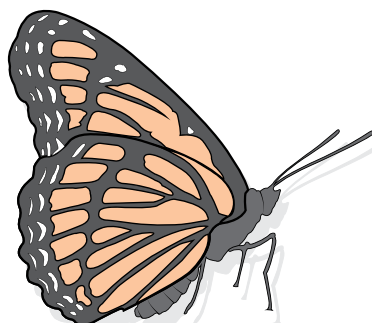
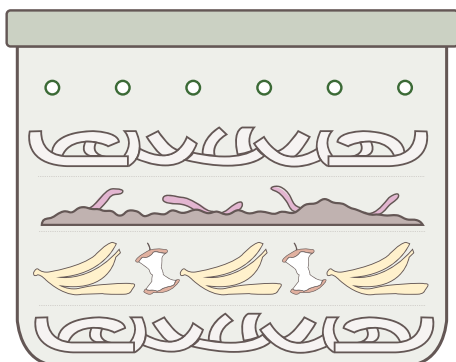
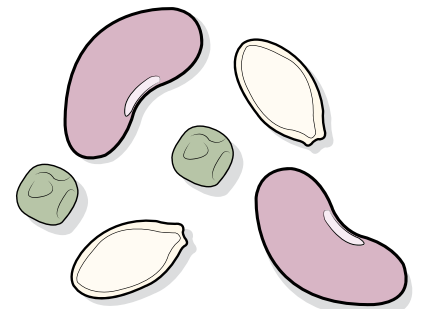
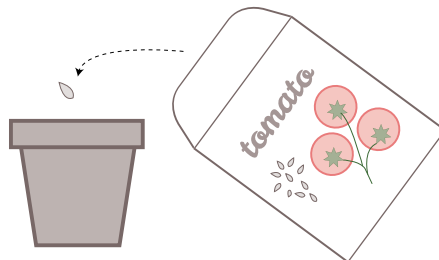
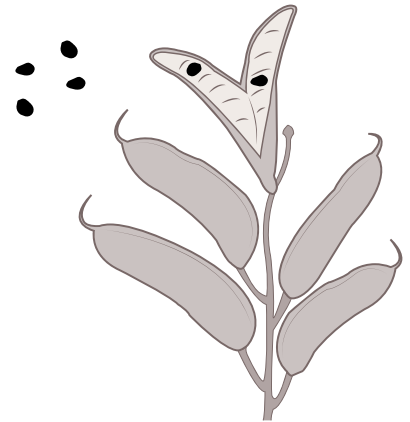
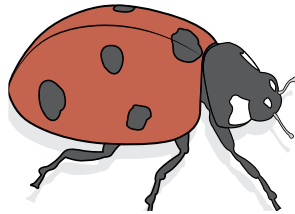
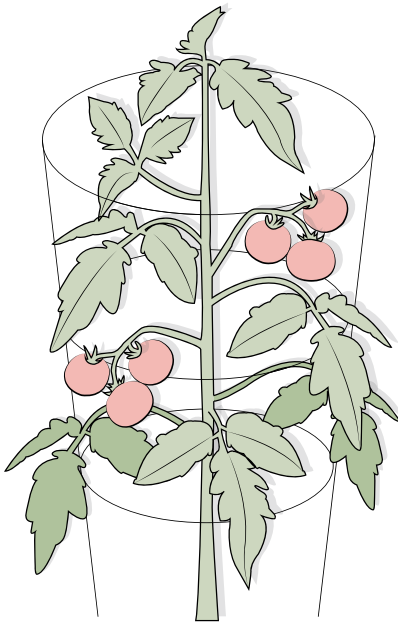
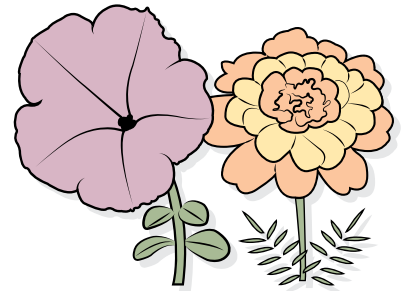
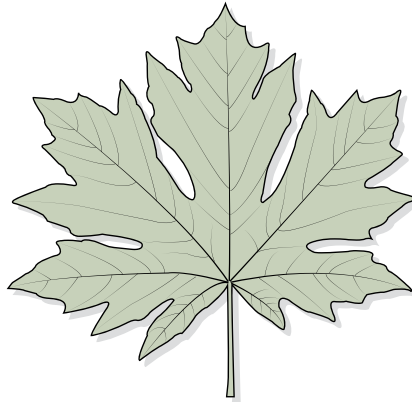
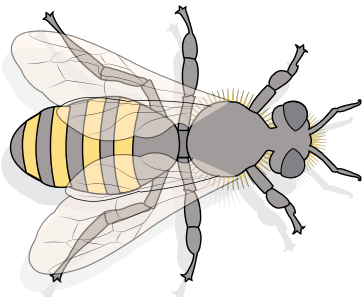
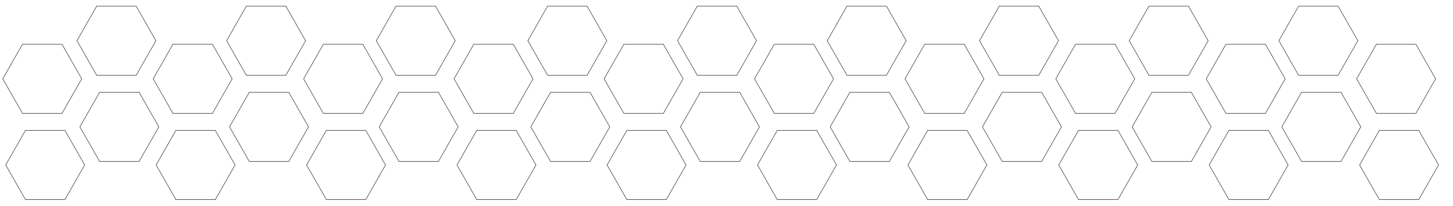


GREEN THUMBS AT SCHOOL: SPEC FOOD GARDEN LESSON BOOK





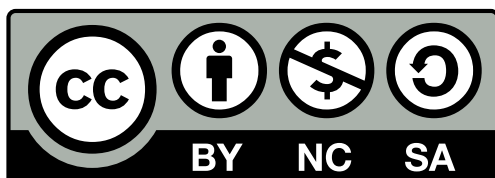
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WITH GENEROUS SUPPORT FROM:



Lessons by Catriona Gordon | Design by Lisa Rilkoff



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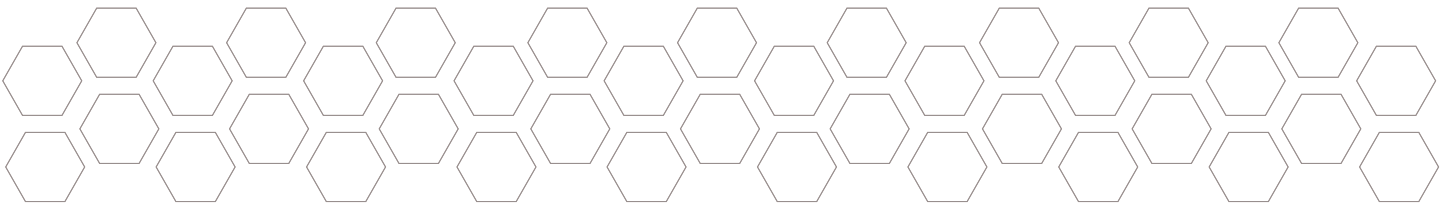


Table of Contents

4 Preface

5 Acknowledgements

6 Unit 1: Soils, Earthworms, & Compost

7 Lesson 1: What is Soil and Who Lives in It?

21 Lesson 2: The Secret Lives of Red Wiggler Earthworms

28 Lesson 3: Making a Classroom Composter

36 Unit 2: Seed Travel and Seed Saving

37 Lesson 4: How Seeds Travel

42 Lesson 5: Seed Saving

50 Unit 3: Leaves, Flowers, & Insects

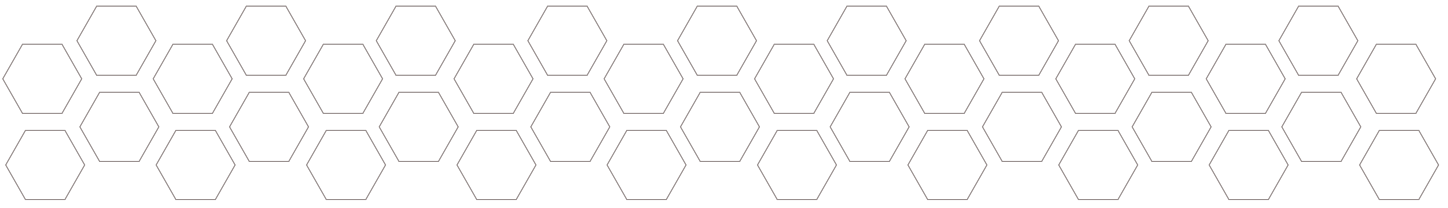
51 Lesson 6: Leaves and How They Work

65 Lesson 7: Flowers and Pollinators

72 Lesson 8: Insects in the Garden

82 Unit 4: Garden Planning and Design

83 Lesson 9: Food Garden Planning and Design



Preface

Humans have used plants as food since the beginning of time. At the Society Promoting Environmental Conservation (SPEC) we see food as a key tool for developing sustainable cities and communities. SPEC has been working in Vancouver, Canada on practical solutions for sustainable cities for 45 years.

This toolkit of 9 food garden ecology lessons is based on 7 years of experience in Vancouver's public schools with SPEC's School Garden Program. Since its inception in 2008, the SPEC School Garden Program has engaged learners both young and old on how to grow food and food systems that are just and sustainable. We have helped schools start their own food gardens, where kids learn about how the sun, water and soil connect with plants, people and our planet.

