SCIENCE EXPO 2023 – Life Science & Health Fair

Organisms and Ecosystems

Food Chain Aim

Passport Question: _____ create their own food using energy from the sun (through photosynthesis). _____ get their energy by eating other organisms. _____ act as nutrient recyclers in the ecosystem by breaking down dead and decaying organisms.
Answer: producers, consumers, decomposers

Learning Target: Students will learn that organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants.

Materials:

- Stuffed animals: raccoon, rabbit, flower, mushroom, green copepod, 2 phytoplankton (green), orange copepod, blue bacteria, brown bacteria, minnow, algae
- Organism description cards (12)
- Producer, consumer, decomposer description signs
- Labeled target bins (3)

Background:

Every organism needs to obtain energy in order to live. For example, plants get energy from the sun, some animals eat plants, and some animals eat other animals. A food chain is the sequence of who eats whom in a biological community (an ecosystem) to obtain nutrition. A food chain starts with the primary energy source, usually the sun or boiling-hot deep sea vents. The next link in the chain is an organism that makes its own food from the primary energy source -- an example is photosynthetic plants that make their own food from sunlight (using a process called photosynthesis) and chemosynthetic bacteria that make their food energy from chemicals in hydrothermal vents. These are called autotrophs or primary producers. Next come organisms that eat the autotrophs; these organisms are called herbivores or primary consumers -- an example is a rabbit that eats flowers. The next link in the chain is animals that eat herbivores - these are called secondary consumers -- an example is a snake that eats rabbits. In turn, these animals are eaten by larger predators -- an example is an owl that eats snakes. The tertiary consumers are eaten by quaternary consumers -- an example is a hawk that eats owls. Each food chain ends with a top predator, an animal with no natural enemies (like an alligator, hawk, or polar bear).When any organism dies, it is eventually eaten by detrivores (like vultures, worms and crabs) and broken down by decomposers (mostly bacteria and fungi), and the exchange of energy continues.

The arrows in a food chain show the flow of energy, from the sun or hydrothermal vent to a top predator. As the energy flows from organism to organism, energy is lost at each step. A network of many food chains is called a food web. Some organisms'

position in the food chain can vary as their diet differs. For example, when a bear eats berries, the bear is functioning as a primary consumer. When a bear eats a plant-eating rodent, the bear is functioning as a secondary consumer. When the bear eats salmon, the bear is functioning as a tertiary consumer (this is because salmon is a secondary consumer, since salmon eat herring that eat zooplankton that eat phytoplankton, that make their own energy from sunlight). Think about how people's place in the food chain varies - often within a single meal.

In this game, the students will work with very simple food chains that only have one producer, one or two consumers, and one decomposer. Descriptions about each organism in the game can be found on the Food Chain Aim Cheat Sheet.

Procedure:

1. Set up the stuffed animals on their respective descriptive card on the table.
2. Introduce the idea of a food chain and how there are distinct parts of a food chain, most notably: producers, consumers, and decomposers. Show the students the descriptive poster on producers, consumers, and decomposers. Talk about each.
3. Show the students the information on the backs of the cards.
4. Allow the students to sort each food chain into producer / consumer / decomposer by reading about each and tossing the animals into their respective bins.
5. Ask the student to explain their thinking to you as they are sorting the animals.
6. Talk to the student about how, through these food chains, the food of every organism can be traced back to plants.
7. Retrieve the stuffed animals from the bins and set them up on their respective cards again.

Discussion:

- What is a producer? Do you know any additional examples of a producer?
  [A producer is an organism that creates its own food from energy from the sun through photosynthesis. An additional example of a producer is a tree.]
- What is a consumer? Do you know any additional examples of a consumer?
  [A consumer is an organism that gets its energy from eating organisms that make their own energy (producers). An additional example of a consumer is a horse.]
- What is a decomposer? Do you know any additional examples of a decomposer?
  [A decomposer is an organism that gets its energy from eating dead and decaying organisms and material in an ecosystem. Through breaking down dead organisms, decomposers return those nutrients into the soil so plants can use them again to grow. An additional example of a decomposer is an earthworm.]
- Can an animal be more than one of these? Can it be a consumer and a decomposer? What would that depend on?
  [Yes, an animal can be more than one of these. It depends on what they are eating at the time. If an earthworm is eating grass it is a consumer but if it is eating decaying material it is a decomposer.]
- Could a rabbit be a part of another food chain with other animals too?

[Yes, a rabbit eats many different kinds of things so it is part of food chains with those different things as well. For example, rabbits also eat grass and lettuce, they don't just eat flowers.]

- What would happen if we lost one of these species?
  [If we lost an element of a food chain, another organism would most likely take its place. For example, if we lost the rabbit, another animal that eats flowers, like a squirrel, might take its place in the food chain.]
- Which category do humans fall into?
  [Humans are consumers because we get our energy from eating organisms that produce their own food or from organisms that eat other organisms that make their own food. Humans cannot make their own food through photosynthesis so humans cannot be considered producers. Humans do not eat dead or decaying material to get energy so humans cannot be considered decomposers.]

Food Chain	Consumer	Consumer	Producer	Decomposer
Aquatic #1 (marine/ocean)	Large Zooplankton (Large Copepod)	Small Zooplankton (Small Copepod)	Phytoplankton (Euglena)	Aquatic Bacteria

1. **Large Zooplankton (Large Copepod): Large copepods can be found in marine and freshwater environments, they often feed on smaller copepods.**
2. **Small Zooplankton (Small Copepod): Found in the sea and nearly every freshwater habitat. Copepods can be planktonic or benthic, if planktonic, they are consumers as they eat phytoplankton, if benthic, they are decomposers as they eat detritus.**
3. **Phytoplankton (Euglena): Found in fresh and saltwater habitats. The long flagella helps euglena swim. Euglena produces its own food through photosynthesis so it is a producer. Euglena can also be a consumer as it can ingest other organisms for food through surrounding a particle of food and ingesting it through phagocytosis.**
4. **Aquatic Bacteria: Found in freshwater and marine environments. Bacteria play an important role in freeing the last of the minerals and nutrients from the last remains of living organisms and recycling them back into the food web. They are decomposers.**

Terrestrial	Raccoon	Rabbit	Flower	Mushroom

1. **Raccoon: Raccoons eat nuts, seeds, small mammals, fruits, fish eggs, amphibian eggs, and bird eggs.**
2. **Rabbit: Rabbits eat grass, forbs, flowers, and leafy weeds. They are consumers.**
3. **Flower: Flowers get their energy through photosynthesis and are thus producers.**
4. **Mushroom: Mushrooms are decomposers as they obtain their nutrition from metabolizing nonliving organic matter.**

Aquatic #2 (freshwater)	Bluntnose Minnow	Phytoplankton (Euglena)	Algae (Anabaena)	Aquatic Bacteria

a. **Bluntnose Minnow: This is the most prominent freshwater fish in the U.S. They have an average length of 6.5 cm and a maximum length of 11 cm. They feed on aquatic insects, phytoplankton, algae, and small crustaceans, making them consumers.**
b. **Phytoplankton (Euglena): Found in fresh and saltwater habitats. The long flagella helps euglena swim. Euglena produces its own food through photosynthesis so it is a producer. Euglena can also be a consumer as it can ingest other organisms for food through surrounding a particle of food and ingesting it through phagocytosis.**
c. **Algae (Anabaena): Cyanobacteria, blue green algae. Found in freshwater ecosystems all over the world, but can handle salinity as well. Anabaena gets its energy through photosynthesis so it is a producer.**
d. **Aquatic Bacteria: Found in freshwater and marine environments. Bacteria play an important role in freeing the last of the minerals and nutrients from the last remains of living organisms and recycling them back into the food web. They are decomposers.**

Bioramas

Passport Question: True or False: Organisms have specific physical and behavioral adaptations that allow them to survive in particular biomes.
Answer: True

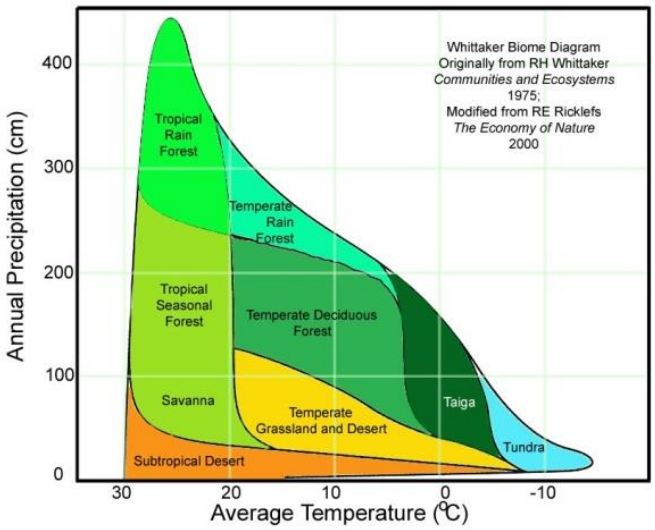
Learning Target: Students will understand that organisms can survive only in environments in which their particular needs are met.

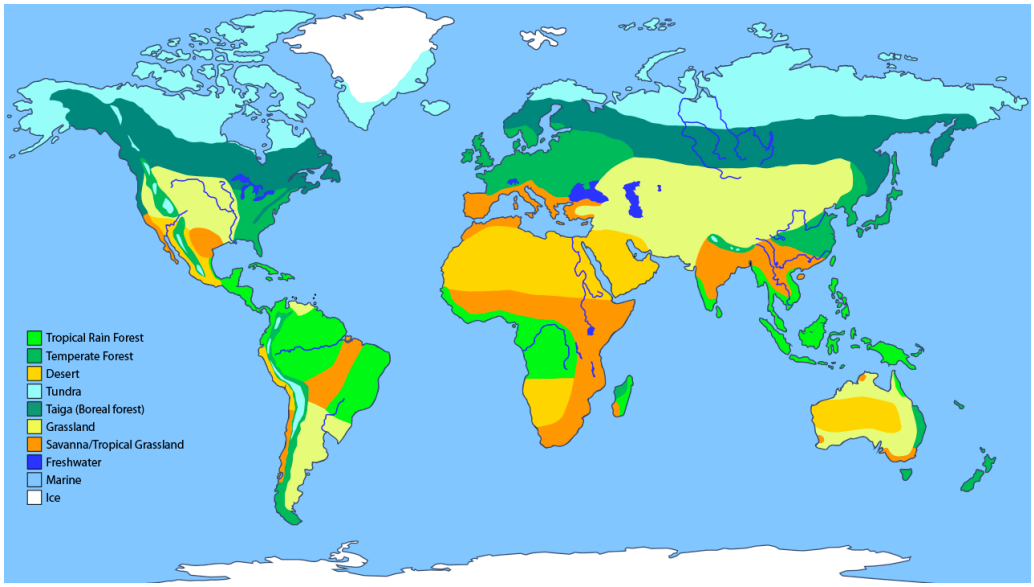
Materials:

- 5 biome boxes with animals:
  - Freshwater Biome
  - Marine Biome
  - Tundra Biome
  - Desert Biome
  - Temperate Forest Biome
- Globe
- Biome Poster

Background:

Biomes are regions of the world with similar climate (weather, temperature), animals, and plants. There are terrestrial biomes (land) and aquatic biomes, both freshwater and marine. There is no definitive assessment of how many different types of biomes there are. Some people say there are only 5 major types of biomes: aquatic, desert, forest, grassland, and tundra. Others split biomes further. Forests are separated into rainforest, temperate forest, chaparral, and taiga; grasslands are divided into savanna and temperate grasslands; and the aquatic biome is split into freshwater and marine. Biomes have changed and moved many times during the history of life on Earth. More recently, human activities have drastically altered these communities. Thus, conservation and preservation of biomes should be a major concern to all.





The biomes exemplified in this station are:

Temperate Forest: Temperate forests are found predominantly in areas with warm summers and cool winters, and vary enormously in their kinds of plant life. In some, needle-leaf trees dominate, while others are home primarily to broadleaf evergreen trees or a mix of both tree types. Temperate evergreen forests are common in the coastal areas of regions that have mild winters and heavy rainfall, or inland in drier climates or montane areas. Many species of trees inhabit these forests including pine, cedar, fir, and redwood. Temperate forests are common in the coastal areas of regions that have mild winters and heavy rainfall, or inland in drier climates or montane areas.

Tundra: Tundra is the coldest of all the biomes. Tundra comes from the Finnish word tunturia, meaning treeless plain. It is noted for its frost-molded landscapes, extremely low temperatures, little precipitation, poor nutrients, and short growing seasons. Dead organic material functions as a nutrient pool. The two major nutrients are nitrogen and phosphorus. Nitrogen is created by biological fixation, and phosphorus is created by precipitation. Tundra is separated into two types: arctic tundra and alpine tundra. Characteristics of Tundra: extremely cold climate, low biotic diversity, simple vegetation structure, limitation of drainage, short season of growth and reproduction, energy and nutrients in the form of dead organic material, large population oscillations.

Desert: Deserts cover about one fifth of the Earth's surface and occur where rainfall is less than 50 cm/year. Although most deserts, such as the Sahara of North Africa and the deserts of the southwestern U.S., Mexico, and Australia, occur at low latitudes, another kind of desert, cold deserts, occur in the basin and range area of Utah and Nevada and in parts of western Asia. Most deserts have a considerable amount of specialized vegetation, as well as specialized vertebrate and invertebrate animals. Soils often have abundant nutrients because they need only water to become very productive and have little or no organic matter. Disturbances are common in

the form of occasional fires or cold weather, and sudden, infrequent, but intense rains that cause flooding.

There are relatively few large mammals in deserts because most are not capable of storing sufficient water and withstanding the heat. Deserts often provide little shelter from the sun for large animals. The dominant animals of warm deserts are nonmammalian vertebrates, such as reptiles. Mammals are usually small, like the kangaroo mice of North American deserts. Desert biomes can be classified according to several characteristics. There are four major types of deserts: Hot and dry, Semiarid, Coastal, and Cold.

Freshwater: The freshwater biome is made up of any freshwater body of water such as lakes, ponds, streams, and rivers. They cover roughly 20% of the Earth's surface and are in various locations all over the world. Most freshwater biomes consist of moving water. The freshwater biome has the second largest diversity among the plants and animals that are found within it. It is believed that more than 700 species of fish, 1,200 species of amphibians, mollusks, and insects all live in these areas. Other inhabitants include frogs, beavers, otters, crab, shrimp, turtles, and tadpoles. The types of fish you will find depend on the location and the time of year. It could be bass, salmon, or trout. You will find many species of low lying plants growing in the freshwater biome. This includes different types of grass and sedge. Cyanobacteria is the blue and green algae that you will find in most freshwater biomes. It is a significant food source for birds, amphibians, and many other living things in the freshwater biome.

