the cell in which all of the organelles are suspended.
The nucleus is an organelle on the inside of the cell that controls the functions of the cell and contains genetic material.
Chloroplasts contain green pigments found in all green parts of plants, especially leaves. They are the organelles in plants where photosynthesis, the process in which plants make their food using the sun's energy, occurs.
Vacuoles are used for the storage of water, food, or wastes inside the cell.
Lysosomes contain enzymes to digest materials inside the cell.
Mitochondria provide energy for the cell by breaking down nutrients.

There are a few specific differences between plant cells and animal cells. Animal cells do not have a cell wall and they have small vacuoles or none at all. They also do not have chloroplasts so they cannot make their own food. However, plant cells have a cell wall, large vacuoles, and chloroplasts.

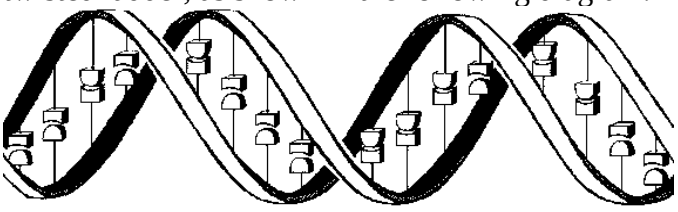
To learn more about cell structure, students can observe the parts of onion cells and skin cells using a hand lens or microscope. Students can draw what they see and label the organelles that can be distinguished. If a hand lens or microscope is not available, you can find several books in the library that have pictures of plant and animal cells. Using the pictures of plant and animal cells, students can note the differences between the two and identify all parts and functions.

DNA, Genes, Chromosomes, Traits

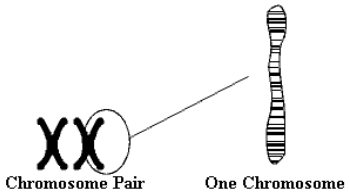
Students should know the basic characteristics of and relationships among DNA, genes, chromosomes, and traits, including the difference between learned and inherited traits.

A trait is a characteristic or feature of an organism. Some traits, like hair color, are inherited from parents when genetic material is passed on during reproduction. Other traits, like how to walk or play the piano, are learned during the life cycle of the animal.

DNA is deoxyribonucleic acid, a chemical found in cells that carries genetic information. It is composed of sugars, phosphates, and nitrogen bases, arranged in the shape of a double helix, or a twisted ladder, as shown in the following diagram.



Genes control heredity, the transfer of characteristics from parents to offspring, and determine the genetic traits that will be expressed. They are segments of DNA.
Chromosomes are structures composed of genes that are linked together; they come in pairs. There are 23 pairs of chromosomes in human cells. The picture below on the right shows a chromosome pair. The picture below on the right shows one chromosome. On this chromosome, there are 50 genes. Each gene is made of DNA.



To study these topics, students can make flash cards that feature the terms and characteristics explained above. Creating and labeling their own DNA molecules will help them understand the structure of DNA. Students can also make a list of their own traits and determine whether each trait is inherited or learned.

Genetics - A

Students should understand that an individual's inherited characteristics, or traits, may be dominant or recessive. Students should also be able to use Punnet squares to determine the probability of offspring expressing a certain trait, including its sex.

Some traits, like eye color and hair color, are determined solely by heredity, while others, like intelligence and musical ability, may be influenced by outside factors. Inherited traits can be dominant or recessive. In most situations, dominant traits are expressed if they are present and recessive traits are only expressed if the dominant trait is not present.

Alleles are letters that represent particular forms of a trait, capital letters for dominant traits and lowercase letters for recessive traits. For example, if you are looking at the gene for the ability to roll your tongue, an "R" may represent the dominant trait of the ability to roll your tongue and an "r" would represent the recessive trait of not being able to roll your tongue. An individual will have a pair of these alleles like Rr, RR, or rr, representing his or her genotype. These genotypes are a combination of one allele from each parent acquired through sexual reproduction. If the genotype has a dominant allele in it, the individual will express the dominant form of the trait. People with a genotype of Rr or RR will be able to roll their tongue. If only recessive alleles are present, the recessive form of the trait will be expressed. A person with a genotype rr will not be able to roll his or her tongue. The actual trait or characteristic that is expressed is called the phenotype. For example, a genotype of RR will cause a phenotype of the ability to roll the tongue.

Students will also need to know the following terms:
Crossbreeding is the reproduction between two individuals of different breeds or genotypes.
A hybrid is an individual that has a genotype with two different alleles, one dominant and one recessive. Rr is an example of a hybrid genotype.
A purebred has inherited two similar alleles, so their alleles are either both dominant (pure dominant) or both recessive (pure recessive). RR is an example of a pure dominant genotype and rr is an example of a pure recessive genotype.

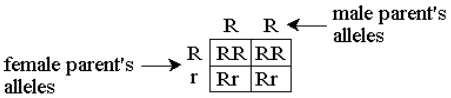
Example 1: Use the following information to determine the genotype of a yellow seed.

The yellow seed is pure dominant.
Y = yellow
y = green

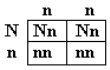
Answer: YY
Students should know that the genotype of a pure dominant yellow seed is YY. Yellow is dominant because it is represented by a capital letter and since the seed is pure dominant, both alleles must be the dominant "Y".

Alleles and genotypes are used to describe the genetic makeup of an individual. They are placed in a chart called a Punnet square, used to find the probability of offspring expressing a certain trait. The

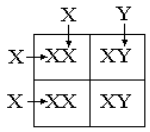
alleles on the outside of the following Punnet square are from the parents' genotypes for tongue rolling. The four different genotypes on the inside represent the possible genotypic combinations for each offspring. The top of the Punnet square is labeled with one parent's genotype, and the side is labeled with the other parent's genotype. In the top left square, the "R" from the mother and the first "R" from the father combine to form RR. The top right square is RR because the "R" from the mother and the second "R" from the father combine. The bottom left square is Rr because the "r" from the mother and the first "R" from the father combine. The bottom right square is Rr because the "r" from the mother and the second "R" from the father combine. In the following Punnet square, the probability of having offspring with a genotype of RR is 50% and having offspring with a hybrid genotype of Rr is also 50%, though all four genotypes will show the same dominant phenotype of the ability to roll their tongue.



Example 2: Using a Punnet square and the following information, find the probability of having a child with cystic fibrosis, a disorder that impairs breathing and digestion.
The mother does not have cystic fibrosis and has a hybrid genotype of Nn.
The father does have cystic fibrosis.
Answer: 50%, or 1/2. Students should know that a Punnet square for this example should look like this:



The mother's genotype is Nn, which means "N" stands for the dominant allele of not having cystic fibrosis because it is a capital letter. The father's genotype is nn because cystic fibrosis is a recessive trait. The only way he can have cystic fibrosis is if both alleles are recessive, and since he is pure recessive, those alleles must both be the lowercase "n". The top of the Punnet square is labeled with one parent's genotype, and the side is labeled with the other parent's genotype. In the top left square, the "N" from the mother and the first "n" from the father combine to form Nn. The top right square is Nn because the "N" from the mother and the second "n" from the father combine. The bottom left square is nn because the "n" from the mother and the first "n" from the father combine. The bottom right square is nn because the "n" from the mother and the second "n" from the father combine. Two of the squares are Nn, which have a phenotype of no cystic fibrosis, and the other two squares are nn, which have a phenotype of cystic fibrosis. The probability of having a child with cystic fibrosis is 50% because two out of four, or one half, of the squares show the phenotype of cystic fibrosis.
The sex of offspring can also be determined using Punnet squares. Males have a genotype of XY and females have a genotype of XX. Neither X nor Y are dominant. Only the presence or absence of a Y chromosome determines sex. Using the following Punnet square, we can see that the two on the right are XX and the two on the left are XY. Since an XX genotype produces a female and XY produces a male, this means parents have a 50% chance of giving birth to a female and a 50% chance of giving birth to a male.

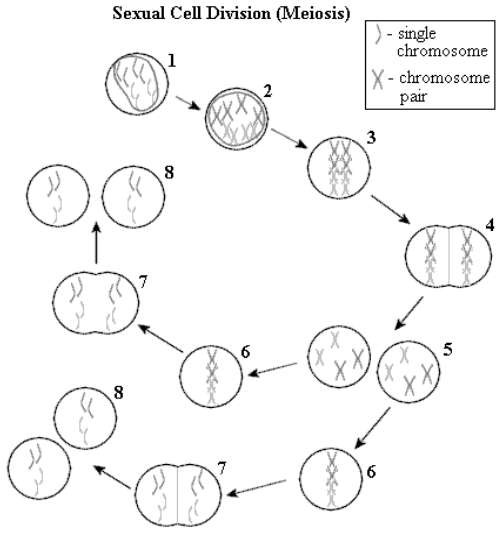


To learn more about heredity, the student can look at pictures of family members and try to guess the genotypes for certain traits by observing the phenotypes. Students can also make some Punnet squares of their own using these genotypes.