Our goal is simple: connect children to their food, to each other, to nature and to global issues of climate change. SPEC has now expanded to 8 Vancouver public schools, teaching students, staff and community members about ecology, food literacy and organic food growing. Our curriculum-based lessons are hands-on, fun and engaging.

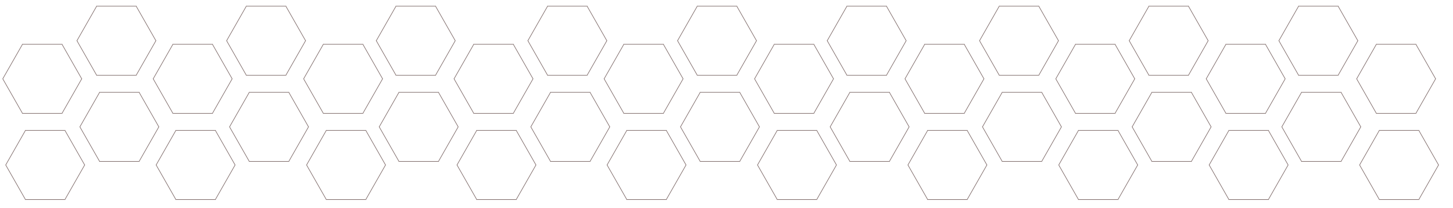
We are pleased to offer these tested lessons online with teachers and community members throughout the City of Vancouver and beyond. We wish to thank the generous support of the Vancouver Foundation and all our partners who made this toolkit possible.

Whether you are a teacher, a learner or a budding gardener we hope you can use these lessons to plant a seed and grow with us!

Dr. Carole Christopher & Dr. Tara Moreau
SPEC Food Committee Co-Chairs

Catriona Gordon
SPEC School Gardens Co-ordinator

July 2014

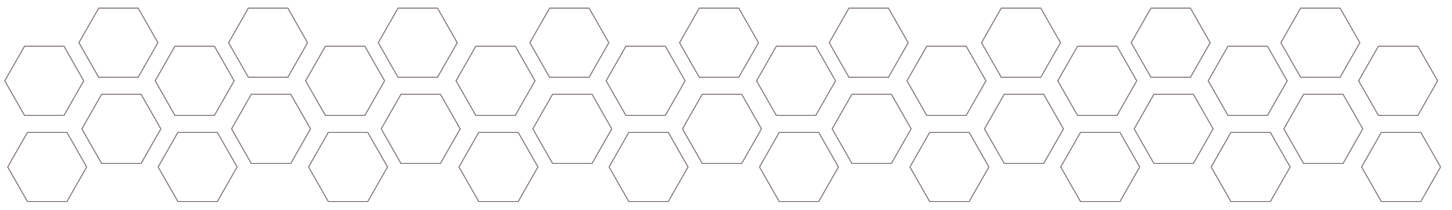


Acknowledgements

SPEC School Gardens Program would like to thank the following groups and organizations for their generous support:

- | | |
|-------------------------------|--|
| Bayview PAC | Brock Junction Daycare |
| Point Grey Community Church | Tupper Tech Careers Program |
| Acme Delivery Company | City of Vancouver |
| BC Lottery Commission | BC Hydro |
| Think & Eat Green @ School | Kitsilano High School PAC |
| TD Friends of the Environment | Ecole Bilingue PAC |
| Vancouver Foundation | Queen Elizabeth School PAC |
| UBC Botanical Garden | Evergreen Foundation |
| VanCity | Hewer's Home Hardware |
| Vancouver School Board | Thunderbird Daycare and Community Centre |
| Whole Foods Market | the metta movement |
| West Coast Seeds | MacInnes Landscaping |

SPEC would also like to thank Teri Taylor, Susan Jung, Natasha Tousaw, Holly Lee, Nikoo Boroumand, Amy Ing and Oliver Lane for their valuable feedback during the creation of these lessons.



UNIT 1

SOIL, EARTHWORMS & COMPOST

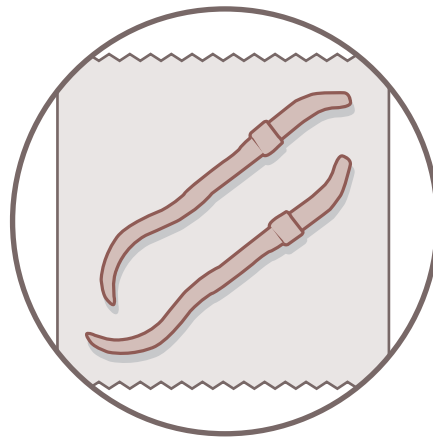
IN THIS UNIT:



1 What is Soil and Who Lives in It?

Learn about **soil composition** and **particles**. Explore how you can determine soil types by **soil texture tests**. Examine **organisms** that live in the soil and learn about their role in the ecosystem. Discover that soil particles **sediment** out into different layers, based on size, when mixed with water.

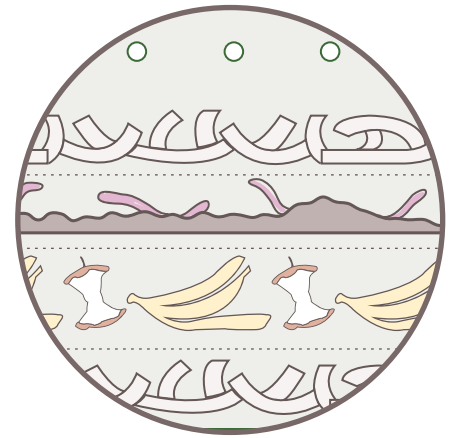
» *pages 7 to 20*



2 The Secret Lives of Red Wiggler Earthworms

Learn about red wiggler earthworms, their **habitat**, **behaviours** and their role in the **compost pile**. Set up a **wormery** to watch earthworms tunnel and mix layers of soil.

» *pages 21 to 27*



3 Making a Classroom Composter

Learn how to set up a successful classroom **composter**. Examine differences between **carbon-rich** and **nitrogen-rich inputs** to compost. Learn about the process of **decomposition**. Discuss responsibilities toward the environment. Take action to lessen one's **environmental footprint**.

» *pages 28 to 35*

What is Soil and Who Lives in it?

Grade K to 7
Science, Math, Art
2 hours
(or divided into 2 or 3 lessons)



information
for the
teacher



Photo Credit: "Touch Healthy Soil" by Natural Resources Conservation Service Soil Health Campaign (NRCS Soil Health on flickr), used under Creative Commons license 2.0 (CC-BY-2.0).

Soil is essential to life on earth and provides the basis for most terrestrial living organisms. Soil is made up of weathered rock and decayed plant and animal matter. Soil particles can be separated into 3 different sizes including sand, silt and clay. The relative proportions of these three particle sizes help to determine the soil type (eg. sandy soil, heavy clay soil, loam). Soil types depend on the underlying rock, or parent material as well as climate, topography and the biotic (living) components.

vocab

LAYERS OF SOIL

- Leaf Litter** Dead plant matter, including leaves, on the ground that when decomposed, turn into humus.
- Humus** Dark brown rich material composed of organic matter (decomposing dead plants and animals), which increases the fertility of the soil.
- Topsoil** The upper-most three centimetres of soil that is high in humus content and micro-organisms. It is the medium in which plant roots thrive.
- Subsoil** Layer of soil found beneath topsoil and above bedrock, with very little organic matter, usually consisting of mineral soil.
- Bedrock** Solid rock under the surface of the ground, below subsoil layer, also known as parent material (see definition below).
- Parent Material** Underlying rock that gives rise to soil via weathering.

TYPES OF SOIL

- Sand** Small gritty particles of weathered rock. Feels grainy or gritty to the touch.
- Clay** Very tiny particles made of minerals 100x smaller than grains of sand. Feels sticky to the touch when rubbed between thumb and forefinger.
- Silt** Very small particles made of minerals, deposited by moving water, in between sand and clay particles in size. Feels soapy or slimy to the touch when rubbed between thumb and forefinger.
- Loam** Soil made up of equal parts sand and silt, with less clay. These soils have good drainage and are agriculturally productive.

What lives in the soil? There are many organisms that live in the soil layer, including soil invertebrates (millipedes, centipedes, mites, earthworms, nematodes) and other microorganisms, which include bacteria, fungi and protists. These organisms help to break down dead plant and animal matter into rich humus, thereby cycling nutrients in the ecosystem.

What kind of soil do we have in BC? It is estimated that 5% of the land in BC has suitable soil for growing crops and other agricultural uses and is therefore part of the Agricultural Land Reserve. Much of the land in BC is made up of forest and mountains and is under threat due to increasing urbanization. Some of the most valuable agricultural soils in BC are those found in the Lower Fraser Valley, near Vancouver. These are alluvial soils (soils composed of particles or sediment deposited over thousands of years by streams, rivers, or other flowing water), which are very fertile grounds for growing food, but they are very limited in area due to the geography of the region, and the threats due to increasing urbanization.

Why should we care about soil? Although soil is considered a renewable resource, it can take between 100-400 years to develop 1 cm of topsoil. Therefore many nations actually consider soil to be a non-renewable resource. In contrast, soil erosion can occur very quickly, so much care should be taken to conserve soils.

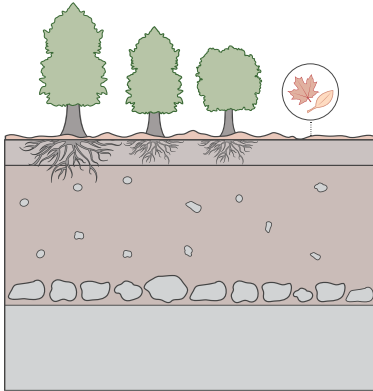
Part 1 Introduction to Soil

Learn about the earth's layers of soil and the different particles and components found within soil.



