Roots and Tails: How Plants and Animals Use Their Structure to Survive

▸ Objective:
To understand how plants and animals use their external parts and adaptations to help them survive, grow, and meet their basic needs; to practice making observations and drawing conclusions.

▸ Next Generation Science Standards:
K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.
1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.
2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.

Lesson 1: How Do Animals Use Their Senses to Survive?

Objective: K-LS1-1. Learn about the 5 senses and their importance to animal survival; understand that both humans and animals have senses, but may experience them in different ways; tune into certain senses outdoors in sensory experience games

Materials: Laminated photos of animals (5-10), speaker (optional), cones (2), blindfolds (2)

Terms: sense, sight, smell, hearing, touch, taste, predator, prey

Part 1: In-Class Discussion (20 min)
Ask the class if they think they know their 5 senses, and call on students until all 5 are shared: sight, smell, touch, taste, hearing. Repeat the senses again, but this time direct the class to point to each body part while repeating the name of the sense out loud.

What do humans use our senses for?
Humans use our senses every day to give us all kinds of information about the world around us. Our senses allow us to navigate within our surroundings, stay safe, be warned of danger, travel, find food, communicate with each other, and enjoy things. We are using them right now! You can hear me talk, you can see me, you can feel the floor

you are sitting on. What was something you smelled today? What was something you tasted today?

What do animals use their senses for? Like us humans, senses provide animals all kinds of information about their surroundings and help them to navigate and survive in their environment. However, animals do not always experience their senses the same way that we do. Each animal has adapted their own way of doing things and how they perceive the world.

For example, snakes smell with their tongue and butterflies have taste buds on their feet! Some animals even have better senses than our own. Eagles have more acute vision than us, and bears can smell food much farther than we can. Some animals even have senses that we humans don't have, like detecting heat or incoming storms.

Animals use their senses to help them survive in nature. How would your world be different if you didn't have your 5 senses?

NOTE: Not everyone can see, smell, hear, feel, or taste the same. Some students may have sensory disabilities. Try to be aware of this and sensitive when discussing the senses.

[Display photos of animals with exemplary senses: 1 animal per sense to discuss, plus you may add in other animals to expand your guessing pool] Explain that these animals have powerful senses in different ways. Introduce each sense one-by-one and call on students to guess which animal has a strong or unique ability for that sense. When a student guesses the correct animal, briefly discuss that animal's ability in that sense. Plus, how does that sense help the animal survive?

Sight: owl
Smell: bear
Touch: raccoon
Taste: catfish
Hearing: deer

■ **Sight: Owl Eyes**
Owls have excellent night vision and are able to see prey from long distances, up to 1/2 a mile away! Their huge eyes are forward facing on their flat heads, giving them binocular vision (seeing an object with both eyes at once) and a 3D perspective. They can't move their eyes in their sockets, but they can rotate their head 270 degrees

around, providing an almost full rotation of vision. Combined with powerful hearing and silent flight, these adaptations make owls excellent hunters.

Have students experience "owl eyes" by focusing on an object (or you) facing forward, then switch to focusing on an object in the far periphery. As an owl, they must rotate their head without moving their eyes in their sockets or moving their shoulders. What was it like to see like an owl?

How does sight help the owl to survive?
To hunt for food, evade dangers, and navigate its surroundings.

■ **Hearing: Deer Ears**
Mule Deer have large, curved ears with strong muscles that move independently from their body. They are able to hone in on specific sounds, detecting tiny movements all around them. They are able to differentiate between dangerous sounds (predator, human) and not dangerous, familiar sounds (river, squirrels, leaves).

Have students cup their hands around their ears to make "deer ears." Be silent and move your ears around to listen. Did you hear any tiny sounds?

How does hearing help the deer survive?
To evade predators, to listen for young/parents, and to avoid other dangers

Optional: Play recordings of animal sounds on a portable speaker and have students guess which animal it is (iTunes, YouTube, Apple music, etc.). Students love this, and it's a great way to introduce the diversity of animal sounds.

■ **Smell: Bear Nose**
Bears can probably smell better than any other animal on earth! They have huge noses with thousands of smell receptors. They can smell 2,100 times better than a human! They can smell a stinky, dead animal from ~20 miles away and other food ~2 miles away. Imagine if you could smell your dinner 2 miles away!

Have students cup their hands around their nose to make a huge bear nose and take a big sniff.

How does smell help the bear survive?
Mainly to locate food, but also to detect warning signs (fire, other animals) and find other bears

■ Taste: Catfish Whiskers

Catfish live in muddy, murky waters with low visibility, making it more difficult to look for food in the water. They have 100,000-175,000 taste buds all over the skin of their body, but mainly concentrated on their whiskers. Their whiskers act as antennae and taste for food nearby underwater.

