Inquiries in Nature

GRADE 5 & 6

Curriculum Connections

Grade 5 Science

- Multi-cellular organisms have organ systems that enable them to survive and interact with their environment.
- Basic structures and functions of body systems:
  - Respiratory
  - Circulatory
  - Musculoskeletal
  - Digestive
- Machines are devices that transfer force and energy.

Grade 6 Science

- Multicellular organisms have organ systems that enable them to survive and interact within their environment.
- Basic structures and functions of body systems:
  - Excretory
  - Reproductive
  - Hormonal
  - Nervous
- Everyday materials are often mixtures.
- Newton's three laws of motion describe the relationship between force and motion; force of gravity.

Grade 6 Social Studies

- Complex global problems require international cooperation to make difficult choices for the future.
- Economic policies and resource management effects on indigenous peoples.
- International cooperation and responses to global issues.

Grade 5 Applied Designs, Skills, and Technology

- Designs can be improved with prototyping and testing.
- Skills are developed through practice, effort, and testing.

Grade 6 Applied Designs, Skills, and Technology

- Design can be responsive to identified needs.

Designs in Nature

The natural world has an infinite number of forms and functions that we can learn from. Try these hands-on activities to delve into simple machines and efficient designs.

Forces in Nature

From the ocean tides to animals' digestive systems, the forces of nature have a profound effect on all life on Earth. Get outdoors, get curious, and may the forces be with you!

Biomimicry

Students go outdoors to observe nature around them and evolutionary adaptations; how the features, structures, or behaviours in the natural world has solved a problem and helped that organism to survive.

Inquire

What can we learn from nature to help us create a more sustainable world? How does evolution shape life on Earth and help organisms to survive? What are some human technologies and inventions that have been created that are inspired by nature?

Teaching Ideas

This project could be done collaboratively with small groups who could observe nature separately but work together to discuss adaptations and invention design.

In Nature

"The people who design our world have a lot to learn from the natural world. All they have to do is take a look."
- Kurt Kohlstedt, writer

Biomimicry, from 'bio' (life); 'mimicry' (imitation); the practice of imitating life. Biomimicry is innovation inspired by nature. Life on Earth has had 3.8 billion years to evolve, innovate, and create efficient systems and designs. We can learn from these lessons from biology to make products, systems, and cities more sustainable.

Some examples of how the natural world has inspired better design include:

- Termite mounds to make efficient building ventilation.
- Birds (wings of an owl, belly of a penguin, and beak of a kingfisher) to make bullet trains faster and quieter.
- Humpback whale fin shape and texture to make more efficient wind and hydro turbines.

Get Outdoors!

Go outdoors to observe structures or behaviours of an organism and how that organism functions and survives.

Try This

Think about the unique adaptations (structures, behaviours and their functions) of something that you observed and how it could be applied to solve a problem in human society. (Optional- do online research on an animal or plant that you observed to learn more about its structures and functions.)

Have your imagination go wild! Dream up an invention inspired by your observations that could change the human world. What problem could it solve? Think about a tool, toy, article of clothing, forms of transportation, or other technology that could be designed to mimic the plant or animal. Give your invention a name and make a sketch or diagram of your invention.

Materials

Biomimicry Copy Page

More Ideas and Resources

- *Here is a video* for students to watch to introduce biomimicry. *"The world is poorly designed. But copying nature helps."* Vox (6:49)
- Children's Book: Nature Did It First: Engineering Through Biomimicry by Karen Ansberry. Dawn Publications, 2020.
- *Biomimicry Institute* has great examples, resources, and a Youth Design Challenge.

Biomimicry Design Challenge

1. Make Observations in Nature: Go outdoors and observe the nature world up close. What forms and behaviours do you see? How do you think these features might help the organism to survive in its environment? If you don't have access to the outdoors, look at images or videos of animals, fungi, and plants to get some ideas.

Organism	Structure or Behaviour	Function

2. Identify a Problem: Think about something that you observed in nature and its unique structures and functions. What human problem might the organism help solve? How?

3. Design Your Invention: What could you invent that would imitate the plant or animal in order to solve the problem? Think about a tool, technology, vehicle, building, toy or sports equipment, or other everyday item that could be improved using design inspired by nature.

   Name of Invention: _____

   Describe your invention and the problem it solves:

   What in nature inspired your invention (how is it an example of biomimicry)?

   Sketch your invention. (Optional: build a prototype of your invention using natural materials)

Adapted from *https://cdn.sourcebooks.com/assets/downloads/activitykits/NatureDidItFirst.pdf*

The Physics of Gardening

Students look for simple machines that are used in the garden (school garden or at home). With adult supervision, students can use the tools and experience how simple machines make our work easier. Students may also design and build a new type of garden tool. In doing this activity, students will also learn about and appreciate First Nations tools and technologies used in harvesting and land management.