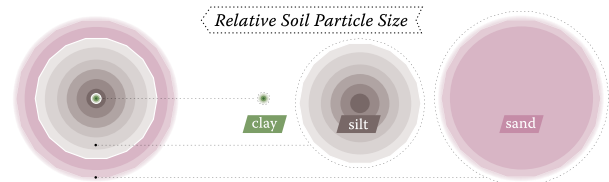
MATERIALS

- 4 visuals included with the soils unit:
 - » Forest Soil
 - » Recycling in Nature (optional)
 - » Soil Particles
 - » Typical Soil
- Forest soil worksheet (1 per student)
- 3 mason jars for soil particles demo (optional):
 - » 1 filled with large stones (representing sand)
 - » 1 filled with medium-sized stones (representing silt)
 - » 1 filled with tiny stones (representing clay)



Introductory Discussion

What is soil?
Why do we need soil?
What is soil made up of?
What lives in soil?
How is soil made?



2. Types of Soil

Write “sand” “silt” and “clay” on the board. Elicit from students:

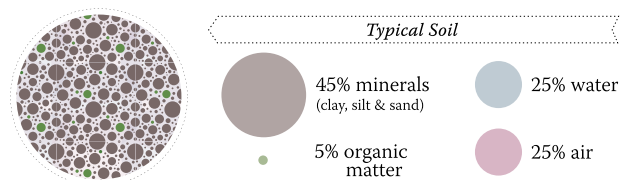
» Common locations:

- Which one of these things would you find on a beach? (*sand*)
- Which would you find near a river (moving water)? (*silt*)
- Which would you find at the bottom of a pond (still water)? (*clay*)

» Texture:

- sand – feels gritty
- clay – feels sticky
- silt – feels soapy or slimy

If you've prepared mason jars with stones (see materials), show them to the students so that they can see the relative particle size of each type of soil. Draw students' attention to the spaces between the stones – which type of soil has the largest spaces between particles? (*sand*). Which has the smallest? (*clay*). Show students the [Soil Particles](#) visual.



3. Growing Plants in Soil

Ask students to guess the type of soil plants like to grow in: 100% sand, 100% clay, 100% silt, or a mixture of the three soil types. (*Plants grow best in soil that contains an ideal mixture of sand, silt, and clay particles. This mixed-particle soil is called **loam**. In loam soils, clay and silt particles help the soil to retain moisture, and sand particles prevent the soil from becoming too compact.*)

Show students the Typical Soil visual, but cover up the “organic matter,” “water,” and “air” labels. Tell students that the typical soil for growing plants contains 45% mineral matter (clay, silt, and sand particles), and have them guess what comprises the other 55%. Elicit from students the importance of organic matter (adds nutrients and helpful organisms to the soil), water (provides a source of moisture for plants) and air (allows space for roots).

1. Soil Layers

Hand out the Forest Soil worksheet to students. Students can label the different layers of soil. Show students the [Forest Soil](#) visual to check answers and use the visual to lead a discussion:

- **What are the largest layers of soil?** (*subsoil and bedrock*)
- **Which is the smallest layer?** (*topsoil*)
- **What are the differences between bedrock and subsoil?** (*Bedrock is rock, whereas subsoil is a soil created from the weathering of the underlying bedrock.*)
- **What are the differences between subsoil and topsoil?** (*Subsoil is comprised mostly of mineral matter such as sand, clay, and silt, and has minimal organic matter. Topsoil contains organic matter from decomposed plants and animals, as well as mineral matter. Topsoil is more fertile than subsoil, and plants, flowers, and trees can grow in it.*)
- **Look at the trees. How deep do their roots go? Where do the trees get their nutrients from?** (*The roots of plants mostly exist in the topsoil layer, perhaps extending slightly into the subsoil layer if they are deep. Trees get their nutrients from the topsoil layer.*)
- **How is new topsoil made?** (*Plants, trees, and animals die and eventually turn back into soil. The [Recycling in Nature](#) visual may be helpful here.*)
- **How long do you think it takes to make 1 cm of topsoil?** (*100 to 400 years. Because things such as wind and water can easily cause top soil to blow or wash away, it is important to conserve topsoil. Putting your vegetable and fruit scraps into a compost pile – rather than the landfill – is one thing you can do to create new soil and support the topsoil layer.*)

Part 2 Soil Testing Activities

Explore the texture, drainage, and particle density of different soils, and observe garden soil fauna.



OBJECTIVES

- Learn about soil composition and particles which make up soil.
- Explore how you can determine soil types by soil texture tests.
- Examine organisms that live in the soil and learn about their role in the ecosystem.
- Discover that soil particles sediment out into different layers, based on size / density, when mixed with water.

MATERIALS

See each of the four science activities for materials lists.

PREPARATION

1. Prior to the lesson, organize soil samples. For each group of 4 to 6 students, prepare a container (such as a clear salad mix container) with 1 labelled ziploc bag each of mineral soil (eg. from an excavation site), pure sand, pure silt, and pure clay. Also include 2 “mystery” soil samples (labelled “A” and “B”) filled with mixed soil.
2. Optional: Prior to the lesson, students can go on a soil hunt around the neighbourhood. Ask students to bring in soil samples from a wide range of areas, including subsoil from a building excavation site (if possible). Compare colours, textures, and smells.

SCIENCE ACTIVITY 1: SOIL TEXTURE TEST

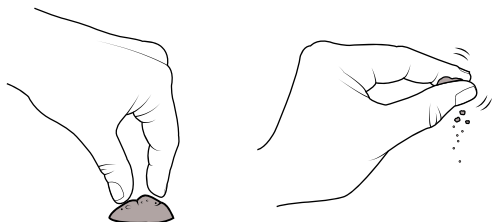
» determine relative proportions of clay, silt, sand from a given soil sample

MATERIALS

- Various soil samples, including mystery “A” and “B” soil samples, pure sand, silt and clay if possible (beach sand or sand box sand, ceramic clay, silt from stream or river)
- Water

General Characteristics

sticky	clay soil
gritty	sandy soil
smooth	silty soil
crumbly	loam soil – looks and feels like a crumbly chocolate cake (presence of clay, sand and silt particles)



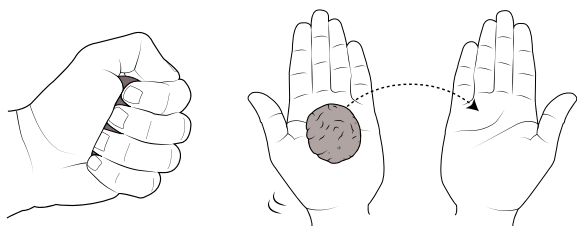
1. Grit Test

Students can do this test first with known sand sample so that students can get an idea of how pure sand feels, then they will be able to detect smaller percentages of sand in mystery soil samples. Place small amount of soil between thumb and forefinger and rub together. Does the soil sample feel gritty or grainy, like sand? If so, then your soil sample is a sandy soil. If your sample does not feel gritty, you have a soil made up of smaller particles such as silt or clay.



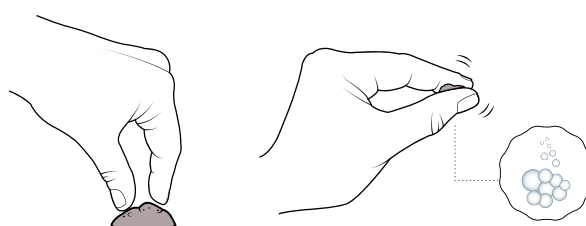
3. Ribbon Test

Do this test first with a known clay sample (ceramic clay) so that students can get an idea of how pure clay feels, and then they will be able to detect smaller percentages of clay in soil samples. Place a tbsp or so, of damp soil into the palm of your hand. Add a few drops of water and try to make a long ribbon or rope. The stronger your ribbon is, the higher the clay content. If you can make a long, strong ribbon you have a clay soil. If your ribbon falls apart or you cannot make a ribbon, then your soil sample has very little clay in it.



2. Ball Test

This can first be done with a pure clay sample for reference. Squeeze your soil in the palm of your hand. If it forms a ball then you have a soil sample that has silt and clay content, with little sand. If you can gently toss the ball from hand to hand and it stays together, your sample has a high clay content.



4. Soap Test

Place a small amount of soil between your thumb and forefinger. Rub together and if your soil sample feels slightly slimy, or soapy, then it has a lot of silt in it. If it does not feel soapy, then it has more clay and/or sand particles.

Part 2 Soil Testing Activities

Explore the texture, drainage, and particle density of different soils, and observe garden soil fauna.



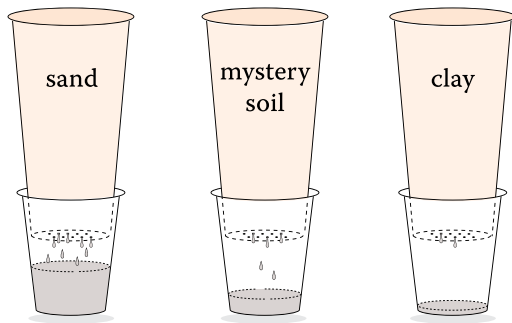
SCIENCE ACTIVITY 2: SOIL PERCOLATION TEST

» determine the drainage rate of different soil samples

MATERIALS

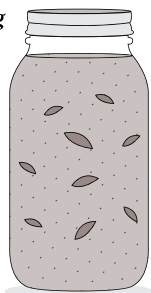
- Various soil samples
- Two sizes of paper coffee cups: 3 small and 3 large per group
- Tool to make holes in the bottom of large coffee cups, such as a large nail, or other sharp pointed object.

Note: With young students, large coffee cups can be perforated prior to the lesson. Small coffee cups are **not** perforated, as they will collect the drained water.