Cell Division and Reproduction

Cell division is a reproductive process in which cells divide to create more cells. There are two main types of cell division processes: one for sexual reproduction, known as meiosis, and one for asexual reproduction, known as mitosis. Students should know the similarities, differences, and basic characteristics of sexual and asexual reproduction, including the main steps of the cell division processes.

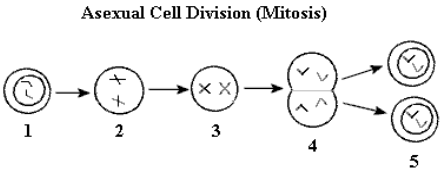
To understand these processes, it is important to understand genes and chromosomes. Genes control heredity, the transfer of characteristics from parents to offspring, and determine the traits that will be expressed. Genes link together to form chromosomes. Chromosomes are the structures that carry genes and are usually found as pairs.Sexual reproduction requires two different sex cells, a sperm and an egg, called gametes. The sperm is the male gamete, and the egg is the female gamete. These two gametes must unite, in a process called fertilization, to produce offspring. If fertilization does not occur, cell division will not begin and the organism will not develop. Gametes only have half the normal number of chromosomes so that when they unite, they produce an organism with the correct amount of genetic material. Since two different gametes from two separate individuals unite in sexual reproduction, the offspring receive a combination of genetic material from each parent. Half the genetic material is from the father, and half is from the mother. This mixing produces variation among the offspring of sexual reproduction. Humans are an example of an organism that reproduces sexually. Meiosis is the sexual cell division process that produces the gametes necessary for sexual reproduction and is shown below with a explanation of each numbered step.



1. This is the original cell that is about to undergo meiosis.
2. The chromosomes duplicate so there are now two copies of each chromosome.
3. The chromosome pairs align.
4. The chromosome pairs separate and the cell begins to divide.
5. The cell has divided into two cells.
6. The chromosomes align.
7. Individual chromosomes separate and the cell begins to divide.
8. The cell has divided into four cells total, each with half the number of chromosomes as the original cell.

Asexual reproduction requires only one cell and is necessary for the growth and repair of cells. This cell division process is called mitosis. During mitosis, the original parent cell will divide into more

cells and will pass on exact copies of its genetic material to its daughter cells. Since there is no contribution of genetic material from another cell, the daughter cells will be identical copies of the parent cell. There is no variation among asexually reproduced offspring. Mushrooms are an example of an organism that can reproduce asexually, with spores, instead of gametes. The asexual cell division process is shown below with a explanation of each numbered step.



1. This is the original (parent) cell about to undergo mitosis.
2. The chromosomes duplicate and begin to move.
3. The chromosome pairs align.
4. The chromosome pairs separate and the cell begins to divide.
5. The cell has divided into two identical cells.

To study this topic, students can make a table that includes all of the characteristics of sexual reproduction and all of the characteristics of asexual reproduction. Also, they can research examples of organisms that reproduce sexually, and ones that reproduce asexually. Finally, students can make a flipbook to show each cell division process. Draw the steps of each process on a separate sheet of paper in the bottom corner. Stack the sheets in reverse order, with the first step on the bottom and the last step on top. When the pages are flipped through quickly, the book will show the process in action.

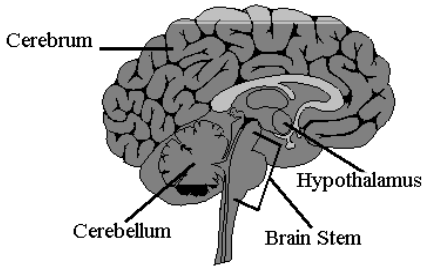
Nervous System - A

Students should be able to identify the central, peripheral, and autonomic nervous systems, the main parts of a neuron and the brain, and recognize reflex actions.

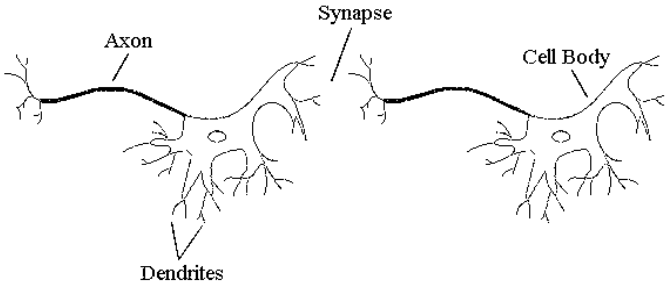
The nervous system controls all of the body's actions and responses. It consists of nerves, the brain, and the spinal cord. Nerves are bundles of neurons, the cells of the nervous system, that carry impulses. An impulse is an electric signal that is sent through the nervous system so that the body can respond to a stimulus. A stimulus is an action or condition that creates a response.

The nervous system can be divided into two major categories: the central nervous system (CNS), which consists of the brain and spinal cord, and the peripheral nervous system (PNS), which consists of all the nerves that extend outside of the central nervous system. The portion of the PNS that controls all of the involuntary actions of the human body, such as the beating of the heart and reflexes, is the autonomic nervous system. Reflexes are involuntary responses to stimuli. An example of a reflex is when your hand automatically pulls back from a hot object that was touched.

The following diagram shows the major parts of the brain:



The cell body is the main part of the nerve cell and contains the nucleus. The axon and dendrites are extensions of the nerve cell that conduct impulses. Finally, the gap between neurons is called the synapse.
The following diagram shows the four basic parts of a neuron:



To study the parts of the nervous system, students can draw and label the parts of a neuron and the brain. Students can also draw a diagram of the nervous system and color code the central, peripheral, and autonomic nervous systems.

Characteristics of Life

Students should understand that there are several characteristics that all living things have in common, including those that occur at the cellular level, and should be able to list these characteristics.

All living things require energy, can reproduce, dispose of wastes, are organized and complex, grow and change, respond to the environment, and are made of one or more cells. Although different organisms may exhibit these characteristics in various ways, they must have all of these characteristics to be considered living.

	Cells	Trees	Cars	Light Bulbs
require energy	✓	✓	✓	✓
can reproduce	✓	✓		
dispose of wastes	✓	✓	✓	
are organized and complex	✓	✓	✓	
grow and change	✓	✓		
respond to the environment	✓	✓	✓	✓
are made of one or more cells	✓	✓		

All organisms require energy so that they can carry out certain life processes, though the method they use to obtain energy varies. For example, organisms can get energy by eating other organisms (animals), absorbing decomposed minerals and nutrients (fungi), or making their own food through a process called photosynthesis (plants). During these processes, organisms produce waste products that must be released. For example, plants release wastes into the air through their leaves. Another process carried out by living things is reproduction. Organisms must reproduce to ensure the continuation of their species. Organisms also grow and change throughout their lives and respond to the environment

for survival. For example, plants may respond to sunlight by growing towards the sun to get more light. Finally, organisms are organized by complex systems that function together to help each organism meet its needs.

All living things are composed of one or more cells (organisms made of one cell are called unicellular, and organisms made of more than one cell are called multicellular), and each cell exhibits the characteristics of life. For instance, all cells require energy to carry out their various functions. Through processes called digestion and respiration, cells are able to obtain valuable nutrients and energy. Waste is produced by cells, and must be disposed of in a process called excretion. Cells are able to reproduce by dividing. Cells are organized by their parts and each part has its own function. Cells can grow, change, and respond to their environment.

Example: Which of the following is NOT a living thing?

copy machine **tree** **mushroom** **paramecium**

Answer: The copy machine. A copy machine may require energy and be able to reproduce, but it is not composed of cells, cannot grow, and cannot dispose of wastes. A tree, a mushroom, and a paramecium can do all of these things. Paramecia are only made of one cell, but they have all the characteristics listed above, so they are considered living things.

To understand the characteristics of living things and the differences between living things and non-living things, students can think of more examples of non-living things that show some, but not all, of these characteristics.

Behavior

Students should understand what behavior is, what causes something to exhibit a behavior, and the two main types of behaviors: learned and innate.