Inquire

How do simple machines help us to do work in the garden? How do machines help make our work more efficient? How did First Peoples work the land (and shore)? What types of simple machines did they use?

Teaching Ideas

Students could share their learning by creating a short video to share with their peers about the garden tool they invented and how it works to transfer force and energy. Pair-share-compare: If students build tools, have them pair up with another student to test out and compare their inventions.

If students don't have access to a garden they could look for simple tools in the home or classroom instead, such as in the kitchen (rolling pin, forks and knives, corkscrew, tongs, scissors, can opener, etc.), in the classroom (scissors, pencil sharpener, stapler, staple remover, etc.) or playground. The same activity described below could be done considering First Nations connections and creating a machine invention to be used in a home setting.

In Nature

There are six types of simple machines: the inclined plane, wedge, lever, pulley, wheel and axle, and screw. People use simple machines to transfer force and energy, making their work easier. In the garden we take care of plants and animals by using tools (simple machines) that help us to dig, rake, plant seeds, prune and chop, harvest, water, haul things, and much more! Imagine how much more difficult and slower it would be to do this work using only your own body.

Indigenous peoples around the world designed and built simple machines that helped them work the land efficiently. For example, different types of digging sticks were carved from strong wood and bone or antlers to harvest edible roots, bulbs, and shellfish.

What simple machines did the First Nations peoples in your region use to manage the land and shore?

Get Outdoors

Visit your garden and the tools that are used to work there. Some tools to consider include wheelbarrow, pruning shears, trowel, rake, large shovel, bucket, secateurs, scissors, hoe, ramp, seed planter/dibbler, spray bottle, water spigot/pump and hose. If you don't have many tools you could also do an internet image search for "garden tools".

Classify the garden tools into the six types of simple machines (inclined plane, wedge, lever, pulley, wheel and axle, screw). Some may be compound machines (made up of more than one simple machine). With adult permission and/or supervision, use the tools and compare how they work. Explain how each type of simple machine/garden tool makes a job easier.

Try This

Build your tool! Invent a simple machine that could be used to solve the problem. Create a design for your personal garden tool using natural materials.

Test out your simple machine in terms of its power or strength capacity and its effectiveness.

Materials

- **Simple tools from the kitchen**: rolling pin, forks, corkscrew, tongs, scissors, can opener, etc.
- **Simple tools from the classroom:** stapler, pencil sharpeners, scissors, hole punch, etc.
- **Simple tools from the garden:** trowel, rake, shovel, hoe, wheelbarrow, etc.
- The Physics of Gardening Copy Page

More Ideas and Resources

- Learn about local First Nations technologies and tools that were used to work the land and shore, such as different types of digging sticks to harvest bulbs or clams. Look for photographs or videos of these tools in use to see how they were used and how they made work easier. What types of simple machines are they?
- *Tools from the Land, Unit 3 Part 2* in "Science First People's Teacher Resource Guide" Grades 5 to 9
- *Grade 5 Place-Based Learning Example* – All Science Big Ideas in the Garden.

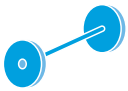
The Physics of Gardening

What Type of Simple Machine is Your Garden Tool and How Does it Work?

INCLINED PLANE

WEDGE

LEVER



WHEEL AND AXLE

PULLEY

SCREW

Garden Tool	How it Works/Observations	Type of Simple Machine

Invent a Gardening Tool

1. Give your tool a name:

2. Describe what your tool does. How does it transfer force and energy and help you to work more efficiently?

3. What type of simple machine/s is your tool?

4. Sketch your tool below!

Simple Machines from Nature

In this activity, students look at photographs of some animals and consider how they are like simple machines. Then they go outdoors (backyard, schoolyard, nearby park or natural area) to look for common animals and plants and consider them from a new angle- how their body parts or behaviours are used like simple machines.

Inquire

What types of simple machines are found in nature? Which types are most common or most rare and why? How are the bodies or behaviours of animals like simple machines? What unique features would you want to have and how would it help you to work/transfer energy more efficiently?

Teaching Ideas

Create a collaborative slideshow or *Padlet* with a page for each type of simple machine. Have each student contribute a photograph, sketch, or an observation that they made of a simple machine in nature.

In Nature

Simple machines are all around us. People make simple machines to make our work easier (consider scissors, a ramp, a shovel, a screwdriver and screw, a pulley, or a bicycle, and what life might be like without them). Parts of our bodies also function as simple machines that allow us to breathe, our blood to flow, and to make all of our movements, from jumping and walking, throwing and pivoting, lifting, and cartwheeling! Like humans, other animals and plants in nature also have features and behaviours that are like simple machines, which allows them to transfer force and energy and helps them to survive.