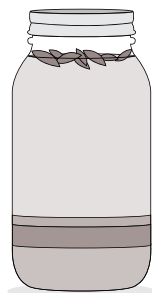


Students can work in groups and have 1-3 types of soil (eg. pure sand, pure clay, and a mystery sample to emphasize different drainage properties based on particle size). Each group should have 2 coffee cups per soil sample (one large coffee cup and one smaller cup). Label large coffee cups with the type of soil you are testing (sand, clay, garden soil etc.). Using a nail or other sharp tool, the bottom of the large coffee cup should be perforated with many small holes. To standardize the test, all large coffee cups should have the same number and size of holes in the bottom. Fill the large coffee cup with 1 cup of soil and place in the small coffee cup (with no holes). All students should begin pouring ~1 cup of water over their soil sample at the same time. Students need to record the time it takes for the water to drain through their soil sample. This test will determine the drainage properties of the soil sample. (Sand or large particles will drain much more quickly than fine clay particles).

Right after shaking



After 24 hours



leaves & twigs

clay (lightest density)
silt (medium density)
sand (heaviest density)

Closure Discussion

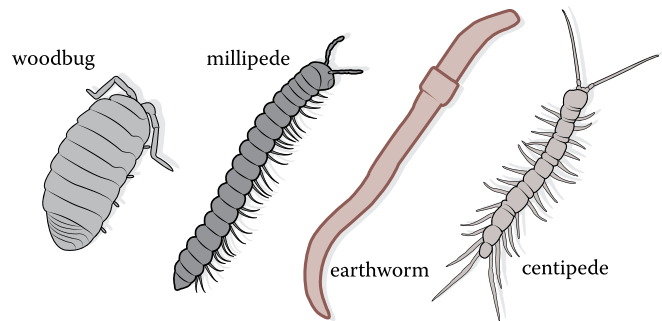
What is soil made of? What is sand? What is clay? What lives in the soil? What is the role of soil animals? (Aerate and mix soil, decompose organic matter, cycle nutrients).

SCIENCE ACTIVITY 3: LIVING COMPONENTS OF SOIL

» explore and identify the different critters that live in garden soil

MATERIALS

- Soil samples with fauna (woodbugs, worms, centipedes, millipedes) from garden or other naturalized area
- Tubs such as recycled plastic salad tubs from supermarket (1 per group)
- Petri dishes, one per group
- Bug jars with magnification or magnifying glasses
- Dissecting microscopes



Hand out a tub of garden soil or other natural soil with soil fauna to each group. Supply students with magnifying glasses, petri dishes and reference books to have a close look at their soil fauna and to identify found organisms. Allow students to explore their soil tubs to find soil invertebrates. Soils may have organisms such as earthworms, woodbugs, slugs, snails, centipedes and millipedes. Students may find worm cocoons and larval stages of some organisms. For older students, one could graph the number of each type of organism found to determine relative abundance.

SCIENCE ACTIVITY 4: SOIL SEDIMENTATION

» see which soil particles are lightest and which are heaviest

MATERIALS

- Large glass jars with lids (one per group – tall thin jars work best)
- 1 cup of soil containing leaf litter, topsoil (1 per group)

Note: Students can use the same soil as in Science Activity 3, provided that as many living organisms as possible have been removed.

◀ Each group of students will need a jar with a lid, and 1 cup of soil with organic matter (dead leaves, twigs etc.). Place the soil in the jar and fill up the jar with water. Get students to shake vigorously until it looks like chocolate milk. Get students to draw what they see. Leave jars in a quiet undisturbed place for 24 hours or longer. All the sediments should have settled into layers, based on particle size, with the largest particles on the bottom (sand), followed by silt and finally the top layer will be clay particles (the lightest). Organic matter such as dead leaves and twigs will be floating and the water should look clearer. This helps students to identify the relative proportions of the different sized soil particles (sand, silt and clay).

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&
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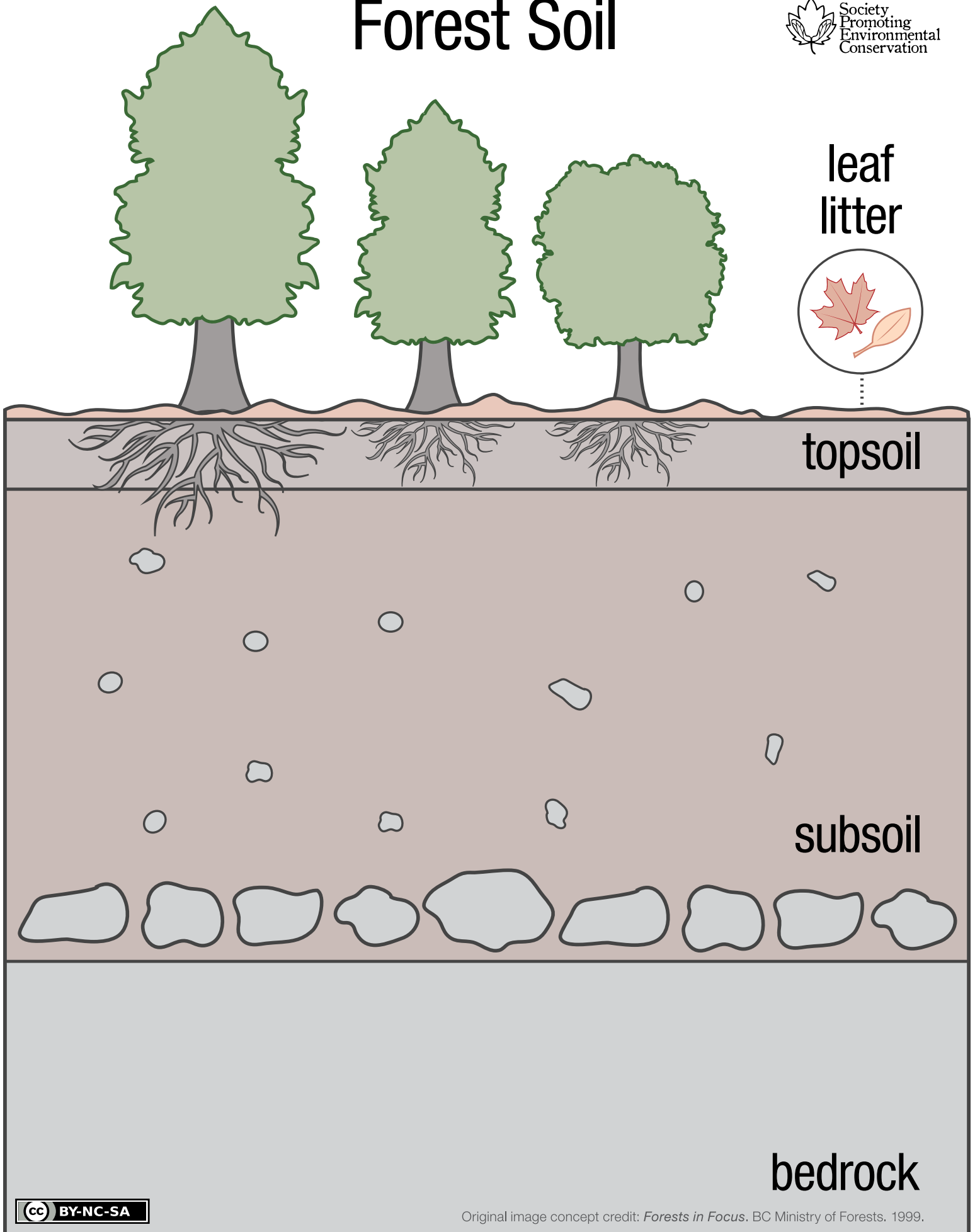
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credits

A portion of this lesson was adapted from the Scientist in Residence Program (www.scientistinresidence.ca). Lesson developed and written by Catriona Gordon. Design by Lisa Rilko