Behavior is the way an organism responds to a stimulus. A stimulus is an action or condition that creates a response. A stimulus can be internal, like a hunger pang, or external, like a cold breeze.

There are two main types of behaviors, those that are learned, and those that are inherited. A learned behavior develops due to interaction with the environment. These are behaviors that are not inherited. An innate behavior is one that an organism is born with and it is inherited from its parents. Involuntary responses and instincts are examples of innate behaviors.

Example: Which of the following is a learned behavior?

A. becoming quiet when your teacher walks into the room
B. naturally pulling your hand away from a hot object
C. your knee jerking when it is hit
D. blinking your eyes

Answer: A. Students do not naturally become quiet when the teacher walks into the room. However, while in school, students may have learned that teachers will tell them to be quiet if they are too loud, so they quiet down when the teacher enters the room. (B), (C), and (D) are innate behaviors, they happen involuntarily or naturally.

Tropisms are the movements or behaviors of plants toward or away from an external stimulus. Examples of these behaviors include flowers opening towards the sun and the growth of roots downward into the ground.

To learn about behavior, students can list some of the behaviors they have exhibited throughout the day and determine if they are learned or innate. Also, students can monitor plants and discuss any tropisms they observe.

Making Conclusions

Students will evaluate the relationship between conclusions and evidence by determining whether or not pieces of evidence support a particular conclusion and determining the best conclusion when given data.

Problems in science can be solved and experiments conducted using a system called the scientific method. The scientific method outlines specific steps to follow in order to reach a solution. The steps are listed below.

Step 1. **Observe** - Observe the problem.
Step 2. **Predict** - Make a prediction based on the observation. Sometimes, this step is combined with step 3 because they are so similar.
Step 3. **Hypothesize** - Form a hypothesis (a statement that is believed to be true) based on the prediction in step 2.
Step 4. **Experiment** - Design an experiment to test the hypothesis, then conduct the experiment.
Step 5. **Record** - Record data and observations during the experiment.
Step 6. **Analyze** - Analyze the data from the experiment.
Step 7. **Conclude** - Determine whether or not the hypothesis is supported by the data from the experiment. If the hypothesis is supported, a conclusion can be reached, and the experiment is complete. If the hypothesis is not supported, then return to step 3 and modify the hypothesis to begin a new experiment.

The purpose of following the scientific method is to reach a conclusion, or decision, about a question based on the information obtained during an experiment. A conclusion is the result of the information gathered at the end of this scientific process. A conclusion is similar to a hypothesis, but it varies in that a hypothesis is a prediction based on observations, and a conclusion is a result that focuses on whether or not the hypothesis is correct, based on evidence. Any information gathered during an experiment is considered evidence whether or not it supports the hypothesis or not. Evidence can also include data gathered that is unrelated to the investigated idea. It is the evidence from an investigation that determines the conclusion.

For example, a student may conduct an experiment about how eating breakfast affects student performance in school. The chart below shows some evidence that could have been gathered during the experiment.

	Days Per Week Student Eats Breakfast	Overall Grade Average
Student 1	7	98 %
Student 2	5	82 %
Student 3	2	65 %
Student 4	0	43 %

After the experiment is complete and the results have been analyzed, the student may form one of the following conclusions:

Eating breakfast causes students to perform well in school.

Eating breakfast causes students to perform better in school than not eating breakfast. These conclusions would be determined by the evidence obtained during the experiment. When forming a conclusion, it is important to take all observations into account. If only one piece of evidence is considered, instead of all of the data from the experiment, then the conclusion can be incorrect or misleading. The conclusion "Eating breakfast speeds up the metabolism of students" would not be a valid one for this experiment. Although this statement may be true, the experiment did not test students' metabolisms and this statement does not directly tell us if eating breakfast affects student performance or not. Relating metabolism and performance goes beyond the scope of the experiment and cannot be determined by the evidence that was gathered. Analyzing the results of an experiment incorrectly can also lead to incorrect conclusions.

Example 1: A researcher conducted an experiment about the relationship between air temperatures and pine tree growth. Three groups of pine trees were used with 100 trees in each group. All of the trees were three feet tall at the beginning of the experiment. The first group of 100 trees was placed in a greenhouse that maintained a temperature of 100º F, the second in a greenhouse with a 60º F temperature, and the third in a greenhouse with a 35º F temperature. After two years, measurements of the trees were recorded. The data is shown in the chart below.

	Greenhouse Temperature	Growth in 2 Years
Group 1	100°F	4 ft
Group 2	60°F	6 ft
Group 3	35°F	11 ft

Which of the following is the best conclusion one could draw from this data?

A. Air temperature does not affect the growth of pine trees.
B. Pine trees show more growth in cooler temperatures.
C. The higher the air temperature, the faster the pine trees will grow.
D. Pine trees need cold air temperatures to grow.

Answer: B. The data shows that the trees in the 35º F greenhouse grew more than those in the 60º F or 100º F greenhouses. (A) is incorrect because the data shows a large difference among the growth of the three groups of trees, so a conclusion that there is no relationship between the growth of pine trees and air temperature is not supported. (C) is incorrect because the data shows that pine trees grew much less in 100º F temperatures than in 35º F temperatures, not more. Finally, (D) is incorrect because the data shows at least some growth in all groups, regardless of temperature, not just in the trees kept in cold temperatures.

After gathering data from an experiment, a person must determine what, if any, pieces of evidence support or disprove a conclusion. If a conclusion is made and the evidence or a piece of the evidence shows what the conclusion has stated, then the evidence supports the conclusion. If the evidence does not show what the conclusion has stated, then the evidence does not support, and may even disprove, the conclusion.

Example 2: Which of the following pieces of evidence goes against the conclusion that the larger a river is, the faster its current?

A. Eight out of the ten rivers measured had very fast currents.
B. The two larger rivers had faster currents than the two smaller rivers.
C. The river with the fastest current was the smallest.

Answer: C. The conclusion states that large rivers have fast currents, but in (C), the smallest stream had the fastest current. That piece of evidence goes against the conclusion. (A) does not give enough information about small rivers to determine whether or not the conclusion is supported. (B) supports the conclusion because the larger rivers did have the fastest currents.

To study the relationship between conclusion and evidence, and to practice determining the best conclusion from data, students can make a conclusions chart. Have the student think of an experiment that he or she has not conducted before, but could do at home. Then, before conducting the experiment, have the student think of several different conclusions that could be drawn from the experiment. The student should write the conclusions in separate rows in the first column. In the column next to each conclusion, the student can write a set of results or evidence that could be obtained from the experiment and that would support the conclusion. After completing the chart, the student should conduct the experiment and record the data obtained that could be used as evidence for a conclusion. Have each student examine the data and decide on the best conclusion that could be drawn from it.

Disease and Impact on Immune System

The three main types of disease-causing pathogens are as follows: those caused by bacteria, by fungi, and by viruses. A person can contract a bacterial, fungal, or viral disease through direct contact with harmful bacteria, fungi, or viruses, and sometimes through inhalation. It is difficult to distinguish among the three types of diseases based on their symptoms. This is because each type can have a variety of symptoms, or they can have similar symptoms. Students will understand different types of diseases, including bacterial, fungal, and viral, as well as how they affect the body's immune system.

Bacteria are single-celled organisms containing genetic material, but having no true nucleus. A nucleus is the part of a cell that contains the genetic material in most cells and controls a cell's activities. When bacteria enter a cell, they either destroy the cell or produce harmful chemicals inside it. Some diseases caused by bacteria include strep throat, pneumonia, meningitis, tuberculosis, tetanus, and cholera. Antibiotics are medicines used to stop the growth of bacteria cells.

Fungi are organisms that obtain food by absorbing nutrients from their surroundings. Fungi usually stay on the surface of the skin and appear as rashes, but they can infect internal organs as well. After the spores (seed-like capsules used for reproduction) of a fungus enter the body, the fungus begins to grow, infecting or damaging the surrounding tissue. Some examples of fungal diseases are athlete's foot, ringworm, and nail fungus. Fungal infections can sometimes go away without any treatment when the immune system is able to combat the infection on its own. Most fungal infections can be treated with anti-fungal creams and medications.