Fun fact: Humans have about 10,000 taste buds on our tongues, so our taste buds do not compare to the catfish! Taste is considered humans' weakest sense.

How does taste help the catfish survive?

Their powerful taste buds help them to locate their prey in murky waters.

■ Touch: Raccoon Hands

Raccoons have very sensitive hands with long fingers and nails. Although they don't have prehensile thumbs like we do, they are still able to pick objects up with their front paws and manipulate them. They are sensing all kinds of information with their hands, and combined with a developed brain, they can process a lot of information. Despite popular belief, raccoons do not "wash their food", the water enhances their sense of touch. A thin layer protects their paws, but becomes more flexible when wet.

Have students wiggle their hands like a raccoon.

Fun Fact: Touch may be the oldest sense in the world. Life forms could probably sense touch before anything else. The young of many animals sense the world through touch first, including humans.

How does it help the raccoon survive?

To locate food, to identify family members, to find mates, to explore surroundings, to detect signs of danger, to prevent injury, and provide comfort

Part 2: Sensory Games (30 minutes)

Head outside to play two games that focus on animal senses and how animal senses play into predator-prey relationships.

■ Hunting Like a Hawk (15 min)

Even the most effective camouflage can fail if a hidden animal suddenly moves and catches the enemy's eye. This game shows how movement can attract predators' excellent vision.

A. Choose 2 students to be "hawks." The rest of the class will be prey animals.
B. Have the prey animals stand in a large circle, with the hawks in the center, standing back to back. The prey will walk about, staying as a circle, while pretending to be their prey animal of choice (songbirds, squirrels, etc). The hawks will be closing their eyes, they are not hunting yet.
C. When you call out "Hawk!" the prey must freeze in any position. The hawks will open their eyes and visually search for any detectable movement, each hawk "hunting" on their half of the circle. Allow **60 seconds** for the hawks to search. The hawks will point at or call out any student that moves, and they must sit down, as they got "eaten".
D. How many prey animals did the hawks catch? Was it difficult to be a hawk? Was it difficult to be a prey animal?
E. Play multiple rounds if time permits.

■ **Deer Ears** (15 min)
In this game, students will tune into their hearing, using their powerful deer ears to detect predators that are trying to sneak up on them.

A. Choose 2 students to be "deer." The rest of the class will be a pack of wolves, trying to sneak up on the deer.
B. The wolves will form a large circle, and the deer will stand in the center, back to back.
C. The deer will be blindfolded, able to rely only on their strong sense of hearing. Place a cone in front of each deer. This object will be what the wolves are trying to steal.
D. On your signal (once the deer are blindfolded), wolves may quietly try to sneak up and grab the cone. If the deer hears any sound, they point in the direction of the sound. If they are pointing at a "wolf", that student is out and must sit down. You will play the role of referee, making the call if a student is out or not. Only allow 4 wolves to be sneaking forward at once. Students will have to watch for this and wait their turn. Moderate this if needed.
E. If the wolves grab both cones, the wolves win and have caught the deer. If the deer catch all the wolves by hearing them, then the deer win and survive. Play multiple rounds if time permits.

Wrap Up:

● As a deer, was it difficult to only rely on your sense of hearing?
● What strategies did you use as a wolf? As a deer?

Lesson 2: Camouflage

Objective: Understand how animals use camouflage, including their external parts and behaviors, to help them survive; introduce the concept of adaptations

Materials: Photos of camouflaged animals, cut-outs of camouflaged animals, plain and green pasta, bowls/buckets (2), timer, sticky tack

Terms: camouflage, adaptation, predator, prey

Part 1: In Class Discussion (15 min)
Introduce camouflage by showing the class photos of camouflaged animals at a distance. What do you see? Have students try to keep their thoughts inside to allow all students to find the animals on their own. What is this strategy called that these animals are using? Camouflage!

Camouflage is the use of appearance and/or behavior for an animal to blend in with its surroundings.

How is camouflage helping an animal to survive? Both prey and predators may use camouflage. Prey animals use camouflage to hide from predators, to avoid being attacked or eaten. Predators use camouflage to not be seen by their prey and have a better chance of catching a meal.

Examples: Satanic Leaf-Tailed Gecko (Madagascar), Leaf Katydid (SE Asia), Malayan Leaf Frog (SE Asia), Eastern Screech Owl (North America), Great Grey Owl (North America), Asian Tiger, Goldenrod Crab Spider (North America)

Camouflage is an example of an adaptation. An **adaptation** is a special trait, evolved over time, that helps a plant or animal survive (like a super power)**.** Have students repeat the word and share other examples of adaptations to further explain the concept: toxins, protective shells, quills, sharp teeth, claws, waterproof fur, etc.