Forest Soil



leaf
litter

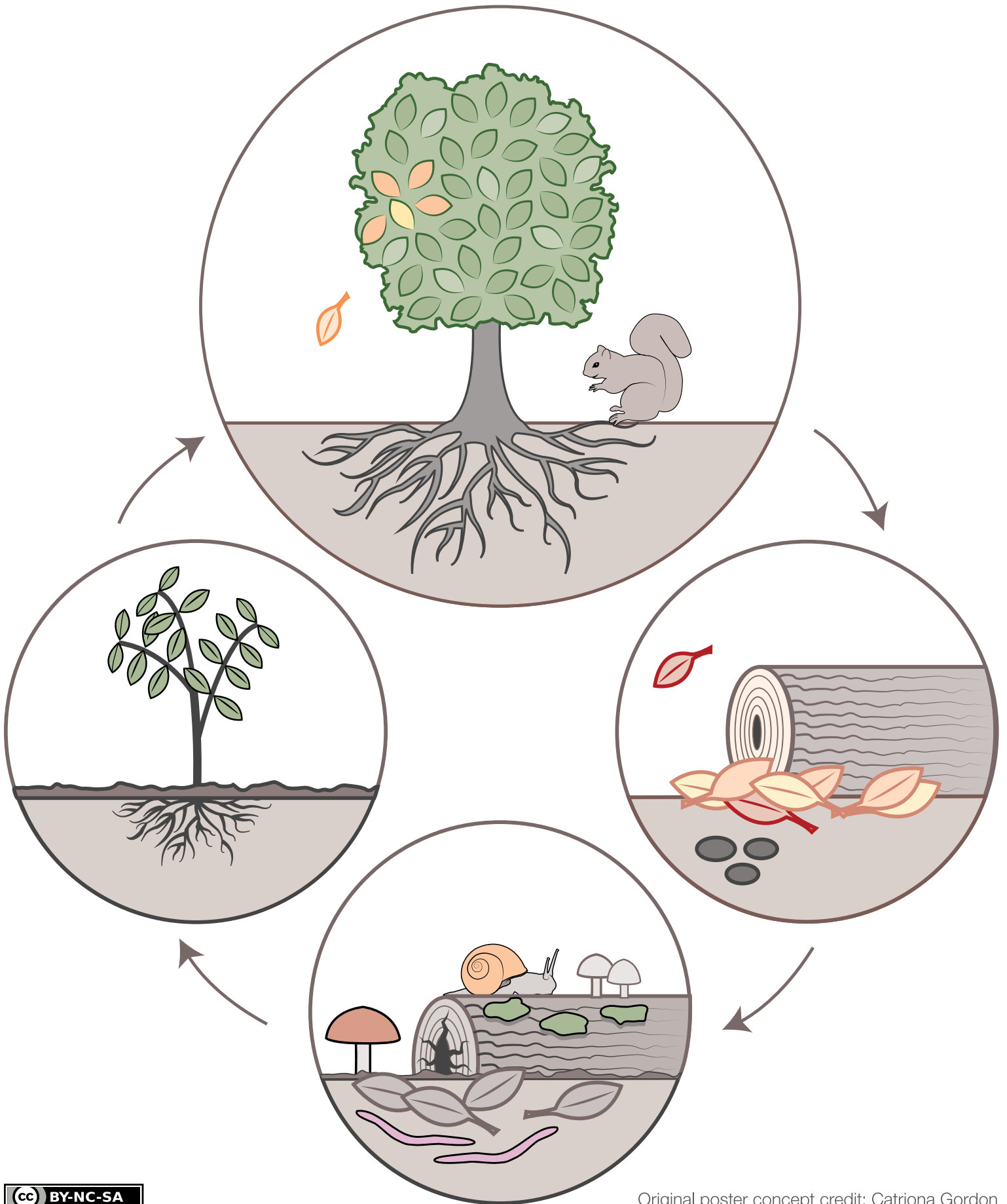


topsoil

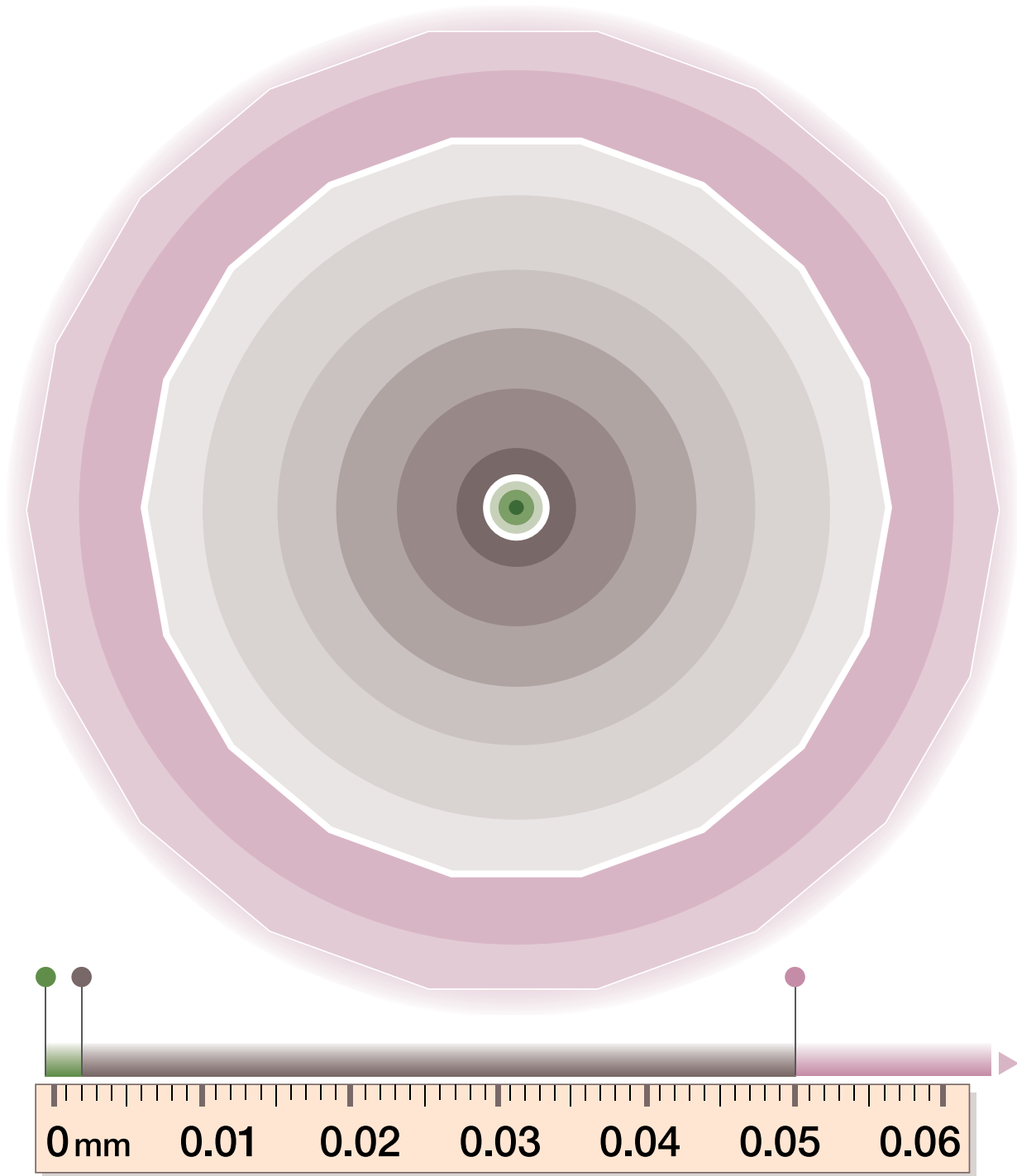
subsoil

bedrock

Recycling in Nature



Soil Particles



 **clay**

< 0.002 mm diameter

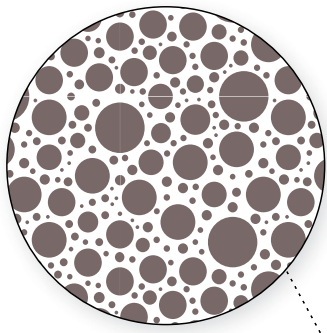
 **silt**

0.002 to 0.05 mm diameter

 **sand**

0.05 to 2 mm diameter

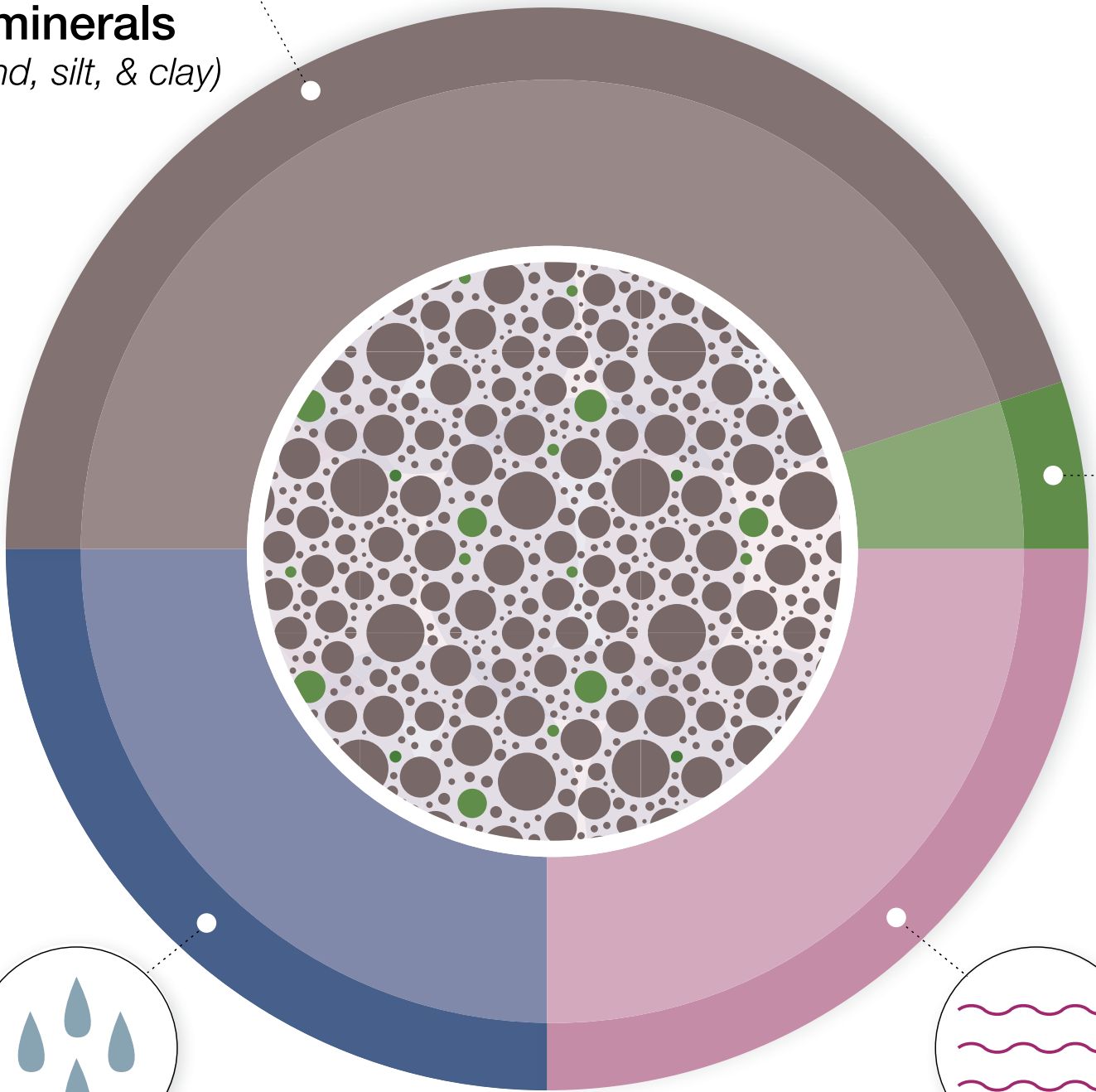
Typical Soil



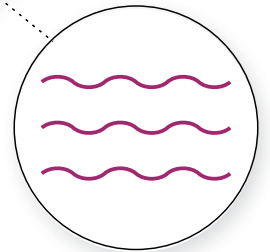
45%
minerals
(sand, silt, & clay)