Viruses are cells that need a living host cell to reproduce. After a person comes in contact with a virus, the virus enters a cell and may either disturb the cell's activities or reproduce and kill the cell, resulting in the virus spreading to new cells. If the virus is not destroyed, it can continue to replicate and reinfect the person. Many years after being infected by a virus, the person may experience symptoms of the virus again. Common viruses include influenza (the flu), chicken pox, measles, the West Nile virus, and rabies. Many viruses are prevented with vaccines. Vaccines contain weakened or dead forms of the virus that stimulate the immune system to build up chemicals called antibodies to fight off the virus if the person should come in contact with it. Vaccines are given orally or by injection.

To combat infectious diseases, a healthy immune system locates bacteria, viruses, or fungi and tries to kill them. Antibodies work with white blood cells to destroy these foreign substances. Often, this causes a collection of pus and swelling in the area of infection or other symptoms, such as fever. Once antibodies are released, they

stay in the body. The immune system will be able to fight off the same disease more easily if contracted in the future because more antibodies can be produced.

To study the fundamental concepts of disease, students can research common diseases and make a chart that includes information on whether the disease is caused by bacteria, fungi, or viruses, exactly how the disease is contracted, and how it is treated. Also, to better understand how the immune system is affected by disease, students can make a flow chart with pictures illustrating how the immune system in fights an infection.

Evaluating Models

Models are often used in science. Students will be able to evaluate models.

Sometimes, it is impossible or impractical to use actual objects to explain concepts or to learn facts. For example, a teacher cannot use an actual atom to explain its parts or may not be able to bring a live octopus to the classroom to show how octopi propel themselves in the water. Representations, or models, of these things can be used in their place. Models do not necessarily have to be objects; they can be descriptions or ideas that help understanding. The best models are those that are very similar to the real thing, but all models have slight differences and limitations. Models should be similar to the objects they represent in the aspects that are being explained or taught. For instance, if a teacher wants to discuss an aquifer, which is a source of water that is trapped in spaces between soil particles, a good model might be a sponge because water in a sponge is trapped in its spaces.

To learn how to evaluate models, students can find objects around the house that could represent objects or concepts they have talked about in science class. They should discuss how the model represents characteristics of the real thing. Also, students can write down a list of objects that would not make good models for something and explain why. Then, they can suggest an alternative object or set of objects that would be a better model of the real thing.

Adaptations

An adaptation is a unique trait, or characteristic, that an organism has inherited that improves its chances for survival in its environment or its reproductive success. Students will recognize the various adaptations of plants and animals and understand how they use their adaptations for survival.

A monkey's strong tail is an adaptation that helps it hold onto tree branches. This adaptation aids in monkeys' survival by allowing them to travel easily through trees when they are looking for food and escaping from predators. The manzanita tree has an adaptation that allows it to control the supply of nutrients and water to certain branches so others can use them to grow. This helps the tree survive in its environment because it can continue to grow even when water and nutrients are scarce. Seals are able to hold their breath underwater for long periods of time while they hunt for food. This is an adaptation that improves the seal's chance for survival in its environment.

Anything that is not a behavioral or physical characteristic of an organism that increases its chances of survival or reproductive success is not an adaptation. The pond where a fish lives, the type of food a bear eats, or the conditions around a plant are not adaptations.

To improve their understanding of adaptations, students can visit a zoo, aquarium, or pet store and write down examples of the different adaptations animals display. Next to each adaptation, have the students write down how the adaptation helps the animal. Students can also create an imaginary plant or animal that doesn't live on

the earth, draw a picture of the organism, and explain some of the adaptations the organism would have to have to help it survive in its habitat on the planet it lives.

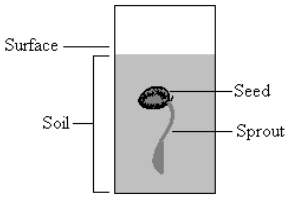
Tropisms

A tropism is a plant's growth response toward or away from a stimulus, or action. Students will demonstrate an understanding of tropisms and determine how a tropism will affect a plant in different situations.

An example of a tropism is a plant turning its leaves toward a light. The light is the stimulus and causes the plant to respond by turning its leaves in the direction of the light in order to receive more. Light can also be the stimulus for tropisms when the stems of plants grow toward light or when the roots of plants grow away from light into the ground.

There are four other types of tropisms besides responses to light; these are responses to gravity, touch, water, and chemicals. Gravity often causes plant roots to grow downward and their stems to grow upward, even if the plant or seed is planted upside-down. When a climbing vine touches an object like a plant or wall, the growth changes direction toward the object. Water tropisms may cause plants to grow downward or sideways to seek out water. Chemical tropisms may also cause plants to grow toward or away from certain chemicals.

Example: A newly sprouting seed is planted upside-down in the soil as shown below. Which of the following statements describes a tropism the plant may display?



A. The roots will grow downward into the soil.
B. The plant's stem will grow down into the soil and die.
C. The roots will not be able to find water.

Answer: A. Gravity or water will cause the roots to begin to grow downward into the soil even though the seed was planted upside-down.

To study the tropisms of plants, students can observe various types of plants and determine if they react to different stimuli. Have them try planting four uncooked beans in different directions in some moist soil. After a few weeks, carefully remove the sprouted beans from the soil and observe how the roots and stems have grown. Students can also try putting a houseplant next to a fluorescent light. Half of the plant should remain in the light and the other half should remain in the shade. Have the students observe the plant after a few weeks to determine if there are any differences between the leaves in the light and the ones in the shade.

Life Cycle of Non-Flowering Plant

Students will be able to demonstrate an understanding of spores and the plants that produce them, as well as an understanding of the life cycles of non-flowering plants.

There are two different types of non-flowering plants: those that produce spores and those that produce seeds. A seed is a plant embryo packaged with stored food in a protective coat. A spore is a reproductive cell or group of cells, and it is neither a male sex cell or a female sex cell. It can develop into a plant that can produce sperm or eggs. Mosses, ferns, horsetails, and liverworts are all spore-producing non-flowering plants. They do not use flowers or fruit to reproduce as flowering plants do and can reproduce asexually (without differing sex cells). During the life cycle of a non-flowering plant, there are two main stages. Each stage produces a different type of plant structure. One structure produces egg and sperm cells (also called gametes) and the other produces spores.

In the first stage of the life cycle of a spore-producing non-flowering plant, eggs and sperm are produced. The eggs and sperm then unite and undergo a process called fertilization that allows reproduction to take place. After reproduction, a new plant structure is formed and spores develop inside. When the conditions are right, the spores are released, and they will eventually grow into the plant structure that produces new gametes and continues the cycle. Spores can exist in a dormant stage for long periods of time before the conditions are suitable for them to begin growing. They are different from seeds because they do not have stored food inside to nurture a young plant. Spores need more specific environmental conditions to grow into young plants than seeds do, but they are often more resistant to bad weather and soil conditions.

Seed producing non-flowering plants do not produce spores, but do produce seeds. Conifers, such as pine trees, and cycads produce their seeds in cones. Another seed producing non-flowering plant, the gingko tree, has its own classification and does not produce cones.

Example: What will happen if a non-flowering plant releases spores during a very dry period?

A. The spores will die, and the plant will be unable to reproduce.
B. The spores will remain dormant until there is enough water for them to grow.
C. The plant will be able to reproduce once, but no more than that.
D. The plant will continue to release spores until conditions for growth become favorable again.

Answer: B. Spores do not need the correct conditions, including amount of water, temperature, or soil, in order to survive in a dormant state. They can stay inactive for a very long time. Eventually, if the conditions become right, they will begin to grow into a plant.

To study the life cycle of a non-flowering plant, diagram the stages of the growth of a fern, including the two main stages of its life cycle. Label the main plant parts and briefly describe each stage. Also, find pictures of plants that produce spores in gardening magazines, cut them out, paste them onto a piece of poster paper or cardboard, and write the common name of the plant underneath each picture.

Vascular/Non-Vascular Plants

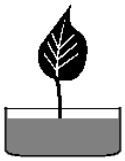
Some types of plants have a system of small tubes inside their stems and leaves that allows water and nutrients to be transported to and from all parts of the plant. This is called a vascular system. Students will demonstrate an understanding of the function of a vascular system, the characteristics of vascular and non-vascular plants, and the outcomes of experiments involving vascular and non-vascular plants.

A very tall tree must transport water and minerals from the soil through its roots all the way up to the leaves on its highest branch. Small straw-like structures help bring the water upwards, to all parts of the plant. There is another set of tubes that transports nutrients from the leaves to other parts of the plant. These two sets of tubes are called the vascular system. All trees, flowering plants, and ferns have a vascular system. Mosses and other plants, such as liverworts and hornworts, are non-vascular.