Briefly discuss 4 types of camouflage: show photos

  A. **Mimicry**: an animal's appearance or behavior imitates that of a harmful or toxic animal, making predators shy away

  Example: Poisonous Coral Snake vs. Non-poisonous Scarlet King Snake

B. **Blending**: the color of an animal's body match its surroundings

Example: Flower Spider

C. **Pattern**: an animal's color markings or pattern blend in with its surroundings, blurring the outline of the animal and making it difficult to see

Example: Screech Owl, Tiger

D. **Disguise**: an animal hides in plain sight by looking like an object in its surroundings

Example: Malayan Leaf Frog, Leaf katydid, Satanic Leaf-tailed Gecko

Part 2: Outside Activities (40 min)
Head outside for a variety of activities exploring camouflage.

■ **Blending In** (5 min)
Challenge the class to try to camouflage themselves in their schoolyard, based on the clothing that they're wearing.

A. Group up outside. Call on a student to define camouflage again. Camouflage allows animals to avoid being seen *without* having to hide. Look at what you are wearing right now. Would you be able to blend in somewhere in the schoolyard?
B. Who is wearing something that blends in well with the schoolyard? Who is not? Call on students to share.
C. On your signal, give students a few minutes to find a place where their **clothing** helps them blend in. They are not hiding, they should be motionless in front of the spot, not behind, under, or inside it.
D. Walk around and "search" for the camouflaged kids, remarking on how easy or hard each one was to see.
E. Re-group the class and discuss. Who succeeded in camouflaging? Who did not? What could you wear to blend in better?

■ **Pasta Prey** (10 min)
Test how color can help camouflage an animal.

A. With two buckets of pasta (plain and green) and a timer, gather in an open, grassy area. Students will be animals looking for juicy caterpillars (the pasta) to eat.

B. Divide class evenly into 2 teams and assign each team a color of pasta. Ask students to turn around and close their eyes while you scatter the pasta.
C. On your signal, time the teams how long it takes to pick up all the pasta pieces. Which team finished first? (Ideally, the plain pasta team should finish first) Why?
D. Switch pasta colors and repeat the challenge. Who finished first this time?
E. Compare data: Which color of pasta took longer to collect? Which color was hardest to find? How does this game show how camouflage helps prey?

■ **Hide and Seek** (20 min)
Practice camouflaging animals in the schoolyard by playing "hide and seek" with cut-outs of camouflaged animals.

Cut-outs: Grey squirrel, grasshopper, butterfly, Cascades frog, Steller's Jay, Western Fence lizard, Rubber Boa, Western rattlesnake, Western pond turtle, Wood Nymph butterfly

A. Divide class into pairs and assign each pair an animal cut-out. Add some sticky tack on the back to be able to stick it to a surface if needed.
B. Establish boundaries and a "home base" line.
C. One student will hide the animal first, while the other student finds it. "Seekers" must close their eyes while the "hiders" attempt to camouflage the animal in the schoolyard. Hiders cannot bury it, it must be on top of a surface.
D. Allow a few minutes to hide, waiting until all hiders are finished and have returned to home base. Release the seekers to find the animals. Hiders stay at home base. If seekers need a hint, they can return to ask their partner for help.
E. After all animals are found, switch roles.
F. What strategies did you use? What was challenging about this game?

Lesson 3: To Eat or Not be Eaten | Predator-Prey Relationships

Objective: 2-LS4-1. Explore the diversity of adaptations in the animal kingdom; understand how adaptations help animals to survive; explore predator-prey relationships and how adaptations play into it

Materials: Colored bandanas, cones, laminated adaptation animal photos, skulls and/or pelts (if available)

Terms: Predator, prey, camouflage, adaptation, structure, function

Part 1: In Class Discussion (25 min)

Remind students about learning of camouflage last week and call on students to define it. **Camouflage** is an example of an adaptation. **Adaptations** are special traits, adapted over time, that help a plant or animal to better survive in its habitat (like an animal "super power"). An adaptation represents a particular **structure**, that serves a **function** for the animal.

Display several photos of animals with specific adaptations. Call on students to choose a few animals to discuss their special adaptations. Use other props if desired (skulls, pelts, tracks).