Marine: There are five marine biomes - Atlantic Ocean, Pacific Ocean, Indian Ocean, Southern Ocean, and the Arctic Ocean. Almost 71% of the Earth is covered by ocean. Some believe that the ocean biome is in fact the oldest of all biomes. Majority of the animals and plants that reside in the ocean biome exist in areas of the ocean that are rarely visited by people. Humans have only explored about 10% of the ocean biome. We can find mollusks, fish, whales, crustaceans, bacteria, fungi, sea anemones and many other animals in the marine biome. Although the temperatures of the oceans can vary, the average temperature of any ocean is 39° F.

Procedure:

Students who visit the station will be given the chance to sort the animal figurines into their appropriate biomes. When a student comes over, the facilitator will hand a couple plastic animals from each biome to the student, help the student figure out what each animal is, and figure out which biome to put it in. The facilitator can help the student explore the globe and which biomes are found where by referencing the biome poster. At the end, have the student answer their passport question for Bioramas. Remove a couple animals from each biome box and start over.

Discussion:

As the student is trying to sort the animals ask them why they think particular animals might go in particular biomes (i.e. bears have thick coats so they can live somewhere cold), ask them what the characteristics of that biome are, where that biome

may be found on earth (they can refer to the big poster), what other animals they think might live there (deductive reasoning).

Sources: http://www.ucmp.berkeley.edu/glossary/gloss5/biome/
http://kids.nceas.ucsb.edu/biomes/ http://tuningpp.com/major-world-biomes-map/
http://www.ucmp.berkeley.edu/glossary/gloss5/biome/tundra.html

Living Together

Passport Question: Name two organisms that have a symbiotic relationship.
Answer: Answers will vary; example: Dwarf Mistletoe and Lodgepole Pine

Learning Target: Discover which plants, animals, fungi and bacteria have symbiotic relationships and how this impacts each organism. Explore the advantages and disadvantages of different types of symbiosis. This activity helps build upon food webs, since students will already have some understanding of the complex relationships between organisms. As a result, this symbiosis lesson could build upon their previous ideas of close interactions and interconnectivity between organisms.

Materials:

- Symbiosis cards(13)
- Asian Clams
- Picture of algae with Asian clams
- Bark with pine beetle trails
- Bacteria(Rhizobia) slide
- Willow gall sample
- Lodgpole pine with dwarf mistletoe sample
- Whitebark pine blister rust sample

Background:

An organism's ability to survive and reproduce in a given habitat may be greatly affected by its interactions with other living organisms. These biotic relationships can also be referred to as symbiosis. Symbiosis is a relationship between two or more organisms that live closely together. There are several types or classes of symbiosis:

- Commensalism: One organism benefits and the other is neither harmed nor helped.
- Mutualism: Both organisms benefit. An obligate mutualist cannot survive without its partner; a facultative mutualist can survive on its own.
- Parasitism: One organism(parasite) benefits and the other (the host) is harmed.

Procedure:

- Students will be given a set of cards that have various organisms from the Tahoe Basin on them. Each card lists one or two things that this organism needs or that it can provide.
- Tell the students that each organism has a symbiotic relationship with another organism. One organism is using the other in order to feed, survive or reproduce.
- Once the students have figured out which organisms share a symbiotic relationship with one another (they don't have to do them all), have them check their answers with you.
- If they are right, have the students guess what kind of symbiotic relationship the organisms on the board have (mutualism, commensalism, or parasitism).

Discussion:

- By the end of the game, students should have a good understanding of what makes a relationship parasitic, commensal, or mutualistic.
- Ask questions like: "Why would a plant or animal want to be in a mutualistic relationship?" or "Why would it benefit an organism to be parasitic?"
- What is a mutualism? Which organisms exhibit a mutualistic relationship? A mutualistic relationship is when both organisms benefit.

Examples:

1) Cedar Waxwing and the Sierra Juniper tree. The Cedar waxwing eats the berries of the sierra juniper and receives nutrition. The berry-like cones of the Sierra Juniper must pass through an animal digestive tract in order to germinate, and therefore the Cedar Waxwing also helps the tree to germinate and spread its seeds

2) Pea plant and the bacteria. The bacteria convert nitrogen gas into compounds that the plant can use for growth, while the plant gives the bacteria the carbohydrates it needs to grow and survive. The pea plant also forms root nodules, offering a protective home for the bacteria to live in while converting nitrogen gas.

3) Green Algae and Fungus. Lichen is a symbiotic relationship between algae and the hyphae of a fungus. Algae provides food for hyphae through photosynthesis. Fungal hyphae provides a suitable environment for the algae to survive. The pictures show algae embedded in clustered hyphae.

What is commensalism? What organisms exhibit a mutualistic relationship?
Commensalism is when one organism benefits and the other is neither harmed nor helped.

Examples:

1) White stickseed and the deer. The white stickseed attaches to the fur of the mule deer and catches a ride to a new location, where the seeds will germinate. The plant gains the benefit of seed dispersal and reproduction. The prickly fruits do not cause any harm to the deer.

2) Asian clam and algae. Asian clams excrete nutrients such as nitrogen and phosphorous into the water, which algae are then able to use for growth. Asian clams are not harmed, nor benefitted by the algae.

3) Curly Leaf Pondweed and Bluegill. The Curly Leaf Pondweed provides shelter and protection for the Bluegill, but the Bluegill does not benefit nor harm the Curly Leaf Pondweed.

What is parasitism? What organisms exhibit a parasitic relationship? Parasitism is when one organism benefits and the other is harmed from the relationship.

Examples:

1) Dwarf mistletoe (parasite) and lodgepole pine (host). The dwarf mistletoe leeches the nutrients out of lodgepole pine trees and eventually causes them to die.

2) Bright red snow plant (parasite) and soil fungi(host).The soil fungi breaks down organic material into usable nutrients and carbohydrates, and the bright red snow plant leeches those nutrients, thus depriving the fungi of those nutrients.

3) Blister rust fungus (parasite) and whitebark pine (host). Blister rust fungus exhibits a very complicated lifecycle, which requires whitebark pine as a host. The fungus grows down to the twig and into the branch and ultimately to the main stem of the tree, killing the cambium, and causing the tree to die. Indigenous trees have not been coevolving with the pathogen, and so many pine trees are especially susceptible to the disease.

4) Western pine beetle (parasite) and Ponderosa Pine (host). The western pine beetle deposits its egg under the bark of Ponderosa Pine. When the eggs hatch out, the tiny larvae feed briefly on the inner bark on the phloem layer, and continue to tunnel within the outer bark. The beetle's behavior will eventually kill the Ponderosa, by blocking nutrients.

5) Lewis's woodpecker (parasite) and Sugar Pine (host). Lewis's woodpeckers feed on insects in Sugar Pine trees. The holes they make expose sap, which attracts insects. Eventually due to more and more holes and insects, the tree will die.

6) Deer tick (parasite) and dog (host). The deer tick burrows into the dog's skin and feeds on its blood, giving the tick all the nutrients it need for growth and survival, but in return causing the dog discomfort or possibly making it sick with one of the many diseases ticks carry.

7) The willow gall sawfly and the willow. The willow gall sawfly causes green to reddish berrylike galls on the willow leaves in response to females inserting their eggs in young willow leaves. The willow gall sawfly benefits because its maggot-like larvae are able to feed inside the leaf galls and develop. The willow tree is harmed and sometimes killed.

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On the Ground & Beneath the Surface

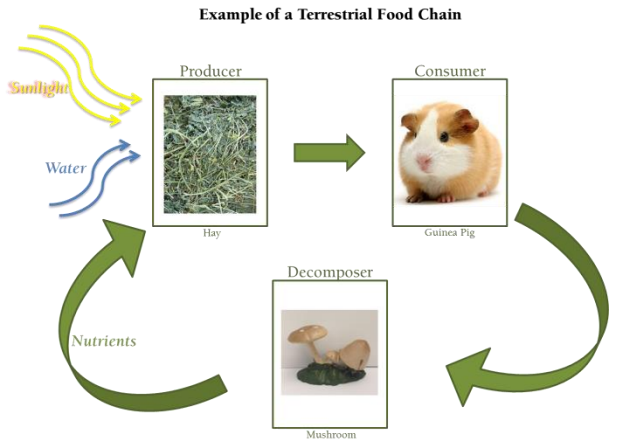
Passport Question: Producers, consumers and decomposers are all important parts of a _____ chain.
Answer: food

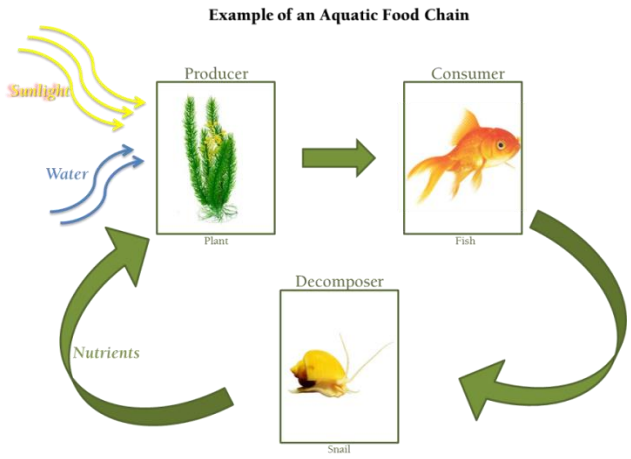
Learning Target: Students will understand how matter and energy cycle through an ecosystem.

Materials:
- 2 Aquariums
- Aquatic species (3)
- Terrestrial species (3)

Background:
Aquatic communities, just like land-based communities, are comprised of producers, consumers, and decomposers. Each type of organism plays a role in the functioning and health of the ecosystem. The producers are things like plants that produce their own food from inorganic substances (sunlight, air, water). Consumers are things like fish or bunnies that eat the plants, thereby getting their energy from compounds created by producers. Decomposers are things like fungus (mushrooms), bacteria, and snails that break down dead and decaying material to get their energy; by doing this decomposers return nutrients into their environment.

Procedure:
Aquatic Producer: Plant
Aquatic Consumer: Fish
Aquatic Decomposer: Snail
Terrestrial Producer: Plant
Terrestrial Consumer: Guinea Pig
Terrestrial Decomposer: Mushrooms





Questions To Think About (these will be posted on the aquariums along with the descriptions of the food chains and the organisms in them):

- Where do plants get their energy? [Plants get their energy through photosynthesis from the sun, the air, and water.]
- What happens to the nutrients the decomposers cycle back into the soil? [The nutrients become available for plants to use to grow, it's a big cycle.]
- What do fish and guinea pigs have in common? [They are both consumers!]
- What do mushrooms and snails have in common? [They are both decomposers!]
- Are humans producers, consumers, or decomposers? [Humans are consumers because we eat other organisms (animals and plants) that produce their own energy.]
- Matter cycles and energy flows through the ecosystem!

In Search of Pollen

Passport Question: Pollination is the process by which _____ is transferred to the female reproductive organs of a plant, thereby enabling fertilization.
Answer: Pollen

Learning Target: Students will understand that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. They will also learn that pollination involves the transport of pollen between the male part of a plant and the female part of the plant and that the evolution of pollination is an example of coevolution between plants and animals.

Materials:

1. 3 – 5 dissecting scopes, dissecting tools
2. Fresh flowers, most likely lilies (they have large stamens and stigmas)
3. Dead pollinator insects or models of these insects (bee, bug, butterfly) to look at under the dissecting scopes along with the flowers (MAY NOT HAVE THIS)
4. Laminated photos of different pollinators, hummingbird, bee, butterfly, etc… with their flowers (photos are included below)
5. Model of flower from SNC
6. Time line of when flowering plants developed (photo included below)

Optional: 2 iPads to play pollination matching interactive website and internet access

Background:

Visit a flower garden in the summer and you'll see and hear lots of activity. Bees are buzzing and busily moving from flower to flower. Butterflies are quieter, but they're visiting the flowers too. Ladybugs crawl and fly about. If you're lucky, you might even see a hummingbird or two. What's going on here? Why is everyone so busy?
These animals are attracted to nectar in the flowers. Nectar is a sweet liquid deep inside a flower. Nectar provides food for bees, butterflies and even bats to grow and also to lay eggs. Plants help animals, but the animals are helping the plants too. When bees and other animals move around flowers, they take pollen, which forms on the male part of the flowers, the anthers, and move it to the pistils, or female parts of the flowers. If the pollen lands in the right spot, it moves down through the pistils, to the eggs, which are inside the flower. Once the pollen meets the egg, a seed is formed. Seeds are usually formed in fruit. A berry is a fruit, so is an apple. Even a pea or tomato is a fruit because they contain seeds. Once the fruit is mature, it releases the seeds. The seeds land on the soil and create new plants. Seeds can't get up and walk, of course, but they move away from the parent plant in many ways. By moving, they can grow in a place where there's enough water, nutrients and light. Seeds have many ways of moving. Sometimes the wind blows them about. When animals eat the berries, the seeds come out in their poop. Some seeds, like cockleburs, attach to people and animals for a ride.

Procedure:

1. Students will first look at the model of the flower, they will then they will identify the reproductive parts of the flower.

2. They will then look at flowers under the dissecting scope and identify reproductive parts of the flowers.
3. Laminated photos of different plants and their pollinators will be set out on the tables, and dead pollinators will be available to look at under the dissecting scopes.
4. Students can play the pollination game on iPads and use flashcards to match different flowers to different pollinators. Students will match the pollinators to the flowers based on the characteristics that they have observed under the scopes, in the flower model and in the laminated photos.

Discussion:

- Is pollination important to plants?
  Yes, it allows sexual reproduction and mixing of genes.
- Do you think plants and pollinators evolved together, why?
  Yes, the shape of the plant fits the shape of the pollinator's beak or mouth parts and they serve a mutually beneficial purpose, food for the pollinator and mixing of genes for the plants.
- What might happen to a plant species if a specific pollinator is not available?
  Because the plant species cannot move if it needs that specific pollinator it might not get pollinated and might not be able to reproduce. This can lead to extinction of a plant species.

Sources: http://easyscienceforkids.com/all-about-pollination/

Planting Party

Passport Question: What four things do plants need to grow?
Answer: soil/nutrients, sunlight, water, carbon dioxide

Learning Target: Students will understand that plants grow through photosynthesis and need only air and water to do so.