5% organic



25% water



25% air

Forest Soil

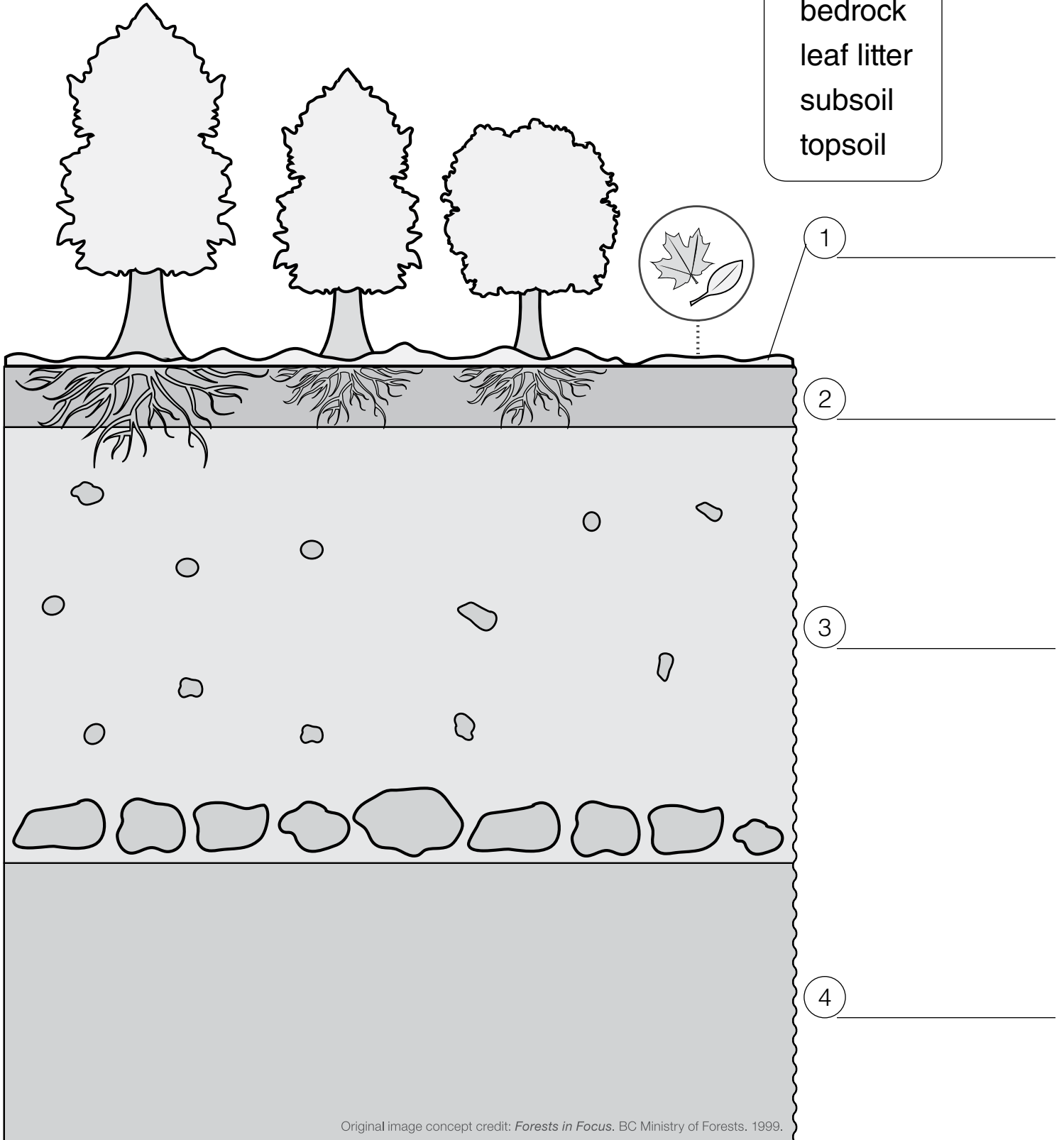
name: _____



Look at the picture. Label the different layers of soil.

Soil Layers:

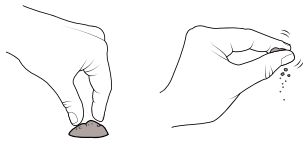
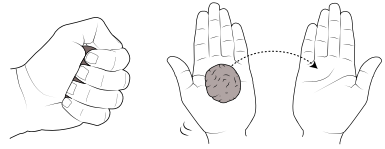

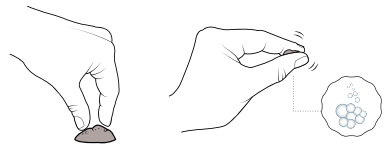
bedrock
leaf litter
subsoil
topsoil



Original image concept credit: *Forests in Focus*. BC Ministry of Forests, 1999.

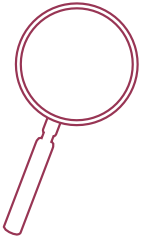
Soil Texture Tests

name: _____

Soil Test	Comments
<p>1. Graininess</p> 	
<p>2. Ball Test</p> 	
<p>3. Ribbon Test</p> 	
<p>4. Soap Test</p> 	
<p>Soil Type:</p>	

What Lives in Soil?

name: _____



Look at the insects and organisms in your soil. Draw a picture of each insect or organism in the boxes below.

What are they? How big are they?

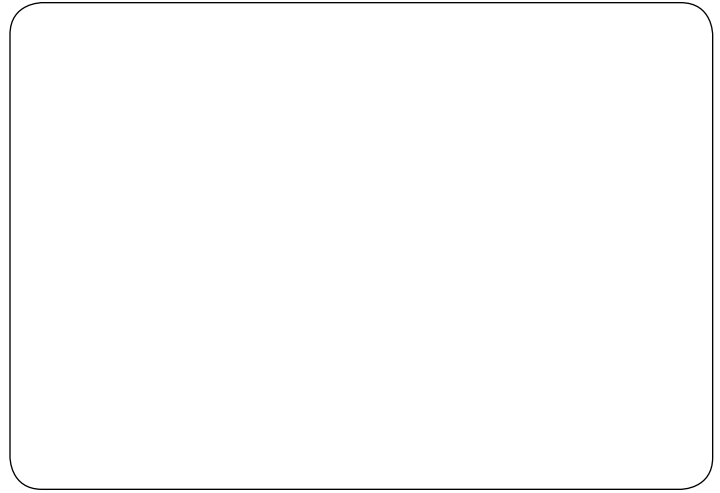
How many of each insect or organism can you find?