Example:
Grizzly Bear
      1. Powerful sense of smell to find food
      2. Thick fur to stay warm
      3. Large, powerful claws/paws for digging, defense, or killing prey

Next, turn it over to the class to come up with their own ideas of animal adaptations. Break up class into small groups of 3-4 and pass out an animal photo to each group. Give the groups a few minutes to discuss and come up with at least 2 adaptations. **What special traits (structures) does the animal have and how (function) are they helping them survive?** After giving a few minutes to discuss in groups, have each group quickly present their ideas of adaptations.

Guiding questions if needed:
- What do you know about this animal?
- What does the animal eat?
- What structure may help them get food?
- What structure may help them in defense?
- How could the shape of its body help the animal?

Animal Adaptation Examples:
Goldenrod Spider (Flower Spider)
      1. Camouflage to catch food and evade predators
      2. Venom to stun prey and liquify insides
      3. Using a flower as a different shelter than webs
Honey Bee
      1. Stinger for defense
      2. Pollen sacs and stiff hairs to collect pollen

3. Taste with feet

4. Excellent sense of smell

River Otter

1. Thick, waterproof fur to stay warm and dry

2. Streamlined body for better swimming

3. Webbed feet to help swimming, but with ability to walk on land

4. Sharp teeth for eating meat and cracking shells

5. Ability to hold breath

Western Rattlesnake

1. Rattle on tail for warning and defense

2. Heat sensing to locate prey

3. Long, sharp, retractable fangs

4. Camouflage

5. Poisonous venom

Great Blue Heron

1. Long, skinny legs for wading in water

2. Long, spear-like beak for spearing fish

3. Long neck for reaching into water

Turkey Vulture

1. Strong sense of smell to locate carrion

2. Naked head to help prevent disease from carrion

Townsend's Mole

1. Wide forefoot and long claws for digging, like shovels

2. Short fur that can bend in any direction

3. Dark, camouflaged fur

4. Streamlined body for tunneling

5. Strong sense of touch, sensitive vibrissae for sensing surroundings

Rufous Hummingbird

1. Long, thin beak for reaching into flowers

2. Long, straw-like tongue for sucking nectar

3. Rapid wing beats and ability to fly backwards while drinking nectar

Hoary Bat

1. Echolocation to find and catch prey at night

2. Large, broad ears for excellent hearing

3. Sharp teeth for catching insects

Part 2: Lizard Tail Tag (30-35 min)

Many adaptations have a lot to do with getting food and not getting eaten, like why animals use camouflage. Lizards have an amazing adaptation that helps them to

escape from hungry predators. Lizards often have a long tail, and predators chasing a lizard may catch their long tail first. Many lizards can detach their tails (most of it actually falls off) if they are caught to help them escape. The predator is left with the tail, and the lizard is left with its life. The missing tail can re-grow (3-5 weeks) and is usually shorter.

Disclaimer to students: DO NOT TRY THIS ON REAL LIZARDS. Detaching a tail is extremely stressful and energy costing for the lizard.

In this game, students will be lizards and predators. **Lizards wear a green bandana tail** tucked into the back of their waistband/pants. Students wearing dresses can stick it into a pocket, jacket, or other alternative spot. **Predators wear a red bandana** tied around their wrist. Predators are trying to steal lizard tails, while lizards are trying to escape and retrieve any lost tails.

If a lizard's tail is stolen, they must FREEZE. But they can steal their tail back and get back in the game via two ways: (1) steal a green tail of anyone running by you (lizard or predator), or (2) a fellow lizard may steal back a tail from a predator and give it to a lizard in need. Predators that have stolen lizard tails must also wear them in their waistband/pants so that they can be stolen back.

Students will often hold on to the bandanas after stealing or tuck them too far in, so make sure to remind students throughout the game that they must be tucked/easily pulled off.

Play 3-4 Rounds:
1. Create boundaries using cones or markers (not too big otherwise they can run too far)
2. Create a "home base" line. This will be the starting point before each round and can also act as a safety zone if students need a break during a game.
3. Assign each student a bandana as their role (predator or lizard), **assign 4-7 predators, most students will be lizards.**
4. At your signal, lizards run out first within the boundary zone, then release the predators.
5. Play for 5 minutes or less, keeping an eye on all players to make sure they are playing correctly and not being too aggressive.
6. Re-group and assign new predators for the next round.

Wrap-Up Questions:

- Was it scary to be chased by predators as a lizard? Why or why not?
- Is it helpful for prey animals to be afraid of predators to survive? Yes, this fear response makes the lizard run and escape; otherwise, it would be caught.
- What is the word for special traits that help an animal to survive?

Lesson 4: Biomimicry | What Would Nature Do?

Objective: 1-LS1-1. Introduce the concept of biomimicry and discuss examples to develop an understanding; engage in activities to challenge students' minds to think of inventions inspired by the external parts of plants and animals.