Simple machines abound in the animal world.
Here are some examples. (From *Discover Magazine*)

- **Inclined plane** - works by decreasing the amount of force needed to move an object to a certain height while increasing the distance the object must move. When birds are learning to fly they run and flap up steep inclines, which uses much less energy than if they flew at those same angles.
- **Wedge** - is anything that can pierce and is used for parting or separating materials. This is very common in nature and includes teeth, beaks, invertebrate mandibles, horns, and claws.
- **Lever** - Bones and joints are levers and fulcrums (the stationary part of the lever). Arms and legs are class 3 levers, which don't make lifting loads easier but increases velocity, allowing the animals to move faster than they otherwise would.
- **Pulley** - is a way of getting force to go around corners. The knee joint is a pulley. If the quadriceps were connected directly to your shin, every time it contracted, the bones of the lower leg would grind into the base of the femur and it would take a lot of effort to move. But with the connection over the top of the knee cap (patella), the force from the quad pulls on the lower leg in front of the shin so the shin moves easily.
- **Wheel & Axle** - are rare in nature because it is difficult to get nutrients (via blood vessels or other tissues) to a fully rotating wheel. But on the microscopic level it is possible and one example is the whip-like flagellum of bacteria, which rotates completely around producing torque and propelling the organism as it spins.
- **Screw** - is an inclined plane wrapped around a cylinder, which is used to hold two things together or raise or lower something. A unique example in nature is the knee of the Papuan weevil (an insect). Scientists studying electron micrographs of the weevil knee joint found miniature screws and nuts, which the weevil use to lock its knees for stability when it lands. Another example is the screw-shaped "spiral valve" of the intestine of some sharks, skates, and rays. The internal coiling of the organ increases surface area and nutrient absorption.

Get Outdoors!

Go outside to look for examples of simple machines in the natural world. This could be in a backyard, school yard, even from a patio or window if outdoor areas aren't available. Consider how the features and behaviours observed are related to simple machines.

Some ideas of things to look for outdoors:

- Worms moving through the dirt
- A bird eating a seed or an insect in the ground
- A spider constructing a web
- A nuthatch spiralling up a tree
- A hummingbird hovering in flight
- An ant carrying something bigger than itself
- A grasshopper jumping/catapulting its body
- Holes in tree bark made by wood boring beetles
- A twining vine spiralling upwards
- A dog or cat digging a hole

Try This

Look for examples of simple machines in nature in photographs of animals and plants. Then go on a Simple Machines in Nature Scavenger Hunt to see what you can find! Notice which types of machines were the most/least observed.

Invent an imaginary animal. Sketch it and label its features or behaviours that help it to survive and how it is like a simple machine. Name your animal.

Materials

- Simple Machines from Nature—teacher notes
- Simple Machines in Nature Scavenger Hunt copy page

More Ideas and Resources

Discover simple machines with the Royal BC Museum:

- *Simple machines at the RBCM* in industry, modern living, transportation and in nature
- *The six simple machines reference chart*

Teacher Instructions

Have students find photographs of local animals and plants and/or use the ones below to explore their connections to simple machines.

When looking at the photos have the students consider the following questions.

- What is happening in this photograph?
- How are the animals or plants like a simple machine? What type of simple machine is it?
- What does this simple machine help the animal/plant do? How does it help them to live and survive?

Additional information below each photograph is provided for teachers only.

https://commons.wikimedia.org/wiki/File:American_Beaver,_tree_cutting.jpg

Teacher notes: Beaver chewing a tree for food, building a shelter (lodge), or altering ecosystems (building a dam). Its teeth are used like a wedge.

Cool fact: Beaver teeth are orange coloured because they have iron in them, giving them strength. The back of the teeth don't have iron and wear away faster than the front, giving them a chisel-shape, which allows them to quickly and efficiently bring down big trees!

Photo by Jason J. Thomas, https://www.flickr.com/photos/jasonjthomas/4829498818/ licensed for non-commercial reuse and name attribution

Teacher notes: Grizzly bear digging a hole, looking for food or building a winter shelter. Their long claws are wedges and their legs are used like we would use shovels (levers).