They are short and must live in wet environments in order to absorb water and nutrients for all of their parts to use. Non-vascular plants do not have true leaves, stems, or roots.

Many experiments on vascular plants involve observing the tube-like structures inside the plant. When the very bottom of a vascular plant's stem, stalk, or leaf is cut and then placed upright in a dish of colored water, its vascular system will take up the colored water, allowing the colored "tubes," or veins, to be seen. The process can take anywhere from minutes to days and is not possible in non-vascular plants.

Example: The stem of the leaf below is cut and placed in a dish of blue colored water. If the leaf came from a vascular plant, what will most likely be the result?



A. The veins in the leaf will turn blue.
B. The leaf will not change at all.
C. The leaf will die because it cannot absorb the water.
D. The veins will dissolve.

Answer: A. The leaf is from a vascular plant, so the vascular "tubes" or veins in the leaf will absorb the colored water.

Students can learn more about plants containing vascular systems by gathering small samples of plant leaves and stems in the back yard and using a magnifying lens to look at the cut section of the stem for the small tube-like structures. To help students understand where the "tubes" are and what they look like, cut the bottom of a celery stalk off, have the student place the cut end into a dish of colored water, and over five days, have them observe the colored "tubes" inside the celery stalk.

Identify Cause or Effect

In any situation where events happen and changes occur, there is always a cause or explanation. Those events and changes will in turn produce effects. Being able to see how different factors relate in any situation and being able to make predictions is important in science. Students will be able to identify the logical cause or effect of an event in a given scenario.

Example 1: Frankie has two fish bowls that are the same size. One has three goldfish in it and the other only has one. Each fish eats one food pellet in the morning and one at night. Frankie makes sure that the bowls have an equal amount of water in them. He notices that the fish that lives alone has grown bigger than the three fish sharing a fish bowl. Which of the following is most likely causing this difference?

A. The fish that lives alone is eating more food.
B. The fish that lives alone has more space in which to grow.
C. The fish bowl that the three goldfish live in is smaller than the other fish bowl.
D. The fish bowl with only one fish has less water in it.

Answer: (B) is the most logical cause of the fish growing bigger. (A), (C), and (D) are not true given details in the scenario, and (D) is not even logical since less water would not make a fish grow bigger.

Example 2: Frankie gets a larger fish tank and decides to put the three goldfish that are sharing a fish bowl into the larger tank along with more water. Which of the following will most likely happen after the fish are placed in the larger tank?

A. The fish will get smaller.
B. The fish will eat more.
C. The fish will grow larger.
D. The fish will eat less.

Answer: (C) is the logical effect of the goldfish moving to a larger tank. (B) is not correct since we are not told that Frankie will feed the fish more than he has in the past, and (A) is not logical since living things generally do not get smaller, but instead tend to grow larger. (D) is also not logical because there is no reason the fish would eat less in a larger tank.

Example 2: After the fish moved to the new fish tank, Frankie recorded the length and number of pellets they now eat. The chart below shows this information for three weeks.

	Fish 1		Fish 2		Fish 3	
	Pellets Eaten	Length	Pellets Eaten	Length	Pellets Eaten	Length
Week 1	14	3 in.	14	3 in.	14	3 in.
Week 2	13	4 in.	16	5 in.	13	3 in.
Week 3	12	5 in.	20	7 in.	10	3 in.

Which of the following most likely caused fish 2 to grow longer than the others?

A. It ate more than the other fish.
B. It had more space to grow than the other fish.
C. It was older than the other fish.

Answer: (A) is the most logical cause of fish 2 growing larger than the other fish, given the information that Frankie collected. If the fish are sharing the fish tank, they have the same amount of space in which to grow, so (B) is not logical. The chart does not tell us the ages of the fish, so (C) is not a logical cause, since there is no evidence to support it.

Students can practice recognizing causes and effects and predicting effects in scenarios using pictures, videos, and stories. Encourage students to guess what might happen next, or what may have caused something to occur. Have students describe the logic behind the choices and predictions they make using the details in the scenario they are given.

Patterns and Predictions

After information from an experiment is recorded in an organized way, a scientist looks carefully at the data for any patterns that may appear. Recognizing patterns and using them to accurately make predictions helps a scientist draw good conclusions. Students will be able to recognize patterns in given information and then make predictions about future events based on the continuation of those patterns.

Predictions about what may happen next are possible if there is a trend in the information. Logically, if something is going up or down, getting bigger or smaller, or becoming more or less, a prediction can be made that it will continue to do so in most cases. A scientist may be able to figure out the interval between values that are increasing or decreasing and mathematically predict the next value.

Example 1: Arjun is helping his family build a brick wall. He brings a load of bricks in a wheelbarrow to the wall, and his family uses them while he goes to get another load. The chart below shows how the construction of the wall is progressing.

Load	1st	2nd	3rd	4th	5th
Total Number of Bricks in the Wall	14	20	26	32	**?**

On Arjun's 5th load, how many bricks will be in the wall?

Answer: There will be a total of 38 bricks in the wall if the pattern of adding 6 bricks to the wall for each load continues.

Example 2: The chart below shows how a bean plant grew over 7 days.

Days	How Tall?	How Many Leaves?
1	less than 1 in.	1
2	1½ in.	1
3	2 in.	1
4	2 ½ in.	2
5	3½ in.	2
6	4 in.	4
7	5 in.	4
8	**?**	**?**

What will most likely be true on day 8?

A. The bean plant will have 6 leaves.
B. The bean plant will be taller than 5 inches.
C. The bean plant will not change.

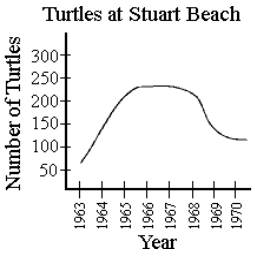
Answer: (B) is the most logical prediction given the direction of the data in this chart. (A) could happen, but the pattern of increasing by two leaves each time is not consistent. (C) is unlikely, given the fact that the plant has changed every day up to day 8. This makes (B) the most logical prediction.

To learn more about making predictions from data, students can gather data from experiments that they conduct themselves or from other sources, such as charts and stock information in the newspaper. Then, they can practice looking for patterns. Should patterns exist, have students make predictions and explain their calculations or the logical reasoning that led them to their predictions.

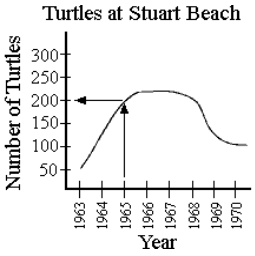
Making Predictions from Line Graphs

Line graphs are often used in science to display information. Students should be able to make predictions based on data from line graphs.

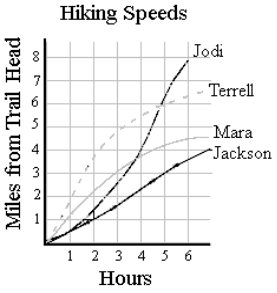
Line graphs have two sides, or axes, that show information. In the graph below, time (in years) is the information on the bottom line, or x-axis, and number of turtles is the information on the vertical side, or y-axis. Each graph also includes a line or a curve that represents a connection of data points. Here, the line represents the turtle population in different years.



This particular graph shows the number of turtles at Stuart Beach every year between 1963 and 1970. For instance, in 1965, there were about 200 turtles on Stuart Beach. To reach this conclusion, find the year 1965 on the x-axis, then go straight up until you reach the data line. From that point, look directly over to the y-axis, where you will see that the number of turtles at Stuart Beach in 1965 was 200.

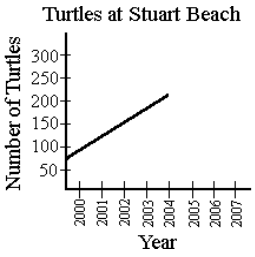


Line graphs sometimes contain more than one line. Each line represents a different set of data. The multiple line graph below shows the time (in hours) and distance (miles from the trailhead) of four different mountain climbers. Each of the four lines on the graph represents the progress of a different climber.

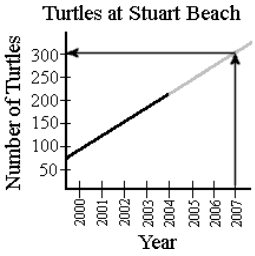


For any given time, you can determine the distance from the trailhead of any of the four people. For example, at hour 5, Jackson was 3 miles from the trailhead and Jodi was a little more than 6 miles from the trailhead. This graph also shows that Terrell was moving the fastest, on average, in the group, until about hour 5 when Jodi became the fastest. (Since Terrell was the farthest away from the trailhead at every hour before hour 5, he must have been moving the fastest, on average.)