What is this? _____

How long and how wide is it? _____

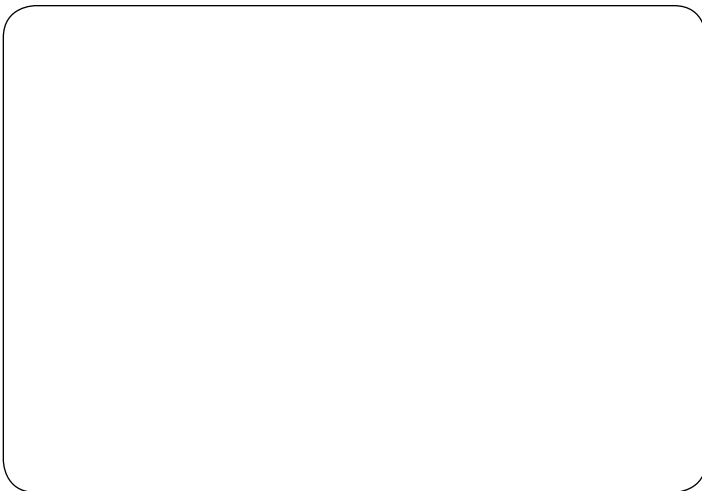
How many did you find? _____



What is this? _____

How long and how wide is it? _____

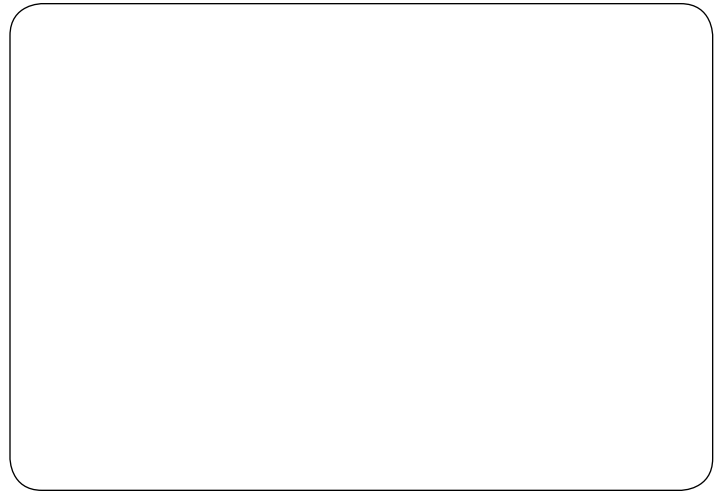
How many did you find? _____



What is this? _____

How long and how wide is it? _____

How many did you find? _____

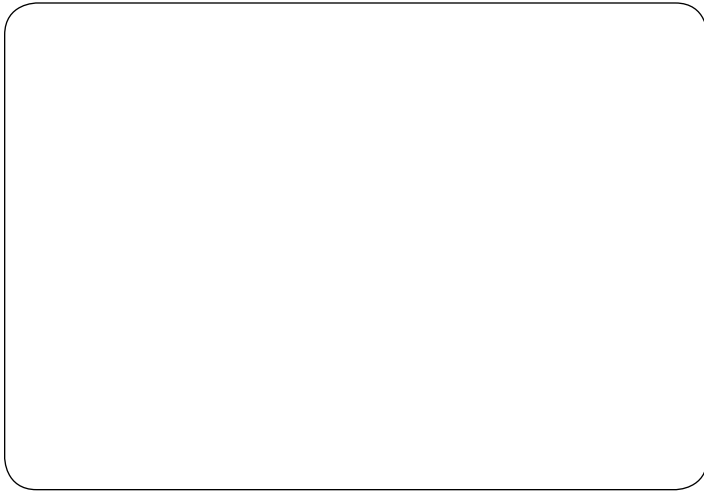


What is this? _____

How long and how wide is it? _____

How many did you find? _____

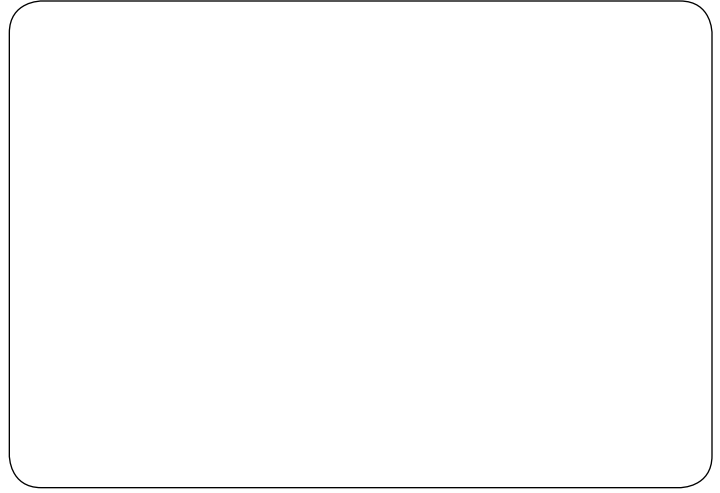
What Lives in Soil? *page 2*



What is this? _____

How long and how wide is it? _____

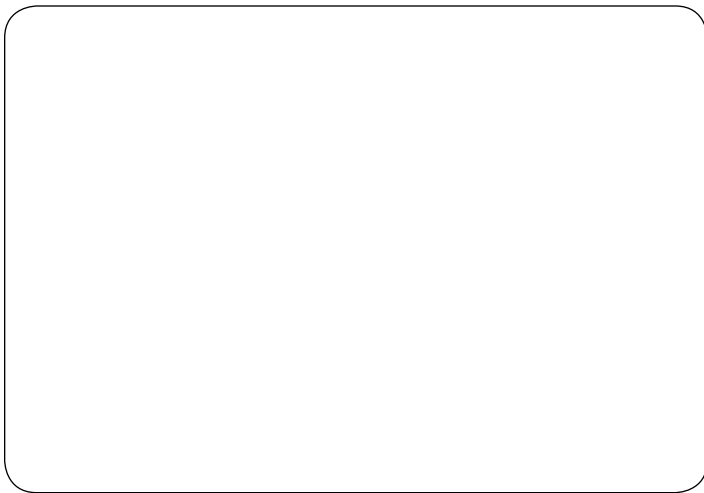
How many did you find? _____



What is this? _____

How long and how wide is it? _____

How many did you find? _____



What is this? _____

How long and how wide is it? _____

How many did you find? _____



What is this? _____

How long and how wide is it? _____

How many did you find? _____

Soil Sedimentation

name: _____

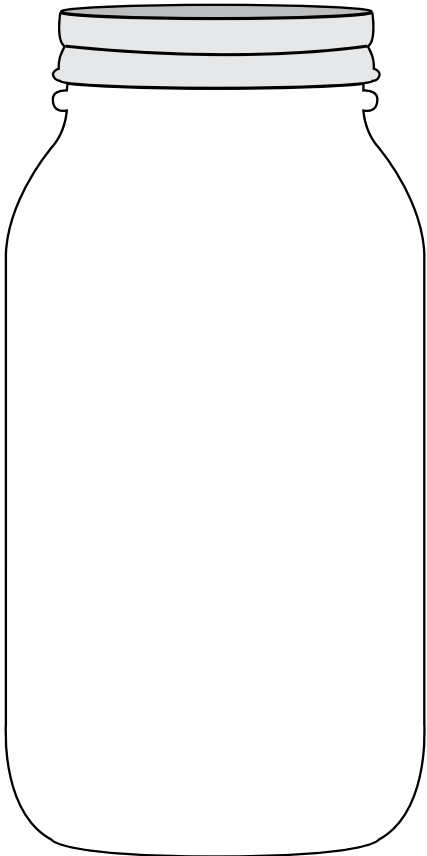


Place a cup of soil in a jar. Fill your jar with water. Put the lid on tightly and shake your jar.



Draw a picture of what you see in your jar now. Wait 24 hours and draw a second picture of your jar.

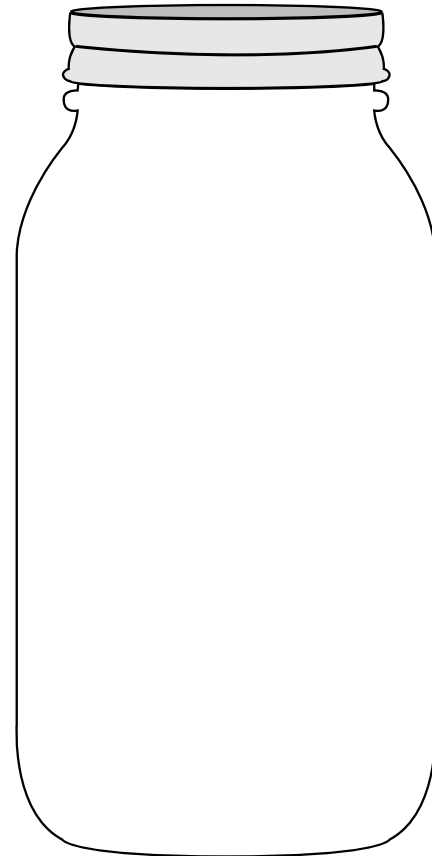
Soil at time of mixing:



Observations at mixing time:

Soil after 24 hours:

(label sand, silt, and clay)



Observations after 24 hours:

The Secret Lives of Red Wiggler Earthworms

Grade K to 4
Science, Math, Art
1 hour and 15 min.



information
for the
teacher

» adapted from the Scientist in Residence Program » www.scientistinresidence.ca



Photo Credit: "20060131 earthworm hits dirt" by S. Shepherd (schizoform on flickr) via Wikimedia Commons, used under Creative Commons license 2.0 (CC-BY-2.0).

When we think about a healthy compost, we always think of the humble Red Wiggler earthworms, *Eisenia fetida*. These little slimy invertebrates, the size of a piece of string, are hard at work converting kitchen and garden waste into dark rich soil. How do they do it? Earthworms are sightless, earless, and toothless, and spend their lives tunneling through compost, manure or soil, seeking out dead plant and animal matter, digesting it and converting it to rich, fertile finished compost or humus. This finished compost is an ideal soil amendment to gardens and helps recycle nutrients.

vocab

ANATOMY OF AN EARTHWORM

Red Wiggler *Eisenia fetida*, a common earthworm found in compost, manure, or decaying leaves which helps to digest decaying organic matter and turns it into finished compost

Clitellum An enlarged belt around the middle of the earthworm which is part of the reproductive system

Hermaphrodite An animal, such as an earthworm or snail, that carries both male and female reproductive organs

Setae Stiff hairs which appear on each segment of an earthworm and are used to provide traction to help it move

Prostomium A firm lip or mouthpart which aids in burrowing, eating and sensing the earthworm's surroundings

How do earthworms breathe? Earthworms belong to the phylum of segmented worms (Phylum Annelida). They have five hearts or pumping chambers to circulate blood, and as they breathe through their skin, they need to be kept moist so that oxygen can pass through their skin by diffusion.

How do earthworms eat? The earthworm takes in food through its mouth or prostomium. Earthworms eat decaying organic matter such as all the things that get thrown in the compost pile, dead leaves, and manure. The earthworm has a crop and a gizzard, much like a bird. In the gizzard, food is ground up into smaller pieces with sand and mineral particles that are ingested along with the food. Often one can see the food move through the digestive tract through the skin of the worm. This is particularly evident on young worms, which are lightly coloured.

How do earthworms reproduce? Earthworms are hermaphrodites, containing both male and female reproductive organs in each worm. During mating, 2 worms line themselves up, each facing opposite ways. They both produce a slime tube and exchange sperm, storing it in a sac. Then each worm returns to its burrow, and later the clitellum on each worm makes a ring and slides this mucous ring over its head, combining the sperm and eggs. The ring turns into a lemon-shaped cocoon, which can contain between 4-20 developing eggs. In 2-3 weeks, the cocoon darkens until the baby worms are hatched. These babies are almost transparent and will grow into an adult in a few months. Cocoons can be produced from an adult worm every 7-10 days. Scientists estimate that 40-900 eggs can be produced from one earthworm in a year, depending on the species.

SOILS AND SYSTEMS

Compost Decayed or decaying plant and animal matter.

Humus The organic component of soil made up of decayed plant and animal matter

Decomposition The breakdown or decay of plant and animal matter, turning it back to soil

Dead Organic Matter Plant and animal material and waste

Sand Fine debris of rock.