Materials:

- Plastic Cups
- Soil
- Planting Basin
- Seeds
- Permanent Marker
- Pencils or dowels
- Plastic Wrap
- Scissors
- Rubber Bands
- Procedure photocopies

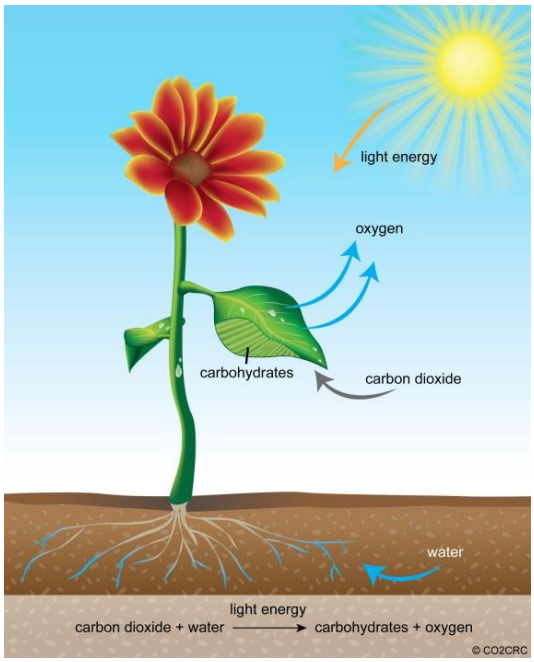
Background:

Photosynthesis converts light energy into the chemical energy of sugars and other organic compounds. This process consists of a series of chemical reactions that require carbon dioxide (CO_2) and water (H_2O) and store chemical energy in the form of sugar. Light energy from light drives the reactions. Oxygen (O_2) is a byproduct of photosynthesis and is released into the atmosphere. The following equation summarizes photosynthesis:

$$6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$$

Photosynthesis transfers electrons from water to energy-poor CO_2 molecules, forming energy-rich sugar molecules. This electron transfer is an example of an oxidation-reduction process: the water is oxidized (loses electrons) and the CO_2 is reduced (gains electrons). Photosynthesis uses light energy to drive the electrons from water to their more energetic states in the sugar products, thus converting solar energy into chemical energy.

We want the students to understand that plants really only need air and water to produce energy and survive.



Procedure:

1. Select a cup and use a permanent marker to label it with the date, your name and the species of your seed.
2. Poke a small hole in the bottom of the cup using a pencil.

3. Fill the cup ¾ full of packed soil.
4. In the center of the cup, create an approximately 3/4 inch deep hole using a pencil or the back of the tweezers.
5. Select a type of seed you would like to plant. Place seed in the hole using tweezers to get it out of the small bag.
6. Collapse hole and cover the entire cup with a thin layer of fresh soil.
7. Gently pack the soil.
8. Lightly water the surface of the soil.
9. Cover the cup with a thin layer of plastic wrap; keep somewhere sunny.
10. Wrap a rubber band around the cup to hold the plastic wrap tight and securely in place.
11. Keep cup covered until the seed germinates.
12. Uncover the seed after it grows to the point where it nearly touches the plastic.
13. Water heavily (until a significant amount of water begins to drain out of the holes in the base of the cup.) Repeat every 3 days.
14. Transplant to a better pot after one month.

Discussion:

- This investigation provides the opportunity to experience how plants grow and reproduce.
- All of the resources that a seed needs to germinate are contained in the mini terrarium that you will create (nitrogen, phosphorus, oxygen, carbon, hydrogen).
- Germination is the event that occurs as the potential for life contained within the seed is properly nourished and begins to grow beyond the confines of its protective armor. As the plant grows so does its ability to collect sunlight that it uses to generate its own energy (variables: leaf quantity and surface area).
- What are the holes in the bottom of the cup for? The leaves of autotrophs "breathe" carbon dioxide. The roots of a plant breathe oxygen. As plants sit in moist soil they have a tendency to deplete the water in the soil of oxygen. The holes in the bottom of the cup allow oxygen rich fresh water to flush old, oxygen deplete water, out of the soil.

Sources:
http://www.co2crc.com.au/images/imagelibrary/gen_diag/Photosynthesis_media.jpg
http://www.phschool.com/science/biology_place/biocoach/photosynth/overview.html

Pumpkins and Butterflies and Frogs, Oh My!

Passport Question: True or false: Many animals and plants go through similar stages during their life cycles.
Answer: True

Learning Target: Students will see the similarities in the phases of each life cycle even though the organisms are so different.

Materials:

- Large posters depicting each life cycle
- 2 sets of life cycle cards for each species (Pumpkin, Butterfly, Frog)

Background:

Pumpkins go through 6 stages: seed, sprout, vine, flower, green pumpkin, orange pumpkin. The seed is the initial stage and the pumpkin grows from that into a sprout with the proper nutrition, adequate water and sunlight. If the adequate conditions persist, the sprout will grow into a vine which will then flower. The flowers grown are both male and female. The flowers require cross pollination, usually by a bee, in order to produce a pumpkin. Once pollinated, the flowers will begin to grow into small, green pumpkins *(this is equivalent to the "birth" stage)*, that will eventually mature into a large orange pumpkins. This is the equivalent of the *"growth" stage* specified by the standard. The mature pumpkin will then produce a bunch of seeds inside of it. The mature pumpkin producing the seed is the equivalent of the *"reproduction" stage* specified in the standard. After a certain amount of time the pumpkin will begin to decompose. This is the *"death" stage*. This whole process occurs over 100 to 200 days. The seed will germinate in four to six days, four weeks later the flowers will start to bloom, two to three weeks after the flowers bloom you will start to see little green pumpkins, the pumpkins reach maturity about 100 days after this, and the mature pumpkins, if undamaged will remain healthy for 8 to 12 weeks before they begin to decay.

Frogs go through 5 stages: egg mass, tadpole, tadpole with legs, young frog, adult frog. During mating, the eggs laid by the female frog are fertilized by the male frog *(this is the "birth stage)*, 6 – 21 days after fertilization, the eggs hatch into tadpoles. After about 6 – 9 weeks the tadpoles start to grow small legs. By 12 weeks old, the tadpole starts to look like a young frog. By 16 weeks the fog will have completed its growth cycle *(end of "development" stage).* The frog will then begin this cycle again to produce new frogs *("reproduction" stage).* Mature frogs live about 10 – 12 years before they die *("death" stage).*

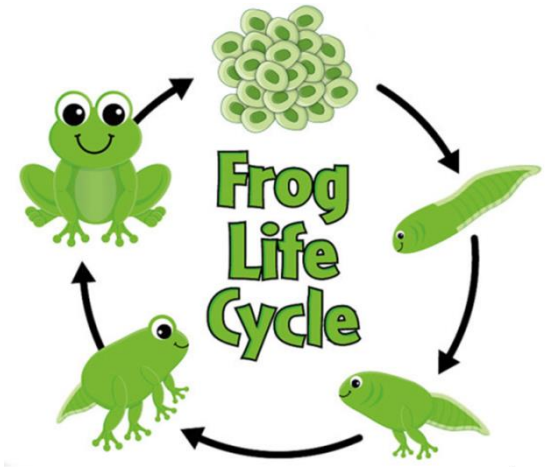
Butterflies go through 4 stages (5 playing cards, though): egg, larva/caterpillar, pupa, emerging adult, adult. Butterflies and moths undergo complete metamorphosis in which they go through four different life stages: Egg - A butterfly starts its life as an egg, Larva - The larva (caterpillar) hatches from an egg *("birth" stage)* and eats leaves or flowers almost constantly, The caterpillar molts (loses its old skin) many times as it grows *("growth" stage)*, Pupa - It turns into a pupa (chrysalis) ("development" stage), Adult - A beautiful, flying adult emerges. There is no growth during this stage. This adult will continue the cycle and reproduce until it reaches the *"death" stage*.

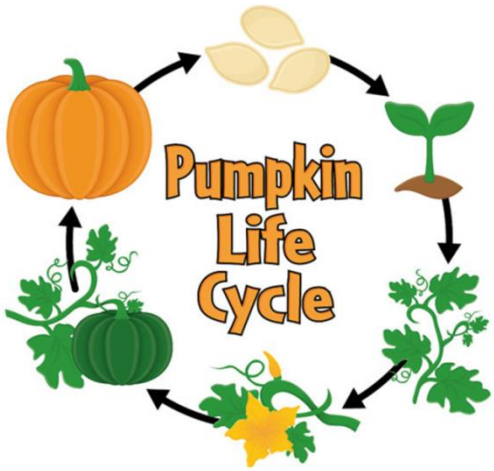
Procedure:

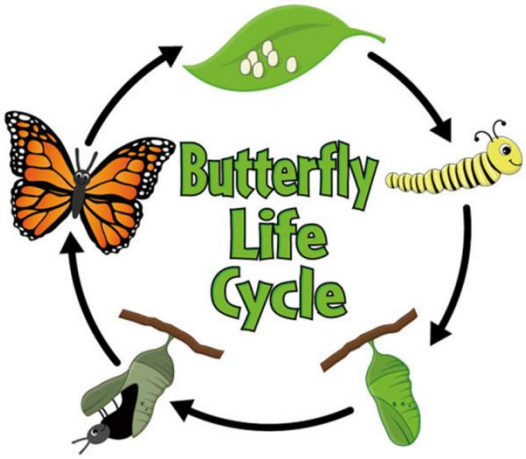
Students can choose to play the frog cards, the pumpkin cards, or the butterfly cards and the facilitator can explain the game to them. For each life cycle (pumpkin, frog, and butterfly), there are two versions of the game, one that has each stage of the life cycle numbered (for younger students), and one with the stages unnumbered (for older students). Each deck has 4 sets of life cycle cards in the deck. Have the students divide the deck in half by dealing one to each person until the cards are gone. They then play just like the traditional War card game. They each play a card, face up on the table between them, and the player who played the card with a more developed life cycle stage on it wins that round so they take both cards into a side pile they have. If the two cards played are the same, each player places three more cards, face down on the table then they play a fourth card and see who's fourth card is the higher card between the two. Once a player has played all the cards in their hand, they can shuffle their side pile and play from that. The idea is that the winner would eventually have all of the cards in the deck in their possession, but that takes a very long time so students can play as long as they would like to. Students can choose to play one or all versions of the game during their time at this station.

Discussion:

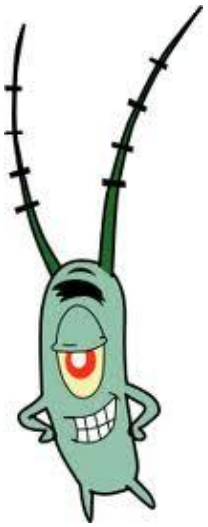
While the students are playing the game the facilitator can discuss with them any similarities they may see between the three life cycles, and how there might be similarities between other organisms as well. Do they know any other life cycles? Dogs? Humans? Butterflies? What are the similarities between each of these life cycles? What do they have in common? What is different between each?







Tahoe Plankton!



Passport Question: Zooplankton play an important role in Tahoe's food web. They eat _____ and are eaten by _____.
Answer: algae/phytoplankton, fish

Learning Target: Students will understand one component of the food web in Lake Tahoe. They will understand that zooplankton act as consumers when they eat phytoplankton, which are producers. They will also understand that zooplankton can act like secondary consumers when they eat other zooplankton (like Mysis Shrimp eating Daphnia).

Materials:

- Microscopes
- Live zooplankton
- Zooplankton slides
- Phytoplankton slides
- Tahoe Food Web poster

Background:

This activity aims to address the Next Generation Science Standard **LS2.A: Interdependent Relationships in Ecosystems** stating "The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or their parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem."

Food webs demonstrate how a variety of plants and animals are interconnected in numerous ways. Since animals often feed on multiple species, a food web involves a more complicated set of connections than a food chain, which follows a straight line. In the Tahoe Region, there are over 260 different species of mammals, birds, reptiles, amphibians and fish. These plants and animals range in size from microscopic zooplankton, such as daphnia, to large mammals, such as bears. Regardless of the size, each species plays an important role in the formation of Lake Tahoe's food web. In the last 135 years, human impact dramatically altered Lake Tahoe's ecosystem and food web. A few of the major changes include the introduction of Mysis shrimp in 1960's by the Department of Fish and Game, which were meant to be a food source for game fish. Instead, the Mysis are omnivorous eating algae, detritus, and other zooplankton, increasing competition with resident fish.

In any food chain or web, it is important to distinguish between producers and consumers. Only plants are producers because, as their name suggests, they use energy from the sun to produce their own food. Animals are consumers since they rely on plants

and other animals for energy. Within the larger category of consumers there are primary consumers (which only eat plants), secondary consumers (which eat herbivores), and tertiary consumers (which eat carnivores).

The species that reside in Lake Tahoe represent a full spectrum of producers and consumers. The ones we're focusing on are plankton: Zooplankton and Phytoplankton. Depending on the sample we get that day, under the microscope we will have Phytoplankton: diatoms, green algae. Zooplankton: Diaptomus, Epischura, Daphnia, Bosmina, Mysis Shrimp.

Some of the most important components in the Lake Tahoe ecosystem are:

- Sunlight and Nutrients – provide the base of the food web.
- Plankton – microscopic organisms which reside in the lake and compose the most basic level of the Lake Tahoe food web. Specifically, there are phytoplankton (microscopic plants and bacteria) and zooplankton (microscopic animals).
    - Phytoplankton are primary producers and use chlorophyll to convert energy from sunlight to carbohydrates. Common Tahoe phytoplankton include Diatoms, Chrysophytes (golden algae), and Chlorophytes (green algae).
    - Zooplankton can be either primary consumers (which eat phytoplankton) or secondary consumers (which eat other zooplankton). Examples of primary consumers are Daphnia, Diaptomus, and Epischura. Similarly, Mysis Shrimp are an example of a secondary consumer because they eat Daphnia, Diaptomus, and Epischura.

Procedure:

1. Set up microscopes and create a diverse sample of zooplankton in a petri dish.
2. Every 10-15 minutes you might need to put a fresh sample of water and plankton in the petri dishes, use your best judgment. Have microscopes already focused and set, so students will not have to adjust.
3. Discuss the background information, especially the difference between producers and consumers. Have students point out where producers are on the Tahoe Aquatic food web, how they know they are producers. Ask students if they can identify any of the species on the poster.
4. Have students identify the species they see in their petri dish sample under the microscope. Students can compare what they can see in the beaker with just their eyes to what they see under the microscope. If there's time, you can ask students if they watch "Sponge Bob Squarepants" (kid's TV show). Is the character shown on this sheet, named "Plankton", a type of zooplankton or a phytoplankton? How do they know? He eats crabby patties, so he isn't a producer.
5. Clean-up and potentially switch out samples if needed

Discussion:

Students should understand that our food web is interconnected; therefore major changes to species population or introducing a new species (potential food source or competitor) can be detrimental to an environment. It may not necessarily be a bad thing but there are many different things that can happen. Have students think about what might happen if a new species is introduced into the Tahoe food web: consumer species

is introduced and therefore competition for food source, if a food source in introduce, a possibility of the consumer species becoming overpopulated, sometimes an introduced species is not necessarily going to be negative, maybe now there's enough of food for all the consumers with the introduction of another producer etc.