Materials: Photos of biomimicry inventions and corresponding plant/animal (30 total); photos or real examples of velcro/burs, flippers/marine mammal

Terms: biomimicry, structure, external part, invention, engineer, adaptation, inspiration

Part 1: In Class Discussion (15 min)
Humans encounter problems all the time, but we're really good at coming up with solutions or inventions to solve these problems and make our lives easier. Sometimes the best solutions to problems come from nature. Nature has been "inventing" things for a lot longer than humans have: 3.8 billion years! Over this time span, the natural world has diversified into a bounty of incredible life forms with amazing adaptations.

Engineers are people who design and build things. Engineers get a lot of inspiration from the special parts of plants and animals (adaptations).

Biomimicry is using nature to inspire design, especially to design solutions to our human problems. "Bio" means life, and "mimicry" means to imitate (copycat), so biomimicry is "to imitate life".

Biomimicry can be seen all over the world! Humans have been inspired by nature for as long as we've been on this planet.

Discuss 1-2 examples of biomimicry (use photos and props if possible):

A. **Velcro**: The sticky material was inspired by plant burrs that stick to animal fur. Engineer George de Mestral looked at the burrs under a microscope and noticed they had hundreds of tiny hooks that could catch on loops of hair or clothing.

B. **Diving flippers**: Marine mammals, like seals and whales, have wide flippers that allow them to swim efficiently underwater and still be agile. Humans have copied this design and developed flippers for divers to swim better underwater.

Part 2: Biomimicry Match-Up
Head outside to further explore the concept of biomimicry and challenge the class to match human inventions to the plant or animal that inspired it.

A. Head to an open area and divide the class in half. Half will represent human inventions, the other half will represent the plants/animals that inspired those inventions. Once divided, hand out a photo to each student.
B. For the first round, have students match up on their own time, but time how long it takes for your knowledge. When they have found their match, they should sit down with their match.
C. When all are finished, walk around and check that all are correct. Of those that are not, have them stand up and try to re-match.
D. For round 2, pass out cards again and see if class can match up in under ____ minutes.
E. For round 3, see if class can match up in under ____ minutes.

Wrap Up:
- Was this match-up challenging?
- What was your favorite example of biomimicry?
- What can we call these special traits of these plants/animals? Adaptations!

Biomimicry Matches:

1.	Owl (camouflage)	Camouflage clothing
2.	Snowshoe hare (hind feet)	Snowshoes
3.	Flying squirrel (patagium)	Jumping suit
4.	Polar bear (thick fur)	Winter parka
5.	Devil's thorn (spikes)	Spikes
6.	Whale (blowhole)	Snorkel
7.	Bird (wings, flight)	Airplane
8.	Turtle (protective shell)	Helmet
9.	Kangaroo (pouch)	Fanny pack
10.	Zebra (tail)	Fly swatter
11.	Honeycomb (structure)	Surfboard
12.	Pangolin (flexible plates)	Armor
13.	Nautilus (spiral structure)	Spiral staircase

| 14. | Crab (elevated eyes) | Periscope |
| 15. | Durian fruit (spiked outer structure) | Esplanade Theatre |

Alternative Activity: Biomimicry Designs

The best activity when learning about biomimicry would be to allow students to design and build their own biomimicry creations inspired by a plant/animal using various materials. This idea is not as feasible for a one-hour NatureHoods lesson, but would be a great multi-day or full-day project for a teacher.

1. Help students choose an animal or plant with a special trait that inspires them.
    a. Provide photos to choose from or allow time for students to research plants/animals.
    b. For example: A giraffe (animal) and it's long neck (special trait)
    c. For example: A cactus (plant) and its spines (special trait)
2. Students will brainstorm ideas for inventions inspired by that special trait.
    a. How could the invention be useful to humans?
    b. Could the invention help solve a problem?
3. Students will choose their favorite idea.
4. Students will plan their design.
    a. What will it look like?
    b. What materials will you use? (show or provide what kinds of materials will be available)
    c. How will you build it?
5. Students will build their design using the materials provided.
6. Share your creation with the class!
    a. What is the invention for?
    b. How does it help humans?
    c. What plant/animal was your inspiration and why?

Material Ideas:

- Paper/newspaper/construction paper
- Rubber bands
- Paper clips
- String/yarn
- Tape
- Toilet paper rolls
- Fabric
- Pipe cleaners

- Glue
- Tin foil
- Pom poms
- Clay
- Scissors
- Pencils
- Cups/bowls
- Clothespins
- Beads
- Foam board
- Cardboard