Cool fact: Grizzly bear claws are up to 10 cm long- longer than a large adult's fingers! They use them to dig for plant roots and bulbs, rodents and insects. The grizzly bear's large shoulder hump (which distinguishes them from black bears) is from a strong muscle that powers their digging forelegs.

https://commons.wikimedia.org/wiki/File:Pileated_Woodpecker_(9597212081).jpg

Teacher notes: This is a pileated woodpecker excavating holes in a tree to look for invertebrate food, like beetle larvae and carpenter ants. They also excavate much deeper, round holes to create their nest sites which, once abandoned, may be used by numerous other animals (songbirds, owls, raccoons, squirrels) for nests or shelter. Its beak is used like a wedge and lever. Its claws grip the tree trunk like a wedge and its tail feathers are stiff and give the bird stability as it pecks (like a fulcrum in a lever). Woodpeckers often move up the tree in a spiral shape (like a screw) as they search for food.

Cool fact: Woodpeckers have long and sticky tongues that they use to grab their food out of holes. Their tongue is so long that it wouldn't fit in their mouth like most birds, so it has evolved a complicated structure of cartilage and bone that wraps the tongue from their nostril around their skull, and when ready, it extends out of their mouth. Could the tongue moving around the skull be like a wheel and axle?

Photo by Stephanie Weinstein

Teacher notes: English Ivy growing on a tree that is completely covered by the thick, woody, old ivy stems. This is an invasive, non-native plant commonly found in southwestern British Columbia. It is sometimes grown in gardens or on buildings, but if it spreads to forests or is left unchecked, it will cover and smother other plants so that they are unable to grow, obtain light or nutrients. Ivy grows as a vine, twining and encircling other plants. It can grow to be thick and tree-like as in this photograph. Is ivy's growth like a simple machine? Look for ivy to see if it grows in a spiral formation, like a screw. If so, perhaps this is an efficient way to grow. Ivy's fuzzy and sticky tendrils can penetrate bricks and the bark of other plants, making them stick like glue, perhaps like a wedge or screw.

Simple Machines in Nature: Scavenger Hunt

Go outdoors and look closely at the features and behaviours of the natural world around you. What simple machines can you find? Write down or sketch what you see.

Inclined Planes	**Wheels and Axles**
Pulleys	**Wedges**
Screws	**Levers**

Winter is Coming!

Learn about and connect to nature's signals that tell us winter is coming! Get to know how different organisms adapt to the winter months by making observations in a scavenger hunt and by doing an experiment to see how animals can keep warm in freezing temperatures.

Inquire

What do you notice when winter is coming? Do you feel different? Do you start to have different behaviours? Does the landscape around you start to change?

Teaching Ideas

Create a *Padlet* page where students can upload photos of what they find on the scavenger hunt and share their observations.

In Nature

Adaptations are inherited behaviours, structures, or physiological traits that help an organism to survive in its environment. Animals and plants that live in temperate environments have specific adaptations that help them to endure - or even thrive!- the cold and dark winter months. Below are some general examples of winter adaptations. What do the animals and plants in your region do to survive the winter? How do they make these changes and what internal systems do they have that help them to survive?

- **Staying warm.** Keeping warm is a primary concern for animals that don't hibernate or migrate in the winter. There are so many incredible ways in which organisms do this! Some examples include:
    - Growing a thicker coat of fur (most mammals)
    - Insulated, feathered feet (ptarmigan and snowy owls)
    - "Snowshoes" to be able to walk on deep snow (ptarmigan, snowshoe hare, lynx and caribou)
    - Specialized blood vessels (countercurrent heat exchange) that prevent bird and mammal feet from freezing when they stand on snow and ice.
    - Antifreeze compounds in the blood of aquatic animals such as some amphibians, reptiles, and fish
    - Find a nearby warm spot...in a tree hole or den, a sheltered valley, woodland thicket, huddled next to many of your 'friends', or in tunnels under a blanket of snow.
    - Plants lose their leaves and reduce the amount of water in their branches and roots, which acts as a natural antifreeze. Roots are also insulated deep in the soil under the snow. Some trees, such as spruce, have downward sloping branches so that snow will slide off and not break them.
- **Storing food.** Having enough food to get through the lean winter months is a matter of life and death. Tree squirrels are busy in the fall burying seeds and nuts and drying mushrooms in tree branches to eat during the winter. Clark's nutcrackers can hide up to 30,000 seeds in the fall and remember where they are 9 months later! Other animals, such as bears and ground squirrels, store food as body fat for their long winter sleep. Deciduous plants store carbohydrates underground in bulbs or roots until spring.
- **Camouflage.** Some animals, such as the snowshoe hare, ptarmigan, and ermine, turn white in winter to blend in with the snow and evade predators.
- **Hibernation.** Marmots, chipmunks, bears, and some bats are some of the animals that enter a suspended state of existence, reducing their metabolism to a fraction of what it is in warmer months. Most insects overwinter as eggs, larvae, or pupae, and hatch in warmer months. Plants also go dormant in the winter months.
- **Migration.** Many birds and bats go on long journeys to warmer areas for the winter to avoid freezing and starvation.