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Meet the Microbes

Passport Question: A _____ is a tiny, microscopic organism found in water, soil, food, and in us!

Answer: microbe

Materials:
First Activity: 2 sets of Microbe Example cards and 2 sets of Microbe group cards, examples of fermented food (Coffee beans, bread/sourdough bread, kombucha, chocolate bar, etc), soil sample.

Second Activity: 1x1 meter PVC pipe frame with white paper, laminated sentence strips, printer paper and various colored construction paper, laminated example images of microbes, 4 metric rulers with centimeters and millimeter marked, 4 hand lenses, 4 scissors, 2 rolls of double sided tape

Main Science Concept: Interdependent Relationships & Ecosystems

Background:
When you think of the various forms of life, you probably imagine all kinds of plants and animals, but did you know that there are tiny, microscopic organisms living everywhere that help us live?

Microbes are very small living organisms, so small that most of them are invisible. The majority can only be seen with a microscope, which magnifies their image so we can see them. In fact, microbes are so tiny you would find over a million in a teaspoon of soil. They make up more than 60% of the Earth's living matter and scientists estimate that 2-3 billion species share the planet with us.

Microbes include the categories Bacteria and Archaea that you may have seen on the Tree of Life. Bacteria and archaea are not only the most ancient forms of life, going back at least 3.5 billion years, but they are also the most diverse and numerous organisms on Earth. For the first 2 billion years of Earth's history, they were the only living things on the planet. These microorganisms exhibit astounding diversity in where they live and how they survive. They also play an essential role in cycling elements that make the planet habitable for all other types of organisms. The diversity of these simple life forms is evident in the diverse places they inhabit, from hydrothermal vents in bubbling geysers to the acidic lining of your stomach.

Procedure:
1. Ask students: *what are some different kinds of microorganisms? Do microorganisms have different kinds of riles? What are some examples?*

Discuss the students' ideas. Tell students that they will be looking at specific examples of materials and resources that involve microbes.

2. Give the students one bag of cards. Have students remove the set of 20 cards, which describes roles performed by certain microbes. Instruct student groups to read, discuss, and decide the best way to sort the cards into categories.

3. After the kids have sorted the cards, have them resort the cards by the following categories (if they haven't already):

Role in Food Production	Role in Causing Disease	Role in Ecosystem/Environment

4. Tell students that the cards can also be sorted by "type/kind of microbe" involved in each process. Then, instruct kids to take the cards that they sorted into each of the three categories in the previous step and further sort each category into "kinds/types of microbes." Encourage them to sort each category one at a time. As they sort, engage them by asking the following questions:

General Discussion Questions: *Which microbe group doesn't have member with cells? Which groups have multicellular members?*

Role in Food Production: *What two groups are responsible for food production? Does this surprise you? What can we now say about microbes?*

Role in Disease: *What are the difference sand similarities between the microbes in food production and the microbes that cause diseases? What general statement could we make about microbes? Is it possible for the same microbe to be both helpful and harmful to humans or to another organism?*

Role in Environment/Ecosystem: *What roles to microbes play in our soil? What about our water? What role do microbes occupy in the food web?*

5. Collect the microbe example cards and the microbe type cards and put them back into plastic bags.

Then, move on to the next part of the activity, where students will compare the size of different microbes using a model.

Procedure:
1. Call students' attention to the laminated strips of paper.

2. Ask students to examine the periods at the end of the phrase with their eyes then with a hand lens. Discuss their observation. Ask: *Did the period appear the same when it was magnified as when you observed it with the naked eye?*

3. Ask students: *what they can say about the size of a period?* Tell students that a period is 0.5 millimeters in length in width. To put this into perspective, have students identify to millimeter and centimeter markings on a ruler. Ask students: *how many periods could be lined up, end-to-end, within a meter? (2,000)*

4. If necessary, review the metric system with students. Explain that meter is fundamental unit of measurement in the metric system, and that a meter is slightly longer than a yard stick. A centimeter is about the width of a human fingernail. Ask students: *how many centimeters are in a meter* (if they are unsure, help them by suggesting that they focus on the prefix centi-). Ask students: *how many millimeters are in a meter? How many millimeters are in a centimeter?*

5. Introduce students to even smaller unit of measurement, the micrometer (micron) which is one millionth of a meter. Mention that a micrometer is a unit too small for the naked eye to see and that a centimeter contains 10,000 micrometers. Ask students: *what the size of the period they observed is, in micrometers?* (500 micrometers). Ask students: *why the ruler is not divided into micrometers?*

6. Then, introduce the concept of a model. Ask students: *what they know about models? Why might scientists or students use models? What are the benefits of using models?*

7. Tell students that they are going to make a scale model of a microbe called a "Microbial Mural." Draw the students' attention to the prepared paper square and explain that this sheet represents the size of the period enlarged 5,000 times. Ask students: *if we enlarged most microbes 5,000 times, do you think that they would be larger or smaller than the period? (Even when enlarged 5,00 times, each of the microbe models will fit on the period.)*

8. Distribute the student sheets and assign each group several microbes the group of students. Instruct students to make a scale drawing or artwork of each of their assigned microbes based on the line drawings and sizes provided on the chart.

9. Have the students place their models on the large paper square. This is an effective way for students to self-check.

11. If the model sheet is getting over crowed, remove some of the model microbes after the students leave the activity station.

Discussion:
Bacteria is everywhere! And it is not all bad. Although many kinds of bacteria can get you sick, there are other kids that keep us healthy!

Ask students what they thought about microbes before this activity, and what they think of microbe now that they've learned more about them? *What do they think of when they hear the word microbe?*

Discuss the mural activity with students. *Did this challenge their idea about the size of microbes?* Ask students*: if they could use any of the microbes on the mural to complete the sentence on their sentence strips?*

Gone Fishing in the Lake

Passport Question: Name one fish found in Lake Tahoe. Is it native or non-native?

Answer: Answers will vary; example: Lake Trout/Mackinaw, non-native

Materials: kiddy pool, laminated fish, food web poster, 2 fishing poles

Main Science Concept: Interdependent Relationships & Ecosystems

Background: Until the mid-1800s, Lake Tahoe existed in its natural state, isolated high in the mountains, and untouched by humans except for a small number of Washoe Indians that lived in the area. European settlers that came to the land immediately knew the area was special for its beauty as well as its abundant natural resources. Much of these natural resources, as they soon discovered, lay beneath the lake surface, in the form of fish.

Several native species of fish existed in the lake, but by far the most impressive of these native fish was the Lahontan Cutthroat Trout, growing up to fifty inches in length and 40 pounds in weight, and being the top predator of the lake. Settlers at once saw the value of this fish as a food resource, and began to harvest it intensively, sending it by train to cities as far away as San Francisco and Chicago. Soon there were almost no trout left in Lake Tahoe, and the officials had to step in to prevent further fishing.

To fix the problem, the government decided to introduce several new species of fish into the Lake to allow fishing to continue, bringing species of fish like the brook trout, brown trout, and rainbow trout. Instead of fixing the problem, this introduction instead created new ones. One of these species, the Mackinaw trout, began to outcompete the few native Lahontan Cutthroat trout that were left, and soon enough they could no longer be found in the lake.

Over the past 150 years, many more non-native species of fish, crustaceans, and plants have found there way into Lake Tahoe, some intentionally and some accidentally. While some of these species fit relatively well into the ecosystem of the lake, others are harmful, preying on or outcompeting native species and leading to disastrous changes in the food web.

Some of the native and non-native species that can be found in Lake Tahoe include:

Native	**Non-Native**
Lahontan Cutthroat Trout	Mackinaw / Lake Trout
Tui Chub	Brook Trout
Mountain Whitefish	Brown Trout

Speckled Dace	Rainbow Trout
Paiute Sculpin	Kokanee Salmon
Lahontan Redside	Bluegill
Tahoe Sucker	Largemouth bass
	Smallmouth bass
	Bullhead catfish
	Crayfish

These species can be classified into three categories…

Native Species: Species originated or spread to the area without human assistance

Non-Native Species: Species accidently or intentionally introduced to the area but with limited consequences

Invasive Species: Species accidentally or intentionally introduced to the area but with harmful consequences to other native species

Procedure:
Ask: Why are we concerned about having lots of non-natives in Lake Tahoe?
- Because they can drive out native species and alter the food web.

Introduce students to the different fish species that can be found in Lake Tahoe.

Have students one at time take turns “fishing”.

When the students catch a fish, ask them to identify the fish by its species (They can look on the chart), then whether it’s native or non-native. After they guess have them check on the flip chart, or if the species is not there, use the chart above.

Discussion:
Did your group catch more native or non-native fish? What does that tell us about the fish populations in Lake Tahoe?
- More non-native. And there are more non-natives than natives in the lake currently.

Why do we care about fish?
- Many people simply enjoy fishing for sport and to catch something tasty to cook up for dinner. But in order to keep being able to fish, we must pay attention to how we treat them and their ecosystems.

What are some ways that we can protect fish and their ecosystems?
- We should limit the number of fish we catch per year, allowing them time to reproduce and grow so they will be enough the next year. We also must be careful about

introducing new species in the lake, doing lots of research before any introduction. These are all regulations we have in Tahoe today!

Inheritance and adaptations

Fruit and Veggie DNA

Passport Question: Name an example of one thing that has DNA and one thing that does not have DNA. **Answer:** Answers will vary.

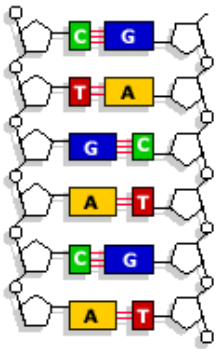
Materials: Strawberries, Peas, Rubbing Alcohol, Salt, Dish Soap, Blender, Strainer, Beaker, Ziploc Freezer Bag, Test Tube, Test Tube Rack, Meat Tenderizer, Tweezers, Plant Cell Poster, Necklace Vials, Gatorade, Pipette, Beaker for Gatorade, PCR Tube Rack, Labels, Tooth Picks, Vials, String

Main Concept: Inheritance.

Background: DNA, or deoxyribonucleic acid, is the genetic code that determines all characteristics of a living thing. It is located in the nucleus of the cell. All living things, such as humans, animals, plants, bacteria, contain DNA. Non-living things, such as rocks, clouds, chairs, stars, and houses, do not contain DNA. You get your DNA from your parents. This is called “hereditary material” and it is passed on to the next generation. Nobody else in the world will have the same DNA as you, unless you have an identical twin.

DNA is written in a special alphabet that is only four letters long! DNA is shaped like a curved ladder. This shape is called a double helix. The letters of the DNA alphabet are called bases and make up the horizontal steps of the ladder. Each base has a name but are referred to by their initials: adenine (A), thymine (T), guanine (G), and cytosine (C). Special sugars and other atoms make up their handrails. These bases are always paired specifically. A and T are always paired while C and G are always paired.

To extract DNA from a cell, scientists typically rely on one of many DNA extraction kits available from biotechnology companies. During DNA extraction, a soap or detergent will cause the cell to pop open, or lyse. This causes the DNA to be released into the solution. The alcohol is then added to the solution which causes the DNA to precipitate out. In this activity, strawberries/peas/cheek cells will be used to extract DNA. The students will be able to transfer the extracted DNA to a vial to wear as a cool necklace!



Prep before each activity round:

- Make sure strawberries and peas are chopped before each activity.
- Rubbing alcohol should consistently be cold. Swap bottles from freezer before each activity round if needed.
- Refill ice water pitcher before each round
- Rinse test tubes.

Procedure:

For Strawberry/Pea DNA

1. Decide if students want to extract DNA from a strawberry or a pea. They will measure out ½ -1 cup of the pieces and add it to the blender.
2. Add 1 cup of cold water and ¼ teaspoon of salt to the blender. **Ask the students**: "What do you think the salt does to the strawberries?" (Answer: the salt makes sure the DNA does not dissolve in the water. It becomes less *hydrophilic*).
3. Blend the mixture on high for 15 seconds or until you have a thin soup.
4. Pour the blended mixture through a strainer into a beaker and add 2 tablespoons of dishwashing soap to the mixture. Swirl thoroughly. **Ask the students:** "What do you think the dishwashing soap does to the solution?" (Answer: the soap solution breaks the cell membranes that are made up of fats – just like soap breaks down grease on your dishes)
5. Set this mixture aside and allow for it to settle out for the next activity round. Use the mixture that was prepared from the previous activity.
6. Fill test tubes about halfway (1 tube for every 2-3 students). Add a pinch of meat tenderizer to each tube and stir GENTLY (if you stir too hard, you will break up the DNA strands and make it harder to see at the end of the experiment. **Ask the students:** "What do you think the meat tenderizer does to the solution?" (Answer: the meat tenderizer breaks apart the proteins in other parts of the cell so the DNA can fully be released into the solution.)
7. Tilt the test tube to the side and pour 2-3 teaspoons of rubbing alcohol slowly down the inside of the test tube. The alcohol should form an inch thick layer on top of the mixture. DO NOT MIX. **Ask the students:** "What do you think the alcohol does to the solution?" (Answer: The alcohol pulls the "salty" DNA from the solution into the alcohol layer)
8. Place the test tubes back in the test tube racks and watch for the DNA to appear at the boundary line between the alcohol and solution. The DNA will appear to be a white, stringy clump of residue. It will take a few minutes for the DNA to precipitate out of the solution.
9. Use the tweezers to gently remove the DNA and place it in the vial. Use a teaspoon to put a small amount of the left-over liquid in the vial as well.
10. Tie string through the vial and allow the kids to wear it as a necklace.

***Because it may take a few minutes to see the DNA to precipitate out, we recommend that for each demonstration you do the experiment as described in the procedure, but for the showing of the clump of DNA, show your results from your previous experiment. ***

For cheek cell DNA:

1. Pipette clear Gatorade into student's mouths (9mL). Have them vigorously swish it around in their mouth for 30 seconds. **Ask the students:** "What does the Gatorade do to our cheek cells?" (Answer: the salt in the Gatorade begin to break the cell membrane and the membrane around the nucleus to free the DNA.)
2. Tell the students to spit the Gatorade into a test tube.
3. Add 1 teaspoon of dish soap and swirl thoroughly. **Ask the students:** "What do you think the dishwashing soap does to the solution?" (Answer: the soap solution breaks the cell membranes that are made up of fats – just like soap breaks down grease on your dishes)
4. Fill test tubes about halfway.
5. Tilt the test tube to the side and pour 2-3 teaspoons of rubbing alcohol slowly down the inside of the test tube. The alcohol should form an inch thick layer on top of the mixture. DO NOT MIX. **Ask the students:** "What do you think the alcohol does to the solution?" (Answer: The alcohol pulls the "salty" DNA from the solution into the alcohol layer)
6. Place the test tubes back in the test tube racks and watch for the DNA to appear at the boundary line between the alcohol and solution. The DNA will appear to be a white, stringy clump of residue. It will take a few minutes for the DNA to precipitate out of the solution.
7. Use the tweezers to gently remove the DNA and place it in the vial. Use a teaspoon to put a small amount of the left-over liquid in the vial as well.