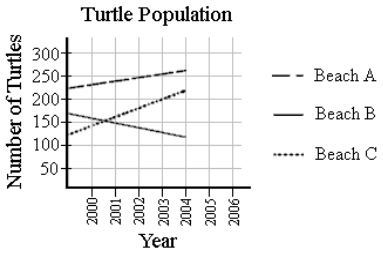
Both single and multiple line graphs can sometimes be used to make predictions, especially when the lines in those graphs are straight. A straight line in a graph shows a consistent trend. By extending the line further, one can predict the data that will be produced after the graph has ended. For example, look at the line graph below.



This graph shows a consistently increasing pattern that can be used to predict that the number of turtles will continue to increase. Specifically, it can be predicted that there will be 300 turtles at Stuart Beach in 2007 by extending the line further, into 2007. This extension is represented by the gray part of the line in the graph below.



Example: Use the graph below to answer the question.



How many turtles will there most likely be at Beach B in 2006?

Answer: 100 turtles. If you look at the line for Beach B and extend it through the gridline for 2006, you see it will cross at 100 turtles.

To help students understand how to make predictions using the data found in graphs, have them make several graphs of their own on graph paper. Graph paper can be found in most stores that carry other school supplies. For each graph, have the students draw and label two axes. Then, have them draw a straight line on the graph, starting at the y-axis. They should make sure the line only reaches halfway across the graph. Finally, have them predict the value on the y-axis at a point beyond where the line they drew reached, as in the example above.

Student Name: _____

Class: _____

Date: _____

Instructions: **Read each question carefully and select the correct answer.**

1. Which of the following has most helped scientists understand that modern plants and animals look very different from ancient plants and animals?

A. studying other planets
B. examining fossils
C. tracking the weather
D. determining the earth's age

2. Which statement is true about evolution?

A. It is a theory that describes how and when the earth was formed.
B. It explains how mutations occur in animals and plants.
C. It is a theory that describes the changes life on earth has undergone throughout time.
D. It explains why some animals live on land and others live in the water.

3. Fill in the blank.

Fossils of ancient organisms show us _____ .

A. the age of the organism when it died
B. how old the solar system is
C. the number of organisms that used to live on the earth
D. how living things have evolved since ancient times

4. Which of the following provides evidence of evolution in organisms?

1. different species with similar internal structures
2. the fossil record
3. changing climates and global warming

A. 1, 2, and 3
B. 1 and 2 only
C. 2 and 3 only
D. 1 and 3 only

5. In the spring, Jessica noticed that the stone statues in the downtown city park had started to change color and most leaves on the trees were dry and yellow. What probably caused both of these changes?

A. deforestation
B. drought
C. a mold outbreak
D. acid rain

6. What is the pH of acid rain?

A. 7
B. above 7
C. below 7

7. Which of the following is NOT a way in which plants are affected by acid rain?

1. They grow taller.
2. They die.
3. Their leaves turn brown.

A. 1 and 2
B. 1 only
C. 2 only
D. 1 and 3

8. Fill in the blank.

Acid rain causes the outsides of buildings to _____ .

A. become stronger
B. deteriorate
C. become unstable
D. look shiny

9. Fill in the blank.

_____ is the process where food is converted to chemical energy.

A. Translation
B. Photosynthesis
C. Respiration
D. Adaptation

10. Fill in the blank.

Cellular respiration and photosynthesis both provide plants with _____ .

A. energy
B. oxygen
C. water
D. food

11. Which organisms undergo cellular respiration?

A. only plants
B. plants and animals
C. only animals
D. neither plants nor animals

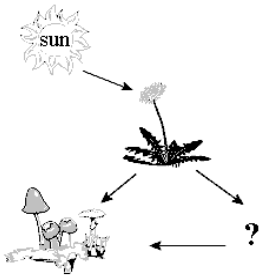
12. What is glucose?

A. a hormone
B. a protein
C. a salt
D. a sugar

13. Which of the following is a consumer?

A. a mushroom
B. the sun
C. an orange tree
D. an eel

14. Use the diagram to answer the following question.



Which of the following could be placed in the blank space?

A. 

B. 

C. 

15. Which sequence correctly shows the flow of energy in an ecosystem?

A. snake → bird → plant

B. insect → apple → mouse

C. crocodile → frog → sun

D. sun → flower → hummingbird

16. Fill in the blank.

_____ are organisms that get energy directly from the sun.

A. Producers
B. Consumers
C. Decomposers
D. Predators

17. Lidia found an animal in her backyard, but she didn't know what it was. What should she look for to figure out if it is an insect?

A. if it had claws
B. if it had a skeleton inside its body
C. if it had 6 legs
D. if it had two main body parts

18. Fill in the blank.

Insects _____ .

A. always have backbones
B. never have backbones
C. always have wings
D. never have wings

19. Which of these is true about an **insect**?

A. It has a hard body covering.
B. It has a backbone.
C. It has four legs.
D. It has two main body parts.

20. Which of these is an **insect**?

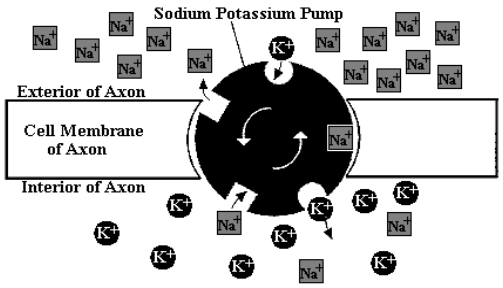
A. 

B. 

C. 

D. 

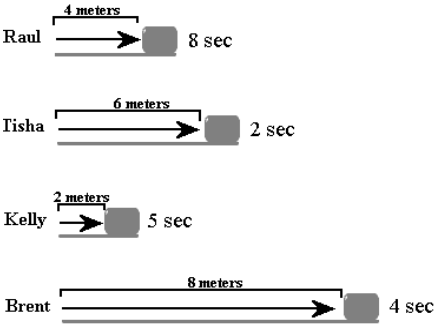
21. The diagram below shows a process involving the sodium potassium pump. Use the diagram to answer the following question.



According to the diagram, which direction does the sodium potassium pump move within the cell membrane?

A. left
B. right
C. counterclockwise
D. clockwise

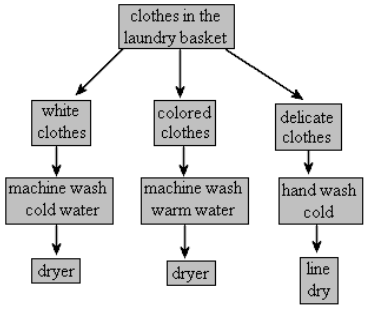
22. Four people pushed boxes across the floor. The diagram below shows the results. Use this diagram to answer the following question.



Which person pushed his or her box exactly 2 meters?

A. Tisha
B. Raul
C. Kelly
D. Brent

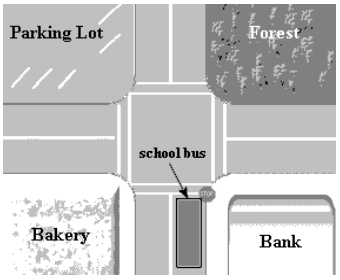
23. Use the diagram to answer the following question.



Which of the following would be the best title for this diagram?

A. Weekly Chores
B. Doing the Laundry
C. Types of Clothes
D. Laundry Basket

24. Use the diagram below to answer the question.



What is most likely the purpose of the diagram?

A. to show the location of the school bus
B. to show what the school bus looks like
C. to show driving directions to the parking lot
D. to show how the bus gets to school

25. Which of the following is true about the information in charts 1 and 2?

1

Height	Age (years)
5 m	1
8 m	2
11 m	3
14 m	4

2

Height	Age (years)
3 m	2
3 m	4
3 m	6
7 m	8

A. The information in both charts shows a linear relationship.
B. The information in neither chart shows a linear relationship.
C. The information in chart 1 shows a linear relationship, but the information in chart 2 does not.
D. The information in chart 2 shows a linear relationship, but the information in chart 1 does not.

26. Which of the following charts includes data that shows a linear relationship?

A.

Height	Weight
2 m	10 g
4 m	26 g
10 m	18 g
8 m	22 g
6 m	14 g

B.

Height	Weight
2 m	18 g
6 m	10 g
10 m	26 g
8 m	22 g
4 m	14 g

C.