Get Outdoors!

Go outside in the autumn or winter and look for signs of seasonal change and adaptations that organisms have to survive winter. See the Materials section for a link to a Signs of Winter Scavenger Hunt.

Write draw what you thought were there the three most interesting things you found and why.

What adaptations - behaviours, structures, or internal systems - does the organism have that helps it to survive the winter? Do you (humans) have similar adaptations?

Try This

Here is a simple experiment to do outdoors at home or in the schoolyard when there is snow and below freezing nighttime temperatures. (Adapted from Below Zero, Cosy in the Cold.)

- Put equal parts water and powdered pectin in a thick plastic vessel (a water bottle or tupperware container). Only fill the vessel half-way.
- Think about where organisms may live in the winter and how they may stay warm.
- Some organisms bury themselves in the snow to keep warm. Find a location with snow in your yard or at school and build your best snow cave to try to insulate your vessel. Do this in the late afternoon/evening.
- Check back in the morning to see if the water in your vessel is frozen or if it stayed liquid/gelatinous throughout the night.
- What happened and why? What do animals have to protect themselves/to help them survive in the winter that your vessel doesn't have?

Get creative! Do the experiment again trying out different types of vessels and different locations. What worked best/worst and why? What does it say about winter adaptations in the wild?

Materials

Copy Page: Signs of Winter Scavenger Hunt

More Ideas and Resources

Winter Resource Collection

- See what insects you can discover and learn their behavioural adaptations for winter:
  - *Winter wise insects / Des insect ingénieux*
- *Wildlife in Winter*— Canadian Wildlife Federation. Includes feature species, lessons, and downloadable poster.
- *Animals in Winter*—Article by Soren Bondrup-Nielsen and P.J. Austin-Smith. Canadian Encyclopedia, 2015.

Soil Investigations

Learn about soil composition by making a "soil shake" by placing one half cup of soil into a jar with a lid and adding two cups of water. Students use their scientific minds and curiosity to hypothesize what will happen if they shake the closed jar and let it settle for a few hours. Then, try it.

Inquire

What is soil? What is found in soil? How are potting soil and backyard dirt different? Or from a sandbox/the beach? Why do you think they're different? What are the living and non-living components of soil? How do plants grow in different types of soil? What does soil look like under magnification? Why can soil be different colours?

Teaching Ideas

Have students share the sketches or photographs of their "soil shakes" to compare and contrast their findings and find their "soil shake matching buddy" (another student whose soil shake most closely resembles theirs). Were the soil shake matches collected from similar locations?

In Nature

Soil is a heterogenous mixture, composed of mineral matter, organic matter, air, and water. There are three main types of mineral particles found in soil: sand, silt, and clay. Sand is the largest particle and has a "coarse" texture, like sand at the beach. Clay is the smallest particle and has a "smooth" texture, like the clay you might use if you were sculpting something. Silt is the medium sized particle, with a texture between the sand and clay, like a fine sandpaper.

Not all soil is brown! Here is a list of some minerals that may be present in soil as indicated by their colour:

- **Reddish, yellowish, or brownish** - iron oxides
- **Red** - hematite
- **Yellowish-brown** - geothite
- **Reddish brown** - ferrihydrite
- **Grey** - quartz and silicate minerals
- **White** - carbonates or other salts
- **Green** - potassium
- **Black/very dark brown** - organic matter
- **Black** - manganese oxides

Get Outdoors!

Spend some time exploring the soil and making observations. Explore a range of places for soil - with plants, without plants, garden, natural landscape.

Run it between the fingers to get a sense of how it feels - smooth, gritty, silky. What do the largest soil particles look like? The smallest? Smell the soil, explore the different colours, and notice what is in the soil (rocks, sticks, litter). Look for signs of life in the soil (animal and plant).

Describe where your soil is from. Draw a picture that shows where you got it. What was growing there? What else did you notice? Record these observations on your data sheet.

Try This

Collect some small soil sample(s) from a few different locations but make sure you have permission first! Do not collect soil from parks where collecting is not permitted. Collect half a cup of soil into a jar with a water-tight fitting lid.

Add two cups of water to your soil sample. Predict what will happen if you shake the closed jar and what will happen after it settles for a few minutes/hours/days? Write your predictions down in your data sheet.

Tightly close the lid and then make your 'soil shake'. Sketch and describe what you see. Let the sample settle for at least 24 hours. Return periodically to describe and sketch what you see over time.

Note: Soils with high clay content may take several days to settle.