Discussion:

Where is most DNA located? And in which part of the cell is most of the DNA located?
-In the cell (refer to the poster). In the nucleus of the cell (refer to the poster).

What are some different living organisms that contain DNA?
-They all do!

Does everybody have the some DNA?
-No! Everybody will have a different copy of DNA genome. Only identical twins will have the same genetic code because they share the same physical characteristics

What are some things you could find outside that don't have DNA?
-Rocks, water, clouds, etc.

What does the soap and meat tenderizer do to the solution?
-Soap breaks up the fats that make up the cell wall (refer to poster) and the enzymes in the meat tenderizer break apart long protein strands that make up other parts of the cell, freeing the DNA.

Why does DNA precipitate out of the water solution when the alcohol is added?
-Adding the salt to the mixture created salty DNA which will precipitate out of the solution when alcohol is added. The rising DNA pulls more strands with it as it rises through the alcohol, creating the clump of DNA.

DNA Recipes

Passport Question: All living things have their own code called ____ that is located inside of the ____. **Answer:** DNA/Cell

Materials: Plastic DNA model pieces, DNA recipes for various organisms, animal cell poster

Main Concept: Inheritance

Background: DNA, or deoxyribonucleic acid, is the hereditary material in humans and almost all other living organisms. Nearly every cell in a person's body has the same DNA. The information in DNA is stored as a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). The order, or sequence, of these bases determines the information available for building and maintaining an organism, similar to the way in which letters of the alphabet appear in a certain order to form words and sentences, or the ingredients in a recipe make up the dish. Differences in how the bases are put together can cause difference in eye color, height, size, hair color, etc.

DNA bases pair up specifically, A with T and C with G. They form units called base pairs. Each base is also attached to a sugar molecule and phosphate molecule. Together, a base, sugar, and phosphate are called a nucleotide. Nucleotides are arranged in two long strands that form a spiral called a double helix. The structure of the double helix is somewhat like a ladder, with the base pairs forming the ladder's horizontal steps. The sugar and phosphate molecules form the vertical sidepieces of the ladder. A strand of DNA is referred to as a double helix.

DNA has the ability to replicate, or make copies of itself. Each strand of DNA in the double helix can serve as a pattern for duplicating the sequence of bases. This is critical when cells divide because each new cell needs to have an exact copy of the DNA present in the old cell.

Each DNA sequence that contains instructions to make a protein is known as a gene. The size of a gene may vary greatly, ranging from about 1,000 bases to 1 million bases in humans. The complete NA instruction book, or genome, for a human contains about 3 billion bases and about 20,000 genes which if unraveled and laid out the strand would stretch from the earth to the sun 100 times! (Cool fact to tell the kids!)

Procedure:

1. Explain to the students:
    - What is DNA? It is the *hereditary* material in all living organisms.

- What is DNA made up of? It is made up of subunits called *nucleotides*. Nucleotides consist of sugar, a phosphate, and a base. There are four bases (A, T, G, and C)
- What is the shape of DNA? The nucleotides are arranged in two long strands that form a spiral called a *double helix*.

2. Students will choose a recipe card of an organism.
3. Explain to the students the different parts of DNA.
    - White—Sugar molecule
    - Black—Phosphate molecule
    - Colored—Base Pairs that are always in a specific pair. (A&T, G&C). In this case, red & yellow and blue & green.
4. Help the students build their DNA strand and twist the ladder into a double helix shape. (Optional: if the students followed the recipe correctly, give them a sticker of the organisms DNA they made.)

Discussion:

Do you notice any patterns in the color code?
-Yes, yellow is always with red, and green is always with blue. This is how base pairs work! Adenine (A) is always with tyrosine (T) and cytosine (C) is always with guanine (G).

How is DNA like a recipe?
-The base pairs make up a code. Their specific order tells one type of cell what other kinds of cells to make, which determines the characteristics of the organism-making a flower have petals or a fish have scales.

Where is DNA found? In what part of the cell?
-In the cell! (Refer to the poster) In the nucleus! (Refer to the poster)

Tree of Life

Passport Question: True or False. All living things are related.

Answer: True

Materials: Big "Tree of Life" poster, organisms with Velcro, real animals/plants

Main Concept: Variation, Natural Selection

Background: Every living thing is connected! We use the "Tree of Life" to model this. The Tree of Life is a metaphor or MODEL and research tool used to explore the evolution of life. It is used to describe the relationships between organisms, both living and extinct, and the idea that all life is related by common descent. The branches on the "Tree of Life" show how organisms are evolutionarily related to each. Charles Darwin was the first to use this metaphor in modern biology and is still used today.

It includes the following groups of organisms:

- Bacteria: One of the first life forms on earth! These are microscopic organisms found in soil, water, plants, and animals.
- Archaea: One of the first life forms on earth! They are made of a single cell and can be found in some of the most extreme places on earth such as within a volcano or a salty lake.
- Protista: Includes algae (plankton), some pathogens, and many other microscopic organisms.
- Fungi: includes yeasts, molds, mushrooms, and more. Fungi are more closely related to animals than plants.
- Mollusca: Squids, octopi, snails, slugs, and shellfish.

We use characteristics traits to identify an organism and group it with other organisms that are similar. However, certain characteristics are not useful for grouping things together on a larger scale (i.e. wings of birds, bats, and insects). Certain characteristics can be useful to separate organisms into smaller groups (species). Other characteristics that we cannot directly see such as, bone structure and DNA sequences are also used to construct the tree of life.

Procedure:

1. Show the students the tree of life poster on the wall. Point out and explain:
    - The different branches

    - The proximity of the different branches
    - How each branch stems from the same spot
2. Explain to the students that all life originally stemmed from one branch and we use this MODEL to portray that. The Tree of Life is a metaphor to MODEL the evolution of life. Scientists use this model to describe the relationships between organisms (both living and extinct).
3. Let the students pick an organism and place it on the Tree of Life poster where they think it best fits. If they are having trouble, remind them that they are grouped on similar *characteristics*.
4. After, they may also observe the live plants and animals and observe their traits.

Discussion:

- How did you decide where the organism belonged on the “Tree of Life”?
- What is one characteristic that the species on your branch had?

Take away messages from this activity:

1. Everything living is related.
2. The Tree of life shows how living things are related to one another.
3. Characteristics, or traits, can be used to put organisms into different groups.
4. Scientists classify organisms into different groups to understand them better.

Brilliant Bird Beaks

Passport Question: The shape of a bird's beak is an ____ for gathering specific foods.
Answer: Adaptation

Materials: Plastic bin, small bowls, tweezers, popsicle sticks, spoons, chopsticks, fish hooks, tea ball, bird seed, yarn, pasta, sequins, stopwatch, bird diversity poster

Main Concept: Natural Selection, Adaptation

Background: When you look at different bird beaks, you're seeing a great example of something called adaptation. Adaptations are traits that developed to perform a certain function and allow organisms to thrive in their environment. Although one adaptation might be very useful for a certain species in a specific environment, that same trait might not be useful for another species in a different environment.

To understand how adaptations arise, it helps to understand the process of evolution. Populations of plants, animals, and other living organisms change over many generations. Scientists call this process natural selection. Natural selection happened in a species when individuals that have traits better adapted for their environment survive longer and have more babies. They pass on the beneficial adaptations to their offspring. So, over the generations these adaptive traits become more common in the population until nearly all individuals in a species have the adaptation.

Have you ever wondered why there are so many types of bird beaks? The most important function of a bird beak is feeding. It is shaped according to what a bird eats. The beak is one of the characteristics used to identify types of birds. You can even figure out what a bird eats where it lives just by looking at its beak!

A bird's beak is a character that has changed for each species over time as an adaptation to food sources. Beaks have changed so much and so drastically because food is a very important factor that determines which birds survive and reproduce better.

- Insect-eaters: Warbler has a long thing bill and tweezer-like bills that help them catch prey. (Tweezers)
- Meat-eater: Carnivorous birds like the hawk have curved beaks with razor sharp tips that help them tear into small parts to make it easy to swallow (Fish hooks)
- Seed/Fruits/Plant-eater: Birds like doves possess a slim and short beak that helps them fee on seeds, fruits, and plants. Some species have also been known to consume worms. (Chopsticks)
- Aquatic plants/fish eaters: Being aquatic birds, ducks possess flat beaks that help strain the water from the sides when they consume food which includes aquatic plants and animals. (Popsicle sticks)
- Fish-eaters: Birds such as the brown pelican widens the lower mandible to enclose a fish in its pouch, which is trapped when the upper mandible shuts. (Spoons)

Procedure:

1. Explain the rules to the students: Do not spill or drop the simulated food. Food is too important to survival for birds to waste any.
2. Fill the large bowl with a small amount of each “food” type.
3. When signaled, each student will simulate the behavior of bird foraging for food. They are given one tool to use as their “beak”. With their “beak” they are to collect as much food as they can into their cup in 30 seconds (keep time on stopwatch)
4. When time is up, have the students observe the 1.) Amount of food they collected 2.) The type of food they were able to collect.
5. On the chart, have the students record how many of each type of food they caught next to their tool with 1 tally mark for each piece of food. Also record the number of bird seed and sequins they collected.

Discussion:
How did different birds develop their different types of beaks?
-Over many generations, bird’s beaks have evolved to adapt to the different types of environments they are in and to the different food sources they have access to.

If the environment were to change, how do you think it would affect which individuals are better able to gather food, survive, and reproduce? Could this affect the kind of beak that becomes common in this population?

Natural Selection in Action

Passport Question: What is the process that caused the moth population to change over time called? **Answer:** Natural Selection

Materials: 4 trees (2 w/Velcro spots, 2 without), Moths with Velcro

Main Science Concept: Natural Selection

Background: The Peppered Moth is widespread in Britain and Ireland and frequently found in ordinary backyard gardens, yet its amazing story has made it famous all over the world. It is one of the best known examples of evolution by natural selection, Darwin's great discovery.

Peppered Moths are normally white with black speckles across the wings. This patterning makes it well camouflage against lichen-covered tree trunks when it rests on them during the day. There is also a naturally occurring genetic mutation which causes some moths to have almost black wings, which are not as well camouflaged on the lichen as the normal colored Peppered Moths. Because they are less camouflaged on the lichen, they are more likely to be eaten by birds and other predators. This means that fewer black forms survive to breed and so they are less common in population. This is the normal situation observed in the countryside of Britain and Ireland.

In the nineteenth century, it was noticed that the black form of the Peppered Moth was more common than the pale form of the moth in towns and cities. The Industrialization and domestic coal fires had caused sooty air pollution which had killed off lichens and blackened urban tree trunks and walls of buildings. So now it was the pale form of the moth that was less camouflaged and more obvious to the predators. The darker colored moth was better camouflaged against the buildings and more likely to survive and produce offspring. As a result, over successive generations, the black moths came to outnumber the pale forms in our towns and cities.

Since moths are short-lived, this evolution by natural selection happened quite quickly. The first black Peppered Moth was recorded in Manchester in 1848 and by 1895 98% of Peppered Moths in the city were black. In the mid-twentieth century controls were introduced to reduce air pollution and as the air quality improved tree trunks became

cleaner and lichen growth increased. Once again the normal pale Peppered Moths were camouflaged and the black forms were more noticeable. Now the situation in urban areas has again become the same as in the countryside, with normal pale Peppered Moths being far more common than the black forms. So natural selection has been seen to work in both directions, always favoring the moth that is best suited to the environmental conditions.

Procedure:

1. Explain that originally most of the Peppered Moth population was white with black specks. The mutant forms of these moths were black with white specks and were very rare. The predators of these moths are birds.
   Show the students the board with the lightest background (should have 2 black moths and 8 white moths).
   Ask the students which colored moth do they think will have a better chance of survival? (Answer: the white ones will have a better chance of surviving because they are camouflaged against the white tree.)
   Demonstrate this by having a student act as a bird hunting for these moths. Have the student close their eyes and explain to them they are a bird looking for food. When they open their eyes, they will grab the first moth they see from the tree board. (They should have taken the black moth because it is less camouflaged and more likely to be **selected off** by their predators.)

2. Explain to the students that over time the trees that the moths were found got darker and darker.
   Show the students the two next two darker boards. Make sure to point out the dates on the bottom of the boards.
   Ask the students why they think the trees could have gotten darker over time. (Answer: the industrial revolution that brought coal production had caused sooty air pollution that covered the trees and sides of buildings). If they are having trouble, point to the timeline below the boards hinting at the coal production.
   Demonstrate this by placing one white moth and one black moth on each of the boards. Tell the students that now the black moths are becoming more camouflaged and the white ones have a less chance of surviving because they are more noticeable against the trees.

3. Explain to the students that now the black moths are more camouflaged and the white ones have a less chance of surviving because they are more noticeable against the trees. Tell them that this mocks the situation 50 years later (1900's).
   Show the students the board with the black background (should have 2 white moths and 8 black moths).

Ask the students which colored moth do they think will have a better chance of survival now? (Answer: the black ones now have a better chance of surviving because they are camouflaged against the dark trees and will not get eaten by their predators.
Demonstrate this by having a student act as a bird hunting for these moths. Have the student close their eyes and explain to them they are a bird looking for food. When they open their eyes, they will grab the first moth they see from the tree board. (They should have taken the white moth because it is less camouflaged and more likely to be **selected off** by their predators.)

4. Lastly, show the white board to the students again and explain that this is what the peppered moth population is like today. After 50+ years later, we stopped burning as much coal for energy and because of this the environment became cleaner and soot free.

Discussion:

- What happened to the moth population over time?
- What caused this change?
- What other types of human pollution could change an animal's habitat?
- How could something similar happen in an air or water environment?

The Adaptation Game

Passport Question: _____ are certain traits living things evolve which make it easier for them to survive in their _____.

Answer: Adaptations

Learning Target: Students will play the adaptation game to discover how certain adaptations help animals survive in different environments. They will use critical thinking to come up with new adaptations animals would need to survive in new environments.

Materials: Worksheet 2.5 – Adaptation Came cards template, drawing paper, colored pencils or markers.