Height	Weight
2 m	10 g
4 m	26 g
6 m	18 g
8 m	22 g
10 m	14 g

D.

Height	Weight
2 m	10 g
4 m	14 g
6 m	18 g
8 m	22 g
10 m	26 g

27. Data was collected for each trial of an experiment. Which trial(s) shows a linear relationship?

Trial 1

Time (sec)	Temp.
2	14°F
4	18°F
6	20°F
8	17°F

Trial 2

Time (sec)	Temp.
2	26°F
4	25°F
6	24°F
8	23°F

Trial 3

Time (sec)	Temp.
2	24 F
4	25 F
6	22 F
8	22 F

A. Trial 3
B. Trial 2
C. Trials 2 and 3
D. Trials 1 and 3

28. The experimental data collected from three trial tests produced the following results. The data from which of these charts shows a linear relationship in the data?

1

Water Temp.	Air Temp.
62°F	53°F
62°F	55°F
65°F	58°F
68°F	60°F

2

Water Temp.	Air Temp.
64°F	58°F
64°F	60°F
64°F	62°F
64°F	64°F

3

Water Temp.	Air Temp.
64°F	84°F
65°F	82°F
66°F	73°F
64°F	70°F

A. 1 only
B. 3 only
C. 1 and 2
D. 1, 2, and 3

29. Which picture shows the legs of a bird that spends a lot of time in a lake or pond?

A. 

B. 

C. 

D. 

30. Hunting birds, such as eagles, hawks, and owls, have sharp claws on their toes. These claws are called talons. How do talons help the hunting birds?

A. Talons hold the bird on a branch while it is resting.
B. Talons help the bird fly faster.
C. Talons grab and hold the food.
D. Talons help the bird swim.

31. Which animal below probably lives in a part of the world that is cold all year round?

A. A
B. B
C. C
D. D

32. Fill in the blank.

A flounder is a type of fish. The flounder can change its color to match the surroundings. If a shark approaches, the flounder lays still, blending into the sandy ocean bottom. This is known as _____.

A. camouflage
B. hibernation
C. migration
D. communication

33. Fill in the blank.

Cardiac muscle can be found in the _____ .

A. shoulder
B. thigh
C. stomach
D. heart

34. How do muscles and bones work together to make movement?

A. Muscles contract and pull the bone.
B. Muscles expand and push the bone.
C. The bone contracts and pulls the muscle.
D. The bone expands and pushes the muscle.

35. Fill in the blank.

The shoulder joint permits movement in all directions. The shoulder is an example of a _____ joint.

A. hinge
B. ball and socket
C. pivot
D. gliding

36. Where are the **tricep** muscles located?

A. the chest
B. the back
C. the arms
D. the legs

37. Mary just completed a long race. She is breathing heavily and her heart is beating fast. Why is this happening?

A. She needs food, so her digestive system is using up stored food.
B. Her lungs and heart are working hard to get oxygen to all of her body's cells.
C. Her muscles are tired and she is trying to rest them.
D. She needs energy, so her digestive system is processing nutrients.

38. Fill in the blank.

Blood picks up oxygen from tiny sacs called _____ at the same time it deposits carbon dioxide there.

A. arteries
B. alveoli
C. bronchi
D. lungs

39. Fill in the blank.

_____ cover the alveoli and are the sites where gas exchange occurs.

A. Capillaries
B. Bronchi
C. Trachea
D. Lungs

40. Which of the following activities would make your breathing and heart rate increase the most?

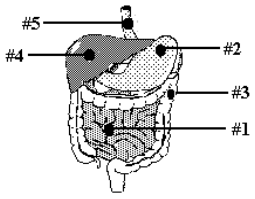
A. jumping rope
B. sleeping
C. reading
D. drawing a picture

41. Fill in the blank.

Bile _____ .

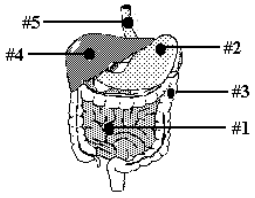
A. helps break down food in the small intestine
B. coats food before it enters the esophagus
C. is stored in the small intestine
D. is a waste product of digestion

42. This picture shows the human digestive system. Name the part labeled #1.



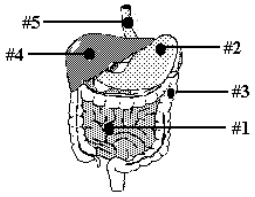
A. liver
B. large intestine
C. small intestine
D. stomach

43. This picture shows the human digestive system. Name the part labeled #4.



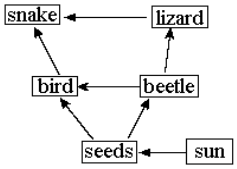
A. stomach
B. liver
C. esophagus
D. large intestine

44. This picture shows the human digestive system. Name the part labeled #3.



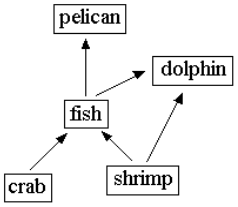
A. large intestine
B. small intestine
C. liver
D. esophagus

45. In the food web below, where do the seeds get their energy?



A. from the sun
B. from the bird and the beetle
C. from the bird only
D. from the sun, the bird, and the beetle

46. Use this food web to answer the question.

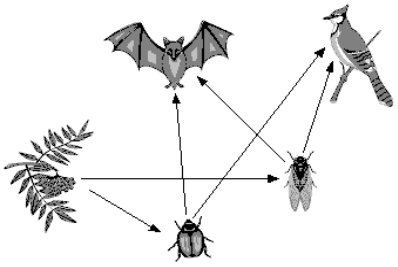


How will the food web be affected if the fish population decreases?

1. The pelican population will decrease.
2. The dolphin population will increase.
3. The crab population will increase.

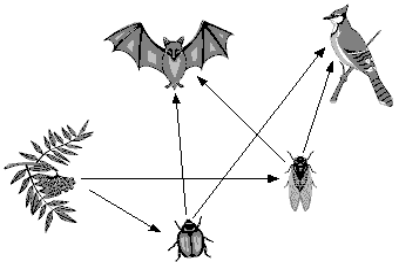
A. 3 only
B. 1 and 3
C. 1 only
D. 1 and 2

47. In the food web below, where does the plant get its energy?



A. the sun
B. the beetle
C. the bat
D. the fly

48. In the food web below, where does the bat get its energy?



A. the beetle
B. the sun
C. the plant
D. the bird

49. Which of the following is an arthropod?

A. 

B. 

C. 

D. 

50. Fill in the blank.

Beetles, grasshoppers, bees, and ants are all _____.

A. arachnids
B. insects
C. crustaceans
D. mammals

51. Where do most crustaceans live?

A. in the air
B. in water
C. on the land
D. underground

52. What do all arthropods have in common?

A. They have claws.
B. They have the same number of legs.
C. They all live on land.
D. They all have jointed legs.

53. What does it mean when an animal is **cold-blooded**?

A. Its blood is blue instead of red.
B. It must live in a cold place to survive.
C. Its blood is always cold.
D. It needs warm surroundings to keep its blood warm.

54. Fill in the blank.

Fish breathe using _____.

A. a blowhole
B. gills
C. lungs
D. their skin

55. What do fish and frogs have in common?

A. They have fins.
B. They have scales.
C. They are cold-blooded.
D. They live underwater.

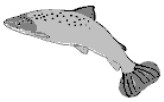
56. What happens to the skin of a snake as the snake grows?

A. The skin stretches as the snake gets larger.
B. The snake sheds its old skin.
C. The snake's skin dissolves.
D. The skin grows with the snake, like humans.

57. Which of these animals can make milk?

A. 

B. 

C. 

D. 

58. Fill in the blank.

Most mammals keep warm by having an outer covering of _____.

A. blubber
B. scales
C. shell
D. fur

59. Which one of these is NOT a mammal?

A. blue whale
B. dolphin
C. shark
D. seal

60. What do all birds have in common?

A. They have wings, feathers, and are cold-blooded.
B. They have wings, feathers, and are warm-blooded.
C. They have wings, feathers, and gills.
D. They have wings, feathers, and talons.

61. Put the numbers in the correct order to show the life cycle of this insect.

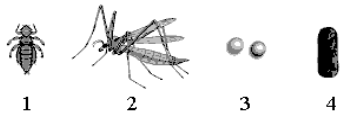
A. 2 - 3 - 1 - 4
B. 1 - 2 - 3 - 4
C. 3 - 2 - 1 - 4
D. 4 - 2 - 1 - 3

62. Fill in the blank.

An amphibian lays its eggs _____.