Materials

Suggested Materials for Soil Shake Activity:

- Trowel
- Sampling containers (glass or plastic jars with tight-fitting screw-top lids)
- Magnifying glass

- Masking tape & pen to label containers
- Data sheet (Soil Investigation) or paper and pencil to record observations
- *Soil Investigation Copy Page*

More Ideas and Resources

- *Paint with Mud!* Explore the different colors and textures of various samples of soil by mixing and painting with mud. The link includes a video with mud painting artist, Henry Neubig.
- Try growing the same type of seeds in different types of soils. Which soil supports plant growth the best?
- *Soil Texture Triangle*— Identify soil types based on percentage of silt, clay, and sand
- *Soil Science Society of America*—K-12 Teacher resources including background information, lesson plans and "ask a soil scientist" program.
- *Digging Deeper*—Complete lesson plan with hands-on investigations of soil properties (Grades 6-12)

Simulate the Tides

Students use models, experiments, and role play to understand and visualize how the gravitational forces of the moon and sun cause changes in ocean tides.

Inquire

What causes tides? Why do tidal heights change over the course of the day and throughout the month? At what phase/s of the moon are there the greatest (and smallest) differences between low and high tides? What adaptations do organisms have to survive tidal fluctuations? How and why are tidal patterns different around the world?

Teaching Ideas

Here are some suggested activities if you aren't able to visit the seashore.

- Listen to sounds from the ocean (such as waves, birds, seals, and boats) and provide some guided imagery to help students imagine being at the seashore and the intertidal environment. Discuss all of our connections to the ocean (leisure, food, trade, oxygen, the water cycle, etc.) regardless of where we live, and how tidal forces influence our lives and the lives of other organisms.
- Have the students learn how to read a tide chart from a specific location (available online, such as *waterlevels.gc.ca* or *tide-forecast.com*). Using several weeks of tide chart data, have the students plan an outing to that location to do a particular activity of their choice, such as kayaking, skimboarding, swimming, harvesting shellfish, or beachcombing. Based on the tide charts, students should select what date and times would be best for their excursion and explain why.
- Research organisms that live in the intertidal zone such as barnacles, mussels, limpets, sea stars, sand dollars, and seaweeds. Have students write a short story or make a theatrical play about a day in the life of a creature that lives under the influence of the tides.

In Nature

Tides are the result of several influences and complex interactions between forces. These influences include the daily rotation of Earth; Moon's revolution around Earth; and Earth and Moon's revolution around the Sun.

Our Sun is 27 million times larger than our Moon but 390 times further from the Earth than is our Moon. Therefore, although it is significantly smaller than the Sun, the Moon exerts about double the gravitational force and generates our tides due to its relative proximity to Earth.

Imagine standing at a location on the seashore. As the Earth rotates, your location will line up with the Moon. When the Moon and your position on Earth are aligned, the Moon's gravitational force causes the ocean to bulge out and be pulled toward the Moon. This is high tide. As the Earth rotates and your position moves perpendicular to the alignment with the Moon, the gravitational forces of the Moon are diminished and a low tide occurs. So as the Earth rotates, high tides and low tides form around the world as they pass under the changing force of the Moon's gravitational pull, typically two high tides and two low tides in a 24 hour period. These patterns of high and low tides change throughout the month. When the Sun is aligned with the Moon (in the full and new moon phases), the gravitational pull of the Sun and Moon are combined, creating larger high tides and lower low tides. These are called "spring tides", because the water "springs" up. When the Sun and Moon are perpendicular to each other (when the Moon is half full, at first and third quarter moon phases), the gravitational pulls of the Sun and Moon upon the Earth are opposing forces. These times of the month have "neap tides", which have a smaller height difference between high and low tide.

Get Outdoors!

Have students find evidence of the high tide line (the "wrack line", usually visible as a line of seaweed and other matter left by the tide). What observations can students make? What is in and under the wrack line? Is the sand wet or dry? Have students predict if the tide is high or low, rising or falling. Explore the beach from the high tide down to the water line, noticing zones where different living organisms are found and changes in abiotic (non-living) seashore conditions (wind, temperature, sand and rocks, salt spray, etc.). Monitor the tides by securely placing a metre stick into the sand at the waterline. Record the water level and time of day in a field notebook. Check on the stick at designated intervals, such as every half hour, and just before leaving the beach and record the water level. Using a tape measure, record

the distance to the waterline above or below the metre stick. If possible, go on multiple trips to the seashore to compare and contrast what the shore looks like at different tidal heights and in different seasons. For each field trip, also record the phase of the moon.