Background: Adaptations are traits that living things evolve over time that make them better suited to life in their environment. It takes a long time to evolve new adaptations because evolution depends on random beneficial mutations. As environments change over time, living things either evolve along with their environment, or they get outcompeted by species that are better suited to the changing environment.

Procedure:

1. Ask participants to define the word ‘adaptation’ in their own words.
2. Once the definition of the word is established, ask participants to make a list of adapted features in animals they are familiar with.
3. Announce to participants that they will play a game of adaptation that is as random and challenging as nature itself.
4. Explain that each group will pick one card from the animal group and match it with a card from the environment group.
5. Demonstrate by picking up a card from each pile and showing it to the groups. Use the example of the raccoon card with the swamp environment. What would such an animal look like? Discuss the possibility of raccoons developing webbed feet or an oily fur to repel water.
6. Explain that participants will attempt to draw pictures of what physical adaptations many generations of animals might develop in a new habitat.
7. Distribute drawing paper and colored pencils/markers to groups and encourage them to include as much detail as possible in their drawings.

Discussion:

- Discuss the adaptations each group gave their animal and how they would help their animal to survive in their new environment.
- List some examples of real adaptations and explain how evolution makes them possible.

Blubber Glove

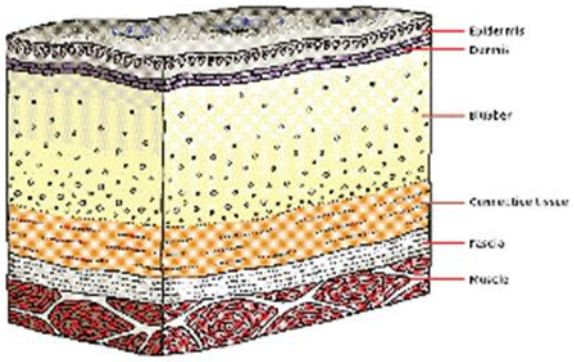
Passport Question: What helps animals in arctic waters stay warm and keep afloat?
Answer: Blubber!

Materials: Freezer bags, Crisco, duct tape, ice, water bin, towels, pictures of Arctic animals

Main Science Concept: Adaptation

Background: Mammals that have evolved to live in cold waters, such as whales, seals, sea lions and polar bears, commonly have a layer of blubber. Whether they are living in cold waters near the North Pole or around Antarctica or are visiting the deep ocean, these animals' blubber is vital to their survival. During the winter, the air in the Arctic (the northernmost part of the world) is often below –40 degrees Celsius (–40 degrees Fahrenheit). Antarctica, the coldest place in the world, can be below –60 degrees C (–76 degrees F). Depending on the species, whales dive more than 400 or 500 meters (about one fourth of a mile) deep in the ocean, where the water can be colder than 12 degrees C (54 degrees F).

Blubber helps these marine mammals from getting too cold. (Cold-blooded marine animals, such as fish, sharks or crabs, do not need to stay warm and can let their body temperatures get closer to that of the water. Thus, they do not need to have this extra insulation.) Blubber is a thick layer of fat (adipose) tissue. Animals store extra digested food in the form of adipose tissue, which contains molecules called lipids. Adipose tissue has a relatively low thermal conductivity, which means that it does not transfer heat as well as other tissues and materials—such as muscle or skin. That way, it helps to insulate an animal's body.



Warm-blooded mammals can live in these chilly conditions because their bodies have some cool warmth-saving adaptations, thanks to generations of natural selection.

In other words, to pass on characteristics (via their genes), the predecessors of modern marine mammals had to overcome different challenges to reproduce, and their descendants received the genes that allowed for their survival. This kind of change in organisms over time is what fuels evolution. An important adaptation for marine mammals is blubber, a thick, insulating layer of fat beneath the skin that helps to keep body warmth in and the cold of the air or water out. Will a layer of fake blubber—in the form of shortening—help you keep from getting cold?

Procedure:

1. Have the students make a prediction about what they think will happen when they put their hand in the ice bucket with the different “gloves”.
2. One at a time, each student will put on the gloves and submerge their hands in the ice bucket. Make sure the students do not dip hands too far to prevent the inside of the glove from becoming wet. The glove with Crisco represents “blubber” and the other glove is the control.
3. Tell the students to attempt to explain what is happening. Have the other students look at the photos of the arctic animals and guess which do and do not have blubber. (The answers are on the back of the cards)

Discussion:

Why do we have these two different gloves?
-In this experiment the glove with Crisco represents a blubber layer and the glove without Crisco represents the absence of a blubber layer.

Besides keeping animals warm, is there anything else that blubber does?
-It improves buoyancy and acts as food reserves for animals. Did your hand with the blubber glove feel lighter in the water than the control hand? That

Pollination Adaptations

Passport Question: True or False: The color, shape, and smell of different flowers are adaptations that help the plant to attract pollinators.

Answer: True

Learning Target: Students will learn about different flower adaptations and how they attract different pollinators.

Materials: Worksheet, colored pencils/markers, drawing paper

Background: Why do flowers have such beautiful and varied shapes, colors, and smells? Because flowers can't move, they use their shape, color, and scent to attract pollinators like moths, hummingbirds, butterflies, honeybees, and beetles. Pollinators are hungry for nectar, the sweet-smelling liquid inside the flower, and when they take nectar from deep within the flower, they get covered with pollen. The pollinator then moves from flower to flower and is unaware that it's spreading pollen along the way. This turns out to be a pretty good deal for both the pollinator and the flower, because the pollinator needs the nectar from the flower for energy, while the flower needs pollen from another flower to be fertilized. Pollinators don't just go to any flower, though. Certain insects and birds are attracted to certain flower shapes and colors. These flower features are ADAPTATIONS. They are strategies the plant has developed over time to help it survive and reproduce in its environment.

The transfer of pollen between flowers of the same species leads to fertilization, and successful seed and fruit production for plants. Pollination ensures that a plant will produce full-bodied fruit and a full set of viable seeds. Pollinators are attracted to certain colors, shapes, and scents of flowers. In this activity, students will explore the different adaptations that plants have to attract a certain pollinator.

Procedure:

1. Start out with a discussion about different adaptations flowers have to attract certain pollinators. Some flowers are shaped loke long tubes so that only pollinators with long beaks or tongues can access their nectar. Some flowers smell like rotting meat to attract flies.
2. Point out the flower and pollinator cards laid out on the table. Note the differences between the cards and ask the kids to place the pollinator cards on the type of flower they think the pollinator would like.
3. Once the cards are sorted, go through each one and explain why the pairing was right or wrong based on the adaptations of the flower.

Discussion:

Why might the beetle like white flowers? (Hint: many beetles are nocturnal)

-White is the easiest color to see in the dark

What is one reason some flowers have large base petals?

-To support the weight of pollinators landing on them to obtain nectar.

Why are some flowers tube shaped?

-To fit a pollinator's long beak (hummingbird) or tongue (butterfly).

Why does a flower want to be attractive to pollinators?

-Because pollinators transfer pollen to different flowers, helping the flower to reproduce.

Seeds on the Move

Passport Question: What is one way a seed can travel? **Answer:** Wind, water, on animals, in animals

Materials: Small fan, stuffed bear, water basin, seed strategy key, various seeds in bags.

Main Concept: Adaptation

Background: Seed dispersal is the movement of seeds away from the parent plant. Dispersal of seeds is important for the survival of a plant species. If plants grow too closely together they compete for light, water, and soil nutrients—therefore, seed dispersal is a way to distribute offspring so they have a better chance of survival. In flowering plants like apple trees, one or more seeds are housed within a fruit which is the portion of the apple that we eat. Sweet fruits like apples are eaten by animals that disperse the undigested seeds. Other plants have fruit that remain on the plant and disperse only the seeds. In either case, plants have evolved different dispersal mechanisms and methods of transport. Some fruits can be carried by water, like the coconut, Burdock fruits have hooks that attach to and are dispersed by animals. Dandelion fruits are suspended from feathery "parachutes" that are carried on the wind. The fruit of ash trees have wings that let them float on air. These various strategies can be categorized into dispersal by wind, water, on animals, or ingestion by animals.

Procedure:

1. Have students choose a bag with a seed in it and observe it closely.

2. Ask each student to describe their seed to you in one word. Have them make predictions of how they think their seed would travel, choosing between the 4 mechanisms of dispersal.

3. Next, they will test their seed using the 4 stations-dropping it in water, letting it go in front of the fan, trying to stick it to the bear, and asking the bird, would you eat this?

4. Have each student decide what they think the seed's dispersal strategy is. Once they have and idea, they can ask you to tell them if they are correct. You will find the answer on the seed key, where each number corresponds with a seed type.

Note: The dispersal method given on the key is not the only way the seed may disperse, so their predictions may have been right- the key just gives its main method.

Facilitator's Quick Key:

- Wind—Catalpa, Redbud, Scotch pine, American Elm, Alfalfa, Cottonwood, Silver Maple, Green Ash

- Water—Black Willow, Sycamore
- On Animals—Sweetgum
- In Animals—Red Cedar, Watermelon, Pumpkin, Tomato, Hackberry, Black Walnnut

Discussion:

- Why do you think dispersal is important for plants?
    - *Dispersal is important because if the seeds are not dispersed, the seedlings will grow very close to the parent plant. This results in competition (for light, space, water, and nutrients) between every one of the seedlings and with the parent plant.*

Health and Nutrition

Train Your Brain

Passport Question: True or false: Every time you learn something new you change the structure of your brain.

Passport Answer: true

Materials:

- Color cards in corresponding color (12)
- Color cards with wrong color (12)
- Spanish color cards with wrong color (10)
- Item cards in different colors (10)
- Timer
- White board and markers

Background:

The psychological test now called "the Stroop effect" was first described in 1935 by John Ridley Stroop. The Stroop effect appears to tap into important cognitive processes. This activity tests the brain to ignore its instinct, to read the words written on the card, and instead name the color it is written in. It is a challenge of concentration and focus, and **teaches students they have changed the structure of their brains by learning to read.**

Procedure:

1) Start with the cards written in the correct color. Tell the student to say the **color the word is written in**. Time how long it takes the student to go through the twelve cards saying the color that is filled in on them.
2) Record on the whiteboard the amount of time it takes to go through the first stack of cards.
3) Next, take the cards with colors written in the wrong color. Tell the students their job is to, again, say the **color the word is written in**. Time how long it takes them to read through the 12 cards this time.
4) Record on the whiteboard.
5) **Compare the times between the two tests.** You are looking for a time difference between the tests to show that the reading skill cannot be “turned off.”

Additional challenges:

6) For an additional challenge students can try 10 Spanish cards written in the wrong color, similar to the second test. For an extra challenge mix English/Spanish words together. It would be great to introduce the Spanish cards to those students who speak Spanish as their first language.

7) Another challenge they can try is to use the set of everyday words and have students say the color opposed to the word written.

Discussion:

- *Why do students think it takes them longer to say the color instead of reading the word? Was it harder or easier to say the color when the words that were written weren't colors?* There are a few hypotheses (see below) to explain why saying the word is harder than reading it. Explain what a hypothesis is (a proposed explanation about how things work). *If you want to keep it simple, just explain the "automatic word recognition hypothesis."*

The "*automatic word recognition hypothesis*" is considered the most plausible explanation for the Stroop Test. This theory says that reading is an automatic process, which cannot be turned off once you learn how to do it. In other words, people see the meaning of words without much effort once they learn to read. On the other hand, naming colors is not automatic. It requires more effort than reading, and causes interference in the Stroop task.

The "*speed of processing*" hypothesis says that word processing (reading) is much faster than color processing (saying). Therefore, when you have to say the color, the written word information arrives at the decision making part of the brain before the color information. This results in processing confusion. On the other hand, when you have to read the word, a decision can be made to say it before the conflicting color information arrives in the brain, since the color information travels slower.

The "*parallel distributed processing hypothesis*" says different tasks develop separate processing pathways in the brain, and practice creates pathway strengths. Therefore it is strength, not speed that is more important. We automatically want to read the word over saying the color because that pathway is stronger. For the Stroop task this means that if two pathways are active at the same time, and the pathway that leads to the response is stronger (naming words), no interference occurs. However, if two pathways are activated at the same time and the pathway that leads to the response is weaker (naming the color of the word), interference results and it takes longer to do.

Think Fast!

Passport Question: _____ are voluntary or something you control; _____ are involuntary and happen without your control.

Passport Answer: reactions; reflexes

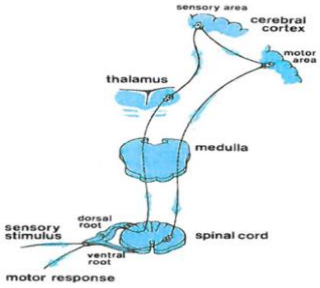
Materials:

- Reaction time rulers (2)
- Percussion Hammer (2)
- Decks of cards (2)
- Pen Lights (2)

Background:

Reflexes and reactions are often confused, but important differences exist. **Reactions are voluntary responses whereas reflexes are involuntary or unintentional, meaning that in most cases they are not subject to conscious control.** Each type of response is initiated by a sensory stimulus. The stimulus excites specialized sensory receptors that respond specifically to a certain type, quality, and/or intensity of stimulation. Once activated, the receptors propagate nerve impulses that travel toward the brain along sensory nerve tracts. The speed of a reflex is greater than that of a voluntary reaction, due largely to the relative complexity of the neural pathway for a reaction (Fig. 1) compared to that for a reflex (Fig. 2).

Fig. 1 Pathway for a voluntary response to a stimulus



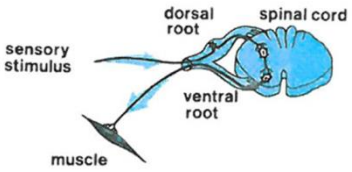


Fig. 2 Generalized Reflex Arc

Procedure:

1. Ask about the words reaction and reflex. See if the students know the words and can explain the difference.
2. Have each student find a partner to go through **the reaction tests.** If there is only one student, he/she can partner with you. Have the students report their times to you and record the times on the whiteboard.
   a. In the first test a student holds the reaction time ruler, and their partner places their thumb and fore-finger about one inch away from the opposite sides of the bottom of the ruler at the “thumb line” ready to catch it when the first person releases it. The location on the ruler where they catch it shows their reaction time in milliseconds. Make sure the student dropping

the ruler is holding it straight up and down. Students can do this a few times to see if they can improve their score. Then they switch.

b. The second test is to go through a deck of cards and sort them by color. They can sort them by suit for a harder test. Students can time each other and compare times amongst themselves.