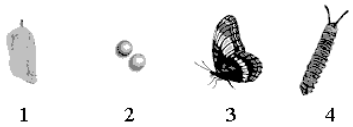
A. on land
B. in other animals' nests
C. in water
D. encased in a leathery shell

63. Put the numbers in the correct order to show the life cycle of this insect.



A. 3 - 1 - 4 - 2
B. 3 - 4 - 1 - 2
C. 4 - 1 - 3 - 2
D. 1 - 3 - 4 - 2

64. Put the numbers in the correct order to show the life cycle of this butterfly.



A. 1 - 4 - 2 - 3
B. 2 - 1 - 4 - 3
C. 1 - 2 - 4 - 3
D. 2 - 4 - 1 - 3

65. Which of the following animals are cold-blooded?

1. reptiles
2. amphibians
3. mammals

A. 1, 2, and 3
B. 2 only
C. 1 and 2
D. 3 only

66. Which one of these animals is a vertebrate?

A. A
B. B
C. C
D. D

67. Fill in the blank.

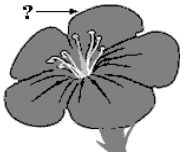
_____ use their own energy to keep their bodies at a specific temperature.

A. All invertebrates
B. All vertebrates
C. Cold-blooded animals
D. Warm-blooded animals

68. Which of the following is true about all invertebrates?

A. They have shells.
B. They are warm-blooded.
C. They do NOT have backbones.
D. They do NOT live in the ocean.

69. Which part of the flower is indicated below?



A. ovary
B. petal
C. stamen
D. sepal

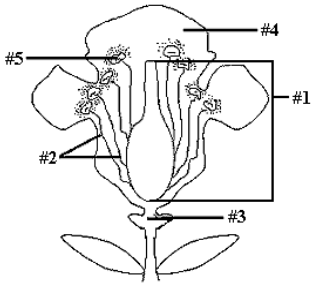
70. Which part of the flower produces the seeds of the plant?

A. pollen
B. pistil
C. petal
D. filament

71. In which part of the flower are eggs produced?

A. anther
B. ovary
C. sepal
D. stamen

72. Use this picture of a flower to name the part labeled #2.



A. filament
B. stamen
C. anther
D. pistil

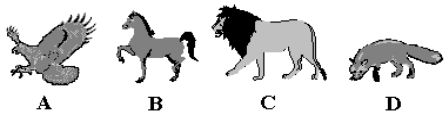
73. Which of the following organisms would belong on the same level of an energy pyramid as a mouse?

A. a butterfly
B. a tree
C. a wolf
D. an owl

74. Which organism listed below would you find in the <u>second</u> trophic level in an ecosystem?

A. hawk
B. snake
C. frog
D. grasshopper

75. Which one of these animals is a primary consumer?



A. A
B. B
C. C
D. D

76. Which organism listed below is considered a secondary consumer?

A. rabbit
B. coyote
C. mouse
D. cow

77. Fill in the blank.

Organisms that use the sun's energy to make food are called _____ .

A. herbivores
B. consumers
C. producers
D. carnivores

78. Fill in the blank.

Decomposers cause dead organisms to _____.

A. germinate
B. reproduce
C. decay
D. molt

79. Which of the following eats plants?

A. producers
B. consumers
C. both producers and consumers
D. neither producers nor consumers

80. Which of the following are **decomposers**?

1. yeast
2. algae
3. virus
4. mold

A. 2 and 3 only
B. 3 and 4 only
C. 1, 2, 3, and 4
D. 1 and 4 only

81. Which statement is true about ALL fungi?

A. They are unicellular organisms.
B. Their cells contain nuclei.
C. They are multicellular organisms.
D. Their cells do not contain nuclei.

82. Fill in the blank.

Cells reproduce by _____ .

A. division
B. pollination
C. locomotion
D. respiration

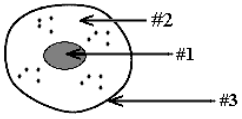
83. Solve this riddle.

I am the barrier between the inside and the outside of the cell.
I allow food, oxygen, and other needed materials to enter the cell.
I am a part of animal and plant cells.

What am I?

A. cell membrane
B. cell wall
C. cytoplasm
D. nucleus

84. Identify the part of the cell that is labeled #1.



A. chloroplast
B. cytoplasm
C. cell membrane
D. nucleus

85. What substance do plants make during photosynthesis using sunlight ?

A. nitrogen
B. carbon dioxide
C. water
D. sugar

86. Which part of a plant contains cells that carry out photosynthesis?

A. the seed
B. the root
C. the leaf
D. the flower

87. During photosynthesis, what two ingredients does a plant need to make sugar?

A. water and carbon dioxide
B. water and oxygen
C. chlorophyll and oxygen
D. oxygen and carbon dioxide

88. How does chlorophyll help a plant survive?

A. It makes the leaves green.
B. It splits carbon dioxide molecules.
C. It converts sugars into starches.
D. It traps energy from sunlight.

89. Gazelles and lions live in the grasslands of Africa. The gazelles travel in large groups to make it harder for the lions to hunt them. What is most likely to be true if a gazelle had an injured leg, and is slower than the other gazelles?

A. The injured gazelle would be more likely to be caught by a lion, so the gazelle has less of a chance for survival.
B. All of the other gazelles would slow down to help protect the injured gazelle, and put themselves at risk of being hunted themselves.
C. The lions would not hunt the injured gazelle because it is not as strong.
D. All of the other gazelles would stop traveling until the injured gazelle completely heals.

90. Why would a smaller, faster cheetah survive better today than a larger, slower cheetah?

A. They would be better at hunting.
B. They would not need as much water.
C. They would migrate more easily.
D. They would have more offspring.

91. If global warming causes the water level in the oceans to rise over time, reducing the amount of dry land on the surface of the earth, which animals have the best chance of survival?

A. wolves
B. yak
C. whales
D. orangutans

92. Fill in the blank.

"Survival of the fittest" means that _____.

A. only the most powerful organisms in a species will survive
B. the faster the organism, the longer it will live
C. organisms that have the traits necessary to adapt will survive
D. the more offspring an organism has, the longer it will live

93. How would fertilizer that runs into streams most likely harm the environment?

1. Algae overgrowth could cause the death of organisms.
2. It could raise the water level and make the stream overflow.
3. Rocks in the stream could get coated with fertilizer and become too slippery.

A. 3 only
B. 1, 2, and 3
C. 1 only
D. 1 and 2

94. Fill in the blank.

During a rainstorm, chemicals from air pollution in the atmosphere may come back to the earth as _____.

A. wastewater
B. gasoline
C. acid rain
D. red rain

95. Which statement is true about sand and soil washing into a pond after a storm?

1. The sand and soil can pollute the pond.
2. The sand and soil can block the light, stopping the growth of plants in the pond.

A. both 1 and 2
B. 2 only
C. 1 only
D. neither 1 or 2

96. How does soil pollution most commonly turn into water pollution?

A. Harmful materials in the soil are absorbed by plants and after the plants die, the water in the plants contaminates lakes and rivers.
B. Harmful materials on or in the soil can seep into underground water sources.
C. Harmful materials on or in the soil evaporate and end up in lakes and oceans.
D. Harmful materials in the soil bind together and then get eaten by animals.

97. Fill in the blank.

Darwin discovered that farm crop populations had changed their traits over time. Plants with favorable traits were pollinated to produce seeds and pass on their characteristics. When humans choose the traits in a population, it is called _____ .

A. natural selection
B. artificial selection
C. artificial insemination
D. directed transition

98. A population of moths has wing patterns that look like tree bark.
How could this affect the moths?

A. The moth population would not be affected.
B. The population could decrease because male moths can't see the female moths.
C. The camouflaged moths probably would not be eaten by predators.
D. The predators could find the moths more easily and eat them.

99. Fill in the blank.

Natural selection occurs in populations where _____ .

A. the organisms do not blend in with the surroundings
B. the organisms are able to blend in with the surroundings
C. all individuals are identical
D. some individuals have a unique trait that helps them survive better

100. In one wildflower population, there are some plants with purple flowers and others with white flowers.
Which of the following would cause natural selection to occur in this wildflower population?

A. The purple flower plant was moved to a new area.
B. Both of the plants became extinct.
C. Both plants started producing pink flowers.
D. The purple flower plants had more offspring than the white flower plants.