Try This

Experiments and roleplay to do in a large space such as at the beach, in the schoolyard, or in the gym:

1. **Why doesn't the sea fall off of Earth? Why are there two bulging high tides on opposite sides of the Earth in alignment with the Moon?**

   - Experiment with centrifugal forces, gravity and inertia using ropes, soft balls or washers tied on them; salad spinners in sinks or spinning small buckets of water off the ground without spilling their contents.

2. **Roleplay how tides are influenced by the Moon and Sun.**

   - Choose three students to be the Earth, Moon, and Sun. All other students are the ocean and form a large circle around Earth, holding on to a large rope or spreading their hands out towards each other. Moon and Sun should be on the outside of the circle, with the Moon closer to the ocean, and Sun farther away.
   - Have the Earth slowly rotate counterclockwise. When the Earth faces the Moon, Ocean students who are facing Earth should pull gently on their rope and take one step backwards, creating a high tide bulge. Those that are directly behind Earth do the same. Those who are perpendicular to Earth and Moon squeeze one step inward (low tide). (If you don't have a rope, high tide students can raise their hands and take a step out and low tide students get down low, bring their hands down, and take a step in towards Earth.) Have the Earth make a full rotation and each student should go through two high tides and two low tides.
   - Now consider the position of the Moon and Sun. The Sun should stay still (and for simplicity, the Earth will not revolve around the sun). Have the Moon revolve (slowly walk) around the Earth counterclockwise as the Earth slowly rotates. Have students create their high tide bulges as the Earth aligns with the moon. Stop when the Moon and Sun are aligned it is spring tide. Have the Ocean students make extra large high and low tides by stepping out/in from the circle by two steps, instead of the usual one. Start the Moon revolution again and stop when it is perpendicular to the Sun. This is neap tide. Have the Ocean students make small high and low tides by stepping out/in from the circle by a tiny half step.
   - Discuss what different parts of the earth (different ocean students) are experiencing as the earth rotates and as the moon revolves around the earth. What are the relative positions of the earth, moon, and sun throughout the month? Have students change roles. See if you can make the revolutions a bit faster.

Materials

Tide-o-Matic: Build a simple model to explore the influence of the sun and moon on our tides. Templates, directions and background information provided.

More Ideas and Resources

- Take a virtual visit to the largest tides in the world at the Bay of Fundy. Watch time lapse videos, such as *this one*.
- Beach Explorations - A Curriculum for Grades 5-10 by Gloria Snively. Kingfisher Press, Sooke, B.C., 2003.
- *HCTF Education Let's Go to the Ocean* - Field trip module for grades 5-7 and Ocean Species Cards.
- *Simulate the Tides Lesson*

Science of Poop

Challenge students to put their new knowledge of the digestive and excretory systems to the test. Learn about body systems in humans and compare it to other animals by exploring the types and modes of excretion. Then go outdoors to look for animal signs, including digestive waste (poop, also known as scat).

Inquire

How do animals get rid of things they are unable to digest or metabolize? Why do animals leave scat? What can we learn about an animal by its scat? What are similarities and differences of the body systems of humans and other animals?

Teaching Ideas

Draw outlines of different types of animals (human, fish, frog, bird, snake, insect, various marine invertebrates, etc.). Have students choose one of the animal outlines. Have them research the digestive and/or excretory systems for that animal and draw and label it inside the outline of their animal. Display the sketches and compare the different body systems that these creatures have to remove digestive or metabolic wastes. Discuss the advantages of the system for the particular life and habitat of that type of animal.

In Nature

All living organisms need food to grow and survive. Animals have **digestive systems**, composed of numerous body parts and organs, that get food into their body, digest the food, absorb the nutrients that are needed, and eliminate any unneeded materials (as poop! Also called feces or scat). The digestive system works with other body systems to get nutrients distributed to all parts of the body. The circulatory system carries absorbed nutrients and chemical signals that control the speed of digestion (from the endocrine system) through the body.

Digestive systems are diverse in the animal kingdom and are adapted to the type of food that the animal eats.

- Mammals have different types of **teeth** (such as broad molars for chewing plants or sharp canines for tearing meat) depending on whether they are carnivores, omnivores, or herbivores, which helps them to catch and/or chew their food and break it into smaller pieces to aid in digestion.
- The gut contains an entire ecosystem of diverse "**microbiota**", including bacteria, protists, fungi and yeasts, that play an essential role in helping animals to digest their food. Animals that feed primarily on the plant fiber, cellulose, such as termites or pandas, wouldn't be able to digest their food without the bacteria in their guts!
- Some animals, including humans, dogs and cats, have one stomach. Other herbivorous animals, such as cows, goats, deer, and sheep ("**ruminants**") have a four chambered stomach, each of which serves a role to help them digest their plant food that they swallow without much chewing.
- They may not have teeth, but birds have a **gizzard**, a muscular organ with grit and stones inside, which acts like teeth, helping to grind up their food.