3. Next the pairs go through the **two reflex tests**.
   a. In the first test instruct students to use pen lights to shine into the side of each other's eyes and observe the reflex of the pupil. The pupils will contract in response to light. Ask students to describe what they see happening.
   b. The second test is using the percussion hammers on each other's knees to get the kick reflex. Have the student who is having his/her reflexes tested sit in a chair.
4. Now that the students have completed the tests, ask them again what the difference is between a reaction and a reflex. Which tests represented reactions? Reflexes?

Discussion:

Why are reactions and reflexes important for humans? Below is an example explaining importance involving baseball.

> A baseball player is at bat. He faces the pitcher, who stands 60 feet away while he prepares to deliver a fastball at 90 mph. The batter will have about a half of a second to either swinging the bat or allow the ball to pass by. The pitcher loses control and hurls a fastball directly at the batter's face. The batter's eyes close involuntarily as he reacts by ducking sideways to avoid being hit.
>
> In the above situation, the batter's eyes closed reflexively in response to the baseball thrown at his face, thereby lessening the likelihood of injury to his eyes. At the same time, he responded to the danger by utilizing voluntary movement to get out of the way.

Reaction time is the amount of time required for an individual to perceive and respond to a sensory stimulus. Reaction time improves somewhat through repetition, but the speed at which a nerve impulse travels along a neural pathway limits reaction time. Reflexes cannot be improved through practice, because the signal doesn't travel through the brain the way a reaction does. It only makes it as far as the spinal cord.

Confusing the Senses

Passport Question: Illusions trick your _____, changing how you perceive and experience your sense of touch, taste, hearing, smell, or sight.

Passport Answer: brain

Materials:

- Optical illusion print outs
- Two-point discriminators (2)
- Extracts – peppermint, vanilla, strawberry, lemon, coconut
- balloons

Background:

An illusion is a thing that is, or is likely, to be wrongly perceived or interpreted by the senses. **Students will investigate different illusions and learn about the limitations of three out of the five of their senses**: sight, touch, and smell.

Students will:

- Learn about the reception of stimuli through the senses of sight, touch, and smell.
- Explore the limitations of the senses and the limitations of perception.

Procedure:

1. The first sense the students can test is their sight using different kinds of optical illusions. Most students are probably familiar with these things and the word optical. Ask them if they know what optical means, and if they think they can trick their other senses.
2. The next test they can try is the touch test. Have the students partner up to use the two-point discriminator. One partner closes their eyes and tries to tell whether they are being touched by one point or two. Students can test neck, back, legs, arms, hands fingers etc. They can test distance by sliding the grey part of the scale. CAUTION: make sure students are being safe and not hurting each other with the two-point discriminator.
   The students may alternate randomly between touching the patient with one point or with two points on the area being tested. Students report whether one or two points were felt. The smallest distance between two points that still results in the perception of two distinct stimuli is the student's two-point threshold.
3. For the smell test, there are various scents in each balloon. We are used to associating smells with an item; see if you can tell each smell without any visual clues as to what it is. The color of the balloon does not correlate with scent inside.

Balloon Scent Answer Key

- Blue: peppermint
- Green: vanilla
- White: strawberry

- Red: lemon
- Yellow: coconut

Discussion:

- Sight
  - Optical illusions: Pictures have descriptions or answers as needed.
- Touch
  - Two-point discriminators: Body areas differ both in tactile receptor density and somatosensory cortical representation. Normally, a person should be able to recognize two points separated by as little as 2–4 mm on the lips and finger pads, 8–15 mm on the palms and 30–40 mm on the shins or back. The posterior column-medial lemniscus pathway is responsible for carrying information involving fine, discriminative touch. Therefore, two-point discrimination can be impaired by damage to this pathway or to a peripheral nerve.
- Smell
  - Imagine the smell of an orange. Have you got it? Are you also picturing the orange, even though I didn't ask you to? Try fish, or mown grass. You'll find it's difficult to bring a scent to mind without also conjuring an image. It's no coincidence, scientists say; your brain's visual processing center is doing double duty in the smell department. Our sense of smell--or at least our skill at identifying different smells--may rely on our sense of vision.

A Close Up of You

Passport Question: Tissues perform special functions in the body and are made up of different types of _____.

Passport Answer: cells

Materials:

- Microscopes (5)
- All About Me human tissue samples slides (5)
- Flip charts on each type of tissue
- Human body book

Background:

Students will get an up close look at five different types of tissue in their body – blood, bone, smooth muscle, skin and epithelial (cheek cells). **Students will learn the body has levels of organization. Cells make up tissues, tissues make up organs, organs make up organ systems, and organ systems make up organisms.**

Procedure:

1. When students approach the table, tell them they have to put their hands behind their back, they can then take turns looking in all the microscopes.
2. Ask students if they know what tissue is? Can they identify the different human tissues under the microscopes?
3. The slides are human tissues: skin, bone, muscle, blood, and epithelial (cheek) cells.
4. After each round of students comes through, check the microscopes to make sure they're in focus.
5. **Students should not touch the microscope knobs themselves!**

Discussion:

Blood

Red blood cells - Blood gets its bright red color when these cells pick up oxygen in the lungs. As they travel through the body, they release oxygen to the tissues.

White blood cells - These are important for the body defending itself against infection. They can move in and out of the bloodstream to reach affected tissues.

Muscle

Smooth muscles - The brain and body tell these muscles what to do without thinking about it. Smooth muscles are at work all over the body, like in the stomach. Cardiac muscle makes up the heart. The thick muscles of the heart pump blood to circulate it through the body. Just like smooth muscle, cardiac muscle works all by itself with no

conscious input. Skeletal muscles have stripped light and dark parts of the muscle fibers. These muscles are controlled voluntarily. Skeletal muscle is attached to ends of bones.

Bone

Bone marrow is like a thick jelly, and its job is to make blood cells. Canals allow veins and arteries carrying blood to pass through bone. Spongy cancellous bone is very strong. The surface of bone is a thin membrane that contains nerves and blood vessels that feed the bone. Compact bone is smooth and very hard. It's the outer layer, the visible part of a skeleton.

Cheek/ Epithelial Cells

Cheek tissue is made up of epithelial cells. They are layers of cells that cover the surfaces of organs, like skin and breathing airways. They are a barrier between what they cover and the surrounding environment. They protect the inside of the mouth from cuts and small germy invaders.

Skin

The skin is made up of three layers, each with its own important parts. The layer on the outside is called the epidermis. The epidermis is the part of the skin you can see. The next layer down is the dermis. The dermis is hidden under the epidermis. The dermis contains nerve endings, blood vessels, oil glands, and sweat glands. The nerve endings in the dermis tell you how things feel when you touch them. The third and bottom layer of the skin is called the subcutaneous layer. It is made of fat and helps the body stay warm and absorb shocks. The subcutaneous layer also helps hold the skin to the tissue underneath it.

*Note: using legos as a metaphor is very helpful. A handful of legos (cells) does not look like anything specific until they are put together as buildings or roads (organs). When the buildings are all in a neighborhood (organ system), they can form a city (organism).

Name That Organ

Passport Question: Name one organ and its function in our bodies.

Passport Answer: answers will vary, see discussion for possible responses.

Materials:

- Organ Vests (2)
- Quiz Cards
- Stick on wall organ poster
- Small organ model
- Large organ model

Background:

An organ is a group of tissues in a living organism that has a specific form and function. Organs are grouped together into organ systems. Organ systems perform a specific task. In most animals there are ten major organ systems. There are 22 internal organs in the human body, not all are represented in this game.

Procedure:

1) Tell the students they are going to participate in a quiz game. Show them the wall poster for reference. Tell them that they have to choose the correct organ from the clue you give them, and then put it in the right spot on the organ vest.
2) If you have multiple students they can team up.
3) Have two students put on the vests, remove all the organs, and place them on the table.
4) Read quiz questions and have them answer by getting the correct organ in the right spot. They can look at the wall poster for help.
5) You can choose to stop when it's completely filled or ask them additional questions so they can point to the correct spot or pull the organ off the vest again.
6) Questions should cover function and fun facts about organs.

Discussion:

Organs are a part of every system in the body. Organs may function within several systems of the body. Systems often work with other systems and rarely work alone. A simple example is the connection between the circulatory and respiratory systems. As blood circulates through your body, it eventually needs fresh oxygen from the air. When the blood reaches the lungs, part of the respiratory system, the blood is re-oxygenated.

Brain – It thinks and tells the body what to do, even when we are dreaming! Protecting the brain during activities is very important. Any symptoms of a concussion should be checked out immediately.

Heart – This is a strong muscle that pumps the blood through the body, delivering oxygen.

Lungs – Fill up with clean air during inhalation, and give the body oxygen through the blood. They also release the used carbon dioxide from the blood back into the air.

The esophagus – The esophagus is a tube that transports food down to the stomach.

The stomach- The stomach holds the food and begins breaking it up into a liquid so that the nutrients can be absorbed and used by the body for energy.

The liver – Cleans the blood and stores vitamins.

The small and large intestines – These organs work together to take all the vitamins and minerals out of food as it travels through the digestive tract. They also push out waste that the body can't use.

The kidneys – Help clean out the blood by removing waste and sending it out through the bladder.

Tips for this station: Keep it simple! Many kids know the basics but the liver, kidneys and intestines may be new to them. You can challenge them by pointing out how systems are connected.

Play To Your Strength

Passport Question: Give two reasons why it's important to exercise
1._____ 2. _____.

Passport Answer: It strengthens muscle, strengthens joints, strengthens bones, prevents injury, prolongs endurance, boosts happiness, improves heart health and helps prevent diseases.

Materials:

- Timers
- Types of muscle foam core sign
- Mirror
- Print out of proper plank and wall sit

Background:

Did you know there are more than 600 muscles in the human body? They do everything from pumping blood throughout the body to helping lift heavy objects. You control some of your muscles, while others, like your heart, do their jobs without you thinking about them at all.

Muscles are all made of the same material, a type of elastic tissue (sort of like the material in a rubber band). Thousands or even tens of thousands, of small fibers make up each muscle. **There are three different types of muscles in the body: smooth muscle, cardiac muscle, and skeletal muscle. Students will lean the effects of exercise on their muscles.**

Procedure:

1. Ask the students to show you some of their muscles – most of the time you will probably get arm flexes. You can then explain how we have three different kinds of muscle and what each type does.

2. The tests at this station are going to focus on skeletal muscles, the ones we can control. Muscle strength is built through exercise. Ask the students why they think it is important to have strong muscles and to exercise. Share with them the reasons from the passport answer above.

3. So where do we have skeletal muscles? The first place to look is in your face. There are 43 muscles in your face, but not everyone can use them the same. You can check them out in the mirror. Facial muscles don't all attach directly to bone like they do in the rest of the body. Instead, many of them attach under the skin. This allows you to contract your facial muscles just a tiny bit and make dozens of different kinds of faces. Your tongue is actually made of a group of muscles that work together to allow you to talk and help you chew food. Stick out your tongue and wiggle it around to see those muscles at work.

4. Next move on to fitness tests. The first test the students will do is a wall sit. Show them how to properly do it by sitting with your back against the wall and your knees at a 90 degree angle. You can time them to see how long they can hold that position for without moving, falling or standing up. You can make this a fun competition.

5. The next test they can do is a plank. To properly do a plank, they have to hold themselves up on their forearms, making sure to keep their butt level, not sticking up in the air, as shown below.

6. Now that you have exercised your skeletal muscles, question the kids about whether or not they think you can exercise the muscles you can't control, like your heart? Discuss how exercise actually benefits all of your muscles.

Discussion:

Smooth Muscle

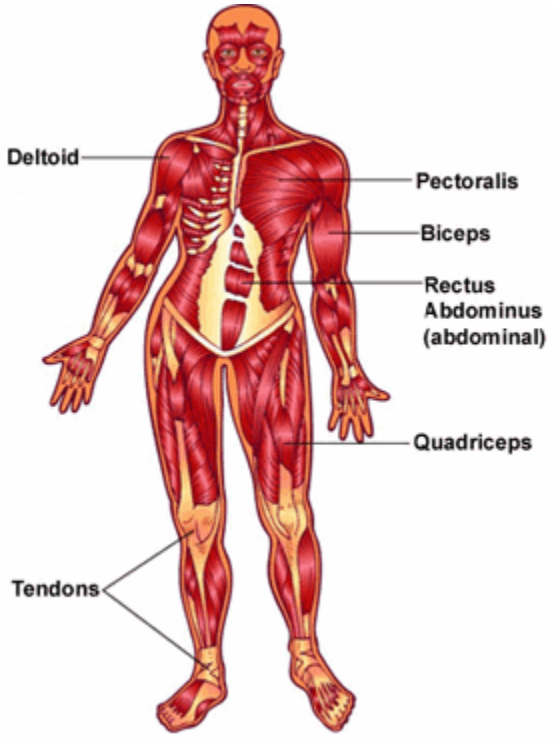
Smooth muscles — sometimes also called involuntary muscles — are usually in sheets with one layer of muscle behind the other. You can't control or exercise this type of muscle. The brain tells these muscles what to do without you even thinking about it. Smooth muscles are at work all over the body. In the stomach and digestive system, they contract (tighten up) and relax to allow food to make its journey through the body.

Cardiac Muscle

The muscle that makes up the heart is called cardiac muscle. The thick muscles of the heart contract to pump blood out and then relax to let blood back in after it has circulated through the body. Just like smooth muscle, cardiac muscle works all by itself with no help from you.

Skeletal Muscle

The kind of muscle you think of when we say "muscle," the ones that show how strong you are.



Skeletal muscles are voluntary muscles, which means you can control what they do. Your leg won't bend to kick a soccer ball unless you want it to. These muscles help to make up the musculoskeletal system — the combination of muscles and bones.

Together, the skeletal muscles work with your bones to give the body power and strength. In most cases, a skeletal muscle is attached to one end of a bone. It stretches all the way across a joint (the place where two bones meet) and then attaches again to another bone.

Skeletal muscles are held to the bones by tendons. Tendons are cords of tough tissue, and they work as special connector pieces between bone and muscle. The tendons are attached so well that when you contract one of your muscles, the tendon and bone move along with it.

Skeletal muscles come in many different sizes and shapes which allows them to do many types of jobs. Some of the biggest and most powerful muscles are in the back, near the spine. These muscles help keep us upright and standing tall.

*Note: if you are short on time or want to keep the station rotating, challenge the students to see who can hold the plank or wall sit for two minutes -- most will start failing before then. If you ask them to see who can hold the positions the longest, many students will exceed five minutes. This is fine if the station is not crowded or the students do not need to rotate to other stations.

A Bone of Your Own

Passport Question: Your _____ is based on posture and the movement of your _____.