The waste products of digestion—scat—can tell us what animal was there and give insights into its diet, behaviour and habitat.

While the digestive system collects and removes undigested solids, the **excretory system** filters metabolic waste products through the bloodstream and removes them from the body. In humans, our lungs excrete carbon dioxide as we exhale, the kidneys filter out nitrogenous and other waste products and excretes them as urine, and our skin sheds excess salt through sweat.

In animals, the **main excretory products** are ammonia, carbon dioxide, urea, uric acid, guanine, and/or creatine.

Based on the excretory product, five modes of excretion are known in the animal kingdom. They are:

- **Ammonotelism** (Type of excretion – ammonia; fish and many aquatic animals including crustaceans and sponges)
- **Ureotelism** (Type of excretion – urea; mammals, most amphibians, sharks, some bony fish)
- **Uricotelism** (Type of excretion – uric acid; birds, insects, reptiles and land snails)

- **Aminotelism** (Type of excretion – amino acids; some molluscs and echinoderms)
- **Guanotelism** (Type of excretion – guanine; spiders, some reptiles, birds, and earthworms)

Animals also have different excretory organs that are adapted to eliminate their waste products. For example, we (and other vertebrates) have kidneys. Insects have malpighian tubules, and earthworms have nephridia.

Scat Facts

- Bears are omnivores, meaning they eat both meat and plants. Their scat often has remnants of berries and seeds that they like to eat.
- Deer scat is shaped like small pellets due to the size of the opening of their colon.
- Everyone who has cleaned a windshield knows that birds' waste has brown and white parts. The excretory and digestive wastes of birds are eliminated together. The white part is uric acid and the black part is digested matter (poop).
- Wombat poop is shaped like a cube! The distinctive shape is due to the fact that all moisture is extracted from the poop and variable muscular contractions in the intestine, which form the uniform size and corners of the poop.
- Cougars, cats, dogs, foxes, and wolves have tubular scats that may have remnants of their diet in it, such as hair or bones.
- Scientists can learn about the diet of extinct animals by studying their fossilized poop, called coprolites.
- River otter poop includes pieces of crab shells, fish bones and other aquatic animal parts, which are deposited on land. Research shows that otter scat provides important nutrients to rocky coastal island soils, much like how dead salmon fertilize forests.
- Owls are unable to digest the fur, feathers, and bones of their prey. Rather than eliminating them as scat, their digestive system creates compact "owl pellets" that they spit up through their mouth, with soft fur and feathers on the outside of the pellet, and skulls and other bones on the inside.

Get Outdoors!

Be 'Digestive Detectives'! Go outdoors in nearby nature and look for signs that animals have been feeding, such as holes on leaves, chewed mushrooms, browsed twigs and stems, bark beetle tunnels on downed logs. Also look for animal scat. Don't disturb or handle scat but take a close look to see the shape, size, and if you can tell what was eaten (can you see fur, bones, plant matter?). Look for tracks of animals and use field guides to try to identify them. Treat all of the observations that you make as evidence that can help you to solve the mystery of who has been feeding, digesting and/or excreting nearby.

Try This

Make models of different kinds of animal poop. Use play dough or make some no bake cookies in the form of different types of animal scat.

Learn the "Scat Rap" and sing it loud and proud! Here are a few stanzas. Look for more lyrics and other versions of this song on the internet, or have students make them up based on local animals and your learning.

It starts with an "S" and ends with a "T".
It comes out of you, and it comes out of me.
I know what you're thinking, but don't call it that,
Be scientific, and call it SCAT.

Down by the creek on a hollow log
Scat full of berries and bones of frogs
Fresh last night, out with the moon
Hunting crawdads, it was a big raccoon.

If you want to find out what animals eat,
Take a good look at what they excrete.
Stuck in the scat are all kinds of clues,
Parts of the food that their bodies can't use.

Materials

HCTF Education Tracks and Scats Field ID Cards

More Ideas and Resources

Poop Bingo, by Laurence King Publishing

Books:

- *Who Pooped in the Park: Tracks and Scats for Kids* (Series, with animals specific to various National Parks in the USA). Gary D. Robson and Steve Kemp.
- *Tracks, Scat and Signs.* Leslie A. Dendy. Young Naturalist Field Guides, Gareth Stevens Publications, 2000.
- *Whose Poop is That?* Darrin Lunde. Penguin Random House, 2017.
- *Poodunnit: How to Track Animals by their Poop, Footprints and More!* Carleton books, 2020.
- *Track that Scat!* Lisa Morlock. Sleeping Bear Press, 2012.