Passport Answer: balance; skeleton

Materials:

- Skeleton models (2)
- Plumb Line
- Bean bags/stuffed animals
- Skeleton wall poster
- X-rays
- (optional) skeleton labeling worksheets

Background:

The human skeleton is made up of 206 bones. **Bones are light and strong and give the body structure, allow for movement in many ways, protect internal organs, and are related to balance and posture.**

A baby's body has about 300 bones at birth. These eventually fuse (grow together) to form the 206 bones that adults have. Some of a baby's bones are made entirely of soft and flexible cartilage, while some are partially made of cartilage. As a child grows, the cartilage grows and is slowly replaced by bone, with help from calcium. Skeletal growth is complete by around age 25.

Your Skeleton and Posture

Posture is the position in which we hold our body and limbs when standing, sitting, or lying down. Ideal postures are those assumed to perform an activity in the most efficient manner utilizing the least amount of energy.

Having good posture means that:

- bones and joints are in line so that muscles can be used properly
- the spine has its three normal curves
- ligaments holding the spine together are not being stressed
- you don't get tired as quickly
- you don't get pain in your back or other muscles
- You look good!

To have good posture, you will need:

- Strong, flexible muscles, especially on each side of the spine
- Well balanced muscles, not overdeveloped on one side
- To be able to move freely
- To be aware of your posture and work to improve it

Procedure:

1) Ask how many bones the students can name in their body, and if they know any facts about their bones. Take them to the x-rays and skeleton posters to check them out.
2) Have students use the plumb line to check their posture. Their ear lobes, shoulders, hips, knees, and ankles should all be in a straight line. Ask them why it's good to have good posture.
3) Next, try the balance tests. Have them stand on one foot. In that position, have them close their eyes. Then, have them try to lower themselves down toward the ground in a 'squat' position on one leg with their eyes closed.
4) Have them try to go from sitting down cross-legged to standing up straight while balancing a bean bag or small stuffed animal on their heads.
5) Next, test their ability to walk from one line, around a designated spot, back across that line with a bean bag or small stuffed animal on their heads.
6) Discuss the relationship between posture and balance; ask them why the think it's important to have good posture and balance. Do they know what posture is and why it's important? What can they do to take care of their bones?

Discussion:

Thinking about good posture and taking good care of the spine will help maintain a strong healthy back. Here are some tips for keeping your bones healthy:

Protect your skull bones (and your brain inside!) by wearing a helmet for bike riding and other sports. When you use a skateboard, in-line skates, or a scooter, be sure to add wrist supports and elbow and knee pads. Your bones will thank you if you have a fall!

Strengthen your skeleton by drinking milk and eating other dairy products – they contain calcium, which helps bones harden and become strong.

Be active! Another way to strengthen your bones is through exercise like running, jumping, dancing, and playing sports.

Your Amazing Heart

Passport Question: Your heart is a muscle that pumps _____ and circulates it around your body through the circulatory system.

Passport Answer: Blood

Materials:

- Pumping heart model (2)
- Valve heart model
- Stethoscopes (2)
- Finger pulse oximeters (2)
- Wall chart
- Sticky notes
- Pens/ markers

Background:

The heart is a muscle, sort of like a pump. The right side of the heart receives blood from the body and pumps it to the lungs. The left side of the heart does the exact opposite: it receives blood from the lungs and pumps it out to the body. The blood provides the body with the oxygen and nutrients it needs, and also carries away waste. **Students will learn what the heart does and the effects of exercise on heart rate.**

Procedure:

1) The first thing to show kids is where their heart is in their body. Do this by putting your hand over your heart like you do when you say the pledge of allegiance.
2) How big is your heart? Have students make a fist, which is the approximate size of their heart. Is it bigger or smaller than their classmates?
3) What do you know about your heart? It is a muscle that pumps blood around your body which circulates oxygen.
4) Show the students how to take their pulse using their fingers. Each beat is caused by the contraction (squeezing) of the heart. It is easiest for students to find their pulse on their neck, but the wrist is also fine.
5) Use a watch or timer and have students count how many beats they feel in 15 seconds, then multiply by 4 to find beats per minute. Check the other chart for average resting heart rate for their age group. When they are resting, they will probably feel between 60 and 100 beats per minute. Have students write their name and resting heart rate on a yellow post it and place it on the graph in the correct location (find the student number on y axis and heart rate on x axis).
6) Students can then use the stethoscopes to listen to each other's heartbeat. Using the heart models, explain what they are feeling/ hearing when they are taking their pulse or listening through a stethoscope.
7) Next, have the students do 30 jumping jacks in place. Have them take their pulse again for 15 seconds, and multiply by 4 to find a minute. Ask them why

they think their heart beats faster when they're doing exercise. *Their heart is trying to supply more oxygen to their body to keep up with exercise*. Have students write their name and heart rate, this time on a pink post it. Again, have them graph it in the correct place.

8) The students can take turns using the pulse oximeter to find out how accurate they were when taking their pulse. They can also see how much oxygen is in their blood, and talk about how their blood circulates oxygen and carbon dioxide to and from their lungs.

Discussion:

The movement of the blood through the heart and around the body is called circulation, and it takes less than 60 seconds to pump blood to every cell in the body. Our bodies need this steady supply of blood to keep them working properly. Blood delivers oxygen to all the body's cells.

The left side of the heart sends oxygen-rich blood out to the body. The body takes the oxygen out of the blood and uses it in the body's cells. When the cells use the oxygen, they make carbon dioxide and other waste that gets carried away by the blood.

The returning blood enters the right side of the heart. The right ventricle pumps the blood to the lungs. In the lungs, carbon dioxide is removed from the blood and sent out of the body during exhalation. Next, an inhalation provides fresh oxygen, which enters the blood to start the process again.

Keep Your Heart Happy!

Remember that your heart is a muscle. If you want it to be strong, you need to exercise it by being active in a way that gets you huffing and puffing, like jumping rope, dancing, or playing basketball. Try to be active every day for 30 minutes to an hour every day.

Eat a variety of healthy foods and avoid foods high in unhealthy fats, such as saturated fats and trans fats (reading the labels on foods can help you figure out if your favorite snacks contain these unhealthy ingredients).

- Try to eat at least five servings of fruits and vegetables each day.
- Avoid sugary soft drinks and fruit drinks.
- Don't smoke. It can damage the heart and blood vessels

Germy Transfer

Passport Question: Germs are tiny living organisms that spread disease and make you sick. Name one or more ways you can prevent the spread of germs.

Passport Answer: hand washing, covering your mouth when you cough or sneeze, getting vaccinated, avoid touching your T-Zone

Materials:

- Glo powder
- Tennis balls/ hacky sack
- Black lights (2)
- Extra AAA batteries
- Glo Box (2)
- Sink
- Hand soap
- Towels

Background:

Germs are tiny organisms that can cause disease. Germs are so small and sneaky that they creep into our bodies without being noticed. When they get in our bodies, we don't know what hit us until we have symptoms that say we've been attacked!

Once germs invade our bodies, they snuggle in for a long stay. They gobble up nutrients and energy, and can produce toxins, which are proteins that are actually like poisons. Those toxins can cause symptoms of common infections, like fevers, sniffles, rashes, coughing, vomiting, and diarrhea.

How do doctors figure out what germs are doing? They take a closer look. By looking at samples of blood, urine, and other fluids under a microscope, doctors can tell which germs are living in your body and how they are making you sick. **Students will learn how germs spread and that proper hand washing can help keep them from getting sick.**

Procedure:

1) Add a very small amount of Glo Powder to the hacky sack/tennis ball
2) **Gently** play catch with the students with the hacky sack/tennis ball
3) Ask the students while you are passing what they know about germs. What are they? What do they do? How do you get them?
4) After a few minutes of discussion, end the game of catch and discuss how passing the ball could spread germs.
5) Gather them around the glow box and have them put their hands inside the box. When you turn the light on, they will see the “germs” on their hands.
6) Have the students wash their hands, and re-do the black light test so they can see how properly washing their hands prevents the spread of germs.

7) Discuss ways to prevent the spread of germs. How well did the students so to remove all the “germs”? Should they wash again?

Discussion:

Explain to the students that any glow on the hands indicates a positive result for the “germ.” If they had been coughed on or shaken hands with a person who was sick, they could have been exposed to the germ and could get sick.

Most germs are spread through the air in sneezes, coughs, or even breaths. Germs can also spread in sweat, saliva, and blood. Some pass from a contaminated object onto our hands.

Handwashing is the best way to steer clear of getting sick. Remember the two words germs fear — soap and water. Washing your hands well and often is the best way to beat these tiny warriors. Wash your hands every time you cough or sneeze, before you eat or prepare foods, after you use the bathroom, after you touch animals and pets, after you play outside, and after you visit a sick relative or friend.

There is a right way to wash your hands. Use warm water and soap and rub your hands together for at least 20 seconds, which is about how long it takes to sing the "A, B, C’s."

Use your elbow to cover your nose and mouth when you sneeze and cover your mouth when you cough to keep from spreading germs.

Using tissues for your sneezes and sniffles is another great weapon against germs. Be sure to toss used tissues into the trash and, again, wash your hands!

Another way to fight and prevent infections is to make sure you get all the routine immunizations from your doctor. No one likes to get shots but these help keep your immune system strong. You can also keep your immune system strong and healthy by eating well, exercising regularly, and getting good sleep. All this will help you to be prepared to fight germs that cause illness.

Now that you know the facts about germs, you may still pick up a cough or a cold once in a while, but you'll be ready to keep most of those invading germs from moving in.

Re-Think Your Drink

Passport Question: Kids should be getting no more than _____ teaspoons of added sugar a day.

Passport Answer: between 3-5 teaspoons; or 12 – 20 grams

Materials:

- Pre-assembled sugar stacks
- Drink bottles
- "How Many Donuts in Your Drink?" display board
- Sugar Shuffle matching game
- Sugar content displays
- Nutrition label displays

Background:

Children do need to consume a small amount of sugar each day because it's an important source of energy. The problem is that many children consume far too much added sugar, which doesn't supply any of the nutrients that growing children need. Natural sugars found in fruits, vegetables, and grains are the best option, since those foods also contain vitamins and nutrients. Too much added sugar in the diet can be harmful. **Students will learn how to read nutrition labels, the sugar content of popular beverages, and the effects of too much sugar on their health.**

Procedure:

1) Explain to students the basics of how to read nutrition labels. Then, have students attempt to arrange the drinks in order from least to most sugar behind the sugar cube displays.
2) Discuss with the kids what they are looking at, what added sugar is, and the maximum amount of sugar they should consume in a day.
3) See what items matched as having the same amount of sugar. How much sugar would you get if you ate both in the same day? Does one item seem okay to have in a day and one not okay?
4) Discuss the relationship between added sugar and natural sugar. Why is natural sugar better than added sugar (see discussion)?
5) Sugar Shuffle: students will try to match the sugar content card to the correct drink.
6) Point out the sugar display jars (3, 4, and 5 tsp in comparison to 6 tbsp).

Discussion:

Daily Recommendations

The average 1- to 3-year-old consumes about 12 teaspoons of sugar each day, and the average 4- to 8-year-old takes in 21 teaspoons, according to the American Heart

Association. And the numbers don't get better for kids between the ages of 9 and 19. Boys in this age group average between 29 and 34 grams of sugar a day, and girls in the same age group average between 23 and 25 grams, according to the journal *Circulation*. These numbers exceed the recommended sugar limits for children by a significant amount. The actual limit of sugar for children is 3 to 5 teaspoons during the preschool and early elementary years, and between 5 and 8 teaspoons during the tween and teen years.

Sizing Up Sugar

Foods that are high in added sugar (soda, cookies, cake, candy, frozen desserts, and some fruit drinks) tend to also be high in calories and low in other valuable nutrients. As a result, a high-sugar diet is often linked with obesity. Eating too many sugary foods also can lead to tooth decay.

The key to keeping sugar consumption in check is moderation. Instead of serving foods that are low in nutrients and high in added sugar, offer healthier choices. Fruit — a naturally sweet carbohydrate-containing snack that also provides fiber and vitamins that kids need.

Instead of soda or juice drinks (which often contain as much added sugar as soft drinks), serve milk, water, or 100% fruit juice. **Note:** although there's no added sugar in 100% fruit juice, the natural sugars can still add up. Limit juice intake to 4-6 ounces for kids younger than 7 years old, and to no more than 8-12 ounces for older kids and teens.

Sugar and Health

Although small doses of sugar do provide children with energy, it's important to provide nutritious sources of sugar. The sugars found in fruits, vegetables and dairy foods are natural, which means they should have a prominent spot in your healthy eating plan. What's dangerous to children’s health is added sugar, which is found in desserts, soda and baked goods, according to MayoClinic.com. White bread, white pasta, and even condiments such as ketchup and barbecue sauce also contain added sugar. Too much added sugar can cause unhealthy weight gain, and it also makes you more susceptible to tooth decay.

High sugar intake over your lifespan can lead to harmful diseases such as diabetes and heart disease. These diseases result from damaging your internal organs because they are not able to process the amount of sugar in the diet. Learning more, exercising, and watching what you eat can lower your risk for getting these diseases!

Neuro Futures Championship Game

Passport Question: What neurotechnology did your group think would benefit society the most?

Passport Answer: answers will vary

Materials:

- Championship bracket
- Velcrow sticky tabs (placed on the neuro futures cards)
- Stack of neuro futures cards
- Tape for hanging the championship bracket

Background:

1. People's values determine which technologies are developed and used.
2. New technologies change society, sometimes in unexpected ways.
3. Scientists, engineers, and designers use their creativity to invent things and imagine the future, just like you do.
4. Brain research benefits from many perspectives, including yours.

How might future brain technologies change our society?

How can we include many diverse perspectives and priorities in the development of brain technologies?

Set up:

1. Select 8 of the 12 Technology Cards and their corresponding Velcro cards. Spread out the Technology Cards across the front of the table, facing participants. Attach the Velcro cards (in random order) to the outermost positions on the bracket board.
2. Explain to participants that they will be deciding, as a group, which of these emerging brain technologies has the most potential to benefit society. Remind them that there are no right or wrong answers—the goal is to explore their own priorities and values.
3. Point to the first pair of technologies, in the upper left corner of the bracket board.
    a. "Our first match is [technology 1] versus [technology 2]. Which of these technologies do you think would be most beneficial? You can read more about them on these cards." (Point out the corresponding Neuro Futures Technology Cards)
    b. You may wish to give a brief verbal description of each technology, in addition to referring participants to the Neuro Futures cards.
4. Continue on to the next pair of technologies and repeat until each of the initial matches have a determined winner; then move on to the semifinals on the left side of the board, the semifinals on the right side of the board, and lastly the final match.

5. Winner Tally: You may wish to keep a tally of the championship-winning technologies on a piece of paper, as participants are often curious about which technology has won most often.