Mineral Soil Soil often found beneath the topsoil layer, consisting mainly of minerals and rock particles, and very little organic matter

Topsoil The fertile, most upper layer of soil, which can be between 5 and 25 cm in depth. This layer contains the most nutrient-rich organic matter and the most soil organisms.

Wormery A partially transparent container to keep worms in for observation and education.

Part 1 Worm Observation

Learn about red wiggler earthworms, their habitat, behaviours and their role in the compost pile



MATERIALS

- earthworms from the garden or compost (1 per student)
- paper towels
- spritzer bottle to keep worms moist
- magnifying glasses and/or stereo microscope
- rulers
- pencils and paper
- chart of earthworm with labeled parts
- earthworm worksheet

PREPARATION

Before the lesson, you'll need to gather earthworms from outdoors (one for each student). Earthworms hibernate, often in very deep burrows during very cold winter months, so **it is best to do this lesson in spring or fall**. Red Wigglers are found in compost, in piles of rotting wet leaves, or in manure piles (if you live near a farm or stable). Garden earthworms can be found in gardens, particularly in moist conditions.

You may wish to pre-teach the parts of the earthworm to the students using the chart before beginning the lesson below.

WARNINGS

❗ **WORMS MUST BE KEPT MOIST IN ORDER TO BREATHE. PLEASE MOISTEN HANDS AND PAPER TOWELS PRIOR TO EXAMINING YOUR WORM!**

❗ **PLEASE TAKE WORMS BACK TO THEIR NATURAL HABITAT AFTER OBSERVING THEM. THEY WILL NOT THRIVE IN A CLASSROOM SETTING.**

❗ **SAFETY GUIDELINE: ALL STUDENTS SHOULD WASH THEIR HANDS AFTER HANDLING THE WORMS, AND BEFORE THEY EAT.**

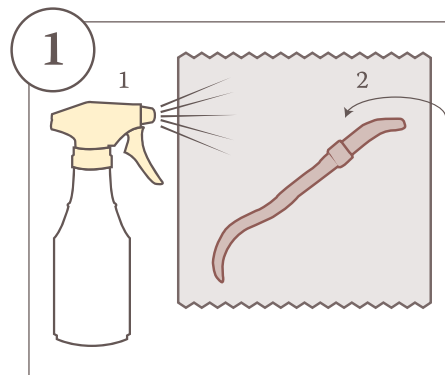
LESSON

Introductory Discussion

Brainstorm about why worms are important and how they help us.

- » What is their job in the compost?
- » What do they eat?
- » How do they move?

If we have a wormery we can observe the worms and see what they do over time.

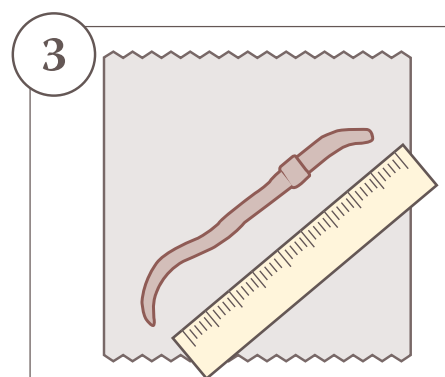


1. **Moisten paper towels and distribute worms.** Hand out paper towels to each student. Get students to dampen the paper towel with a spray bottle filled with clean water.

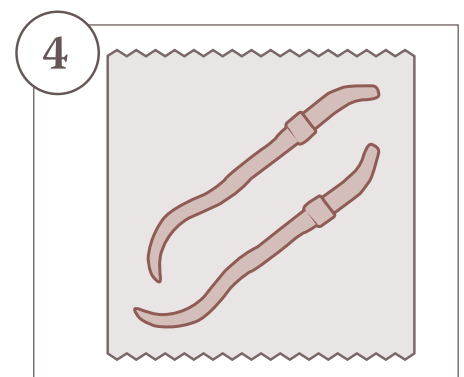
Once the paper towel is dampened, hand out an earthworm to every student. Let students explore their earthworm, gently touching/holding it, with dampened hands.



2. **Examine worms.** Using a magnifying glass get students to look for setae (bristles), clitellum (enlarged reproductive area which may contain eggs), segments, head, mouth and tail.



3. **Measure and draw worms.** With rulers (or a piece of string for a more accurate measurement), allow students to measure the length and width of their worm. Instruct students to draw their worm and label all its parts. Briefly place your worm on a dry piece of paper and put your ear close. Can you hear the scratching sound of the worm's setae?



4. **Observe two worms.** Return your earthworm to the moistened paper towel. Place two earthworms together. How do they react?

After observing your earthworm, return it to the wormery (as described in Part 2) or back to the garden or compost.

Part 2 Worms in the Wormery

Set up a wormery to watch earthworms tunnel and mix layers of soil.



MATERIALS

- garden earthworms from the garden (NOT COMPOST)
 - plexiglass wormery or clear 2 litre pop bottle
 - spritzer bottle to keep wormery moist
 - black paper to keep wormery dark
 - masking tape
- **Materials for wormery interior:**
- small pebbles or gravel (helps to keep air in bottom of wormery)
 - sand from a sand box or playground
 - » DO NOT use beach sand as the salt will harm the worms
 - mineral soil (can be found in any excavated area)
 - » sand can be used if mineral soil is not available
 - topsoil (can be found in any garden or schoolyard)
 - dead leaves
 - fresh leaves and/or other worm food

PREPARATION

Before the lesson, you will need to either:

- assemble a wormery from plexiglass sheets and wooden batens, or
 - create a wormery from a clear 2 litre pop bottle
- You will find assembly instructions on the next page.

WARNINGS

! GARDEN EARTHWORMS ARE BETTER SUITED TO A WORMERY THAN RED WIGGLERS

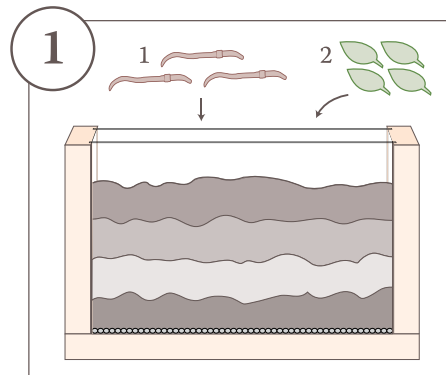
! WORMS DO NOT THRIVE IN A CLASSROOM ENVIRONMENT AND SHOULD ONLY BE KEPT FOR A MAXIMUM OF 3 WEEKS IN A WORMERY BEFORE THEY ARE PUT BACK OUTSIDE IN THE SOIL.

LESSON

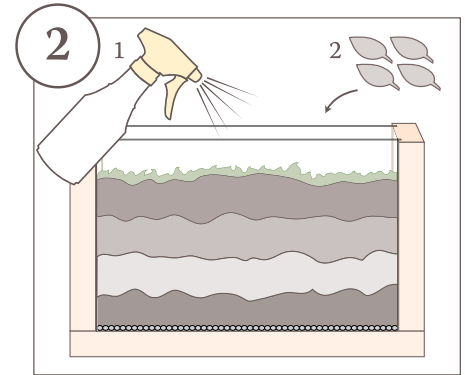
Wormery Setup

This can be done as a demonstration. First, place pebbles in the bottom of the wormery. Next, place topsoil, followed by sand, mineral soil and then topsoil again, in clear layers. Repeat if there is space, ending with topsoil.

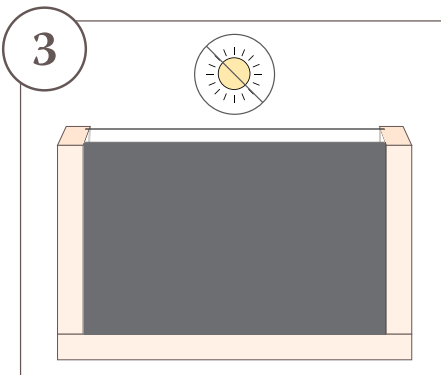
See the illustration on the next page for visual detail.



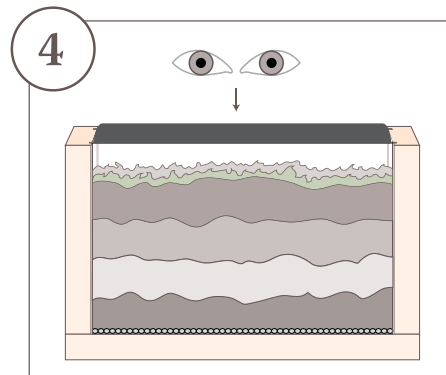
1. Place earthworms in the top layer of the topsoil and cover with fresh leaves.



2. Spray the top layer with water from a spray bottle and cover with dry leaves.



3. Cover the sides of the wormery with black construction paper and place in a cool area of the classroom, out of direct sunlight.



4. Allow students to lift the black paper to observe the wormery every few days. Spray daily with water. After a week or so, tunnels and mixing of the soil layers should be visible.

Closure Discussion

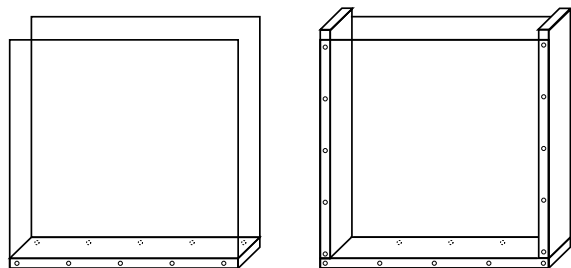
- » Can you see evidence that the earthworms were working in the wormery? What looks different?
- » Can you see any tunnels?
- » Do the soil layers look any different?
- » How do earthworms help us?
- » How do they help plants?
- » Why are earthworms good recyclers?

INSTRUCTIONS ON MAKING A WORMERY

Version 1: Plexiglass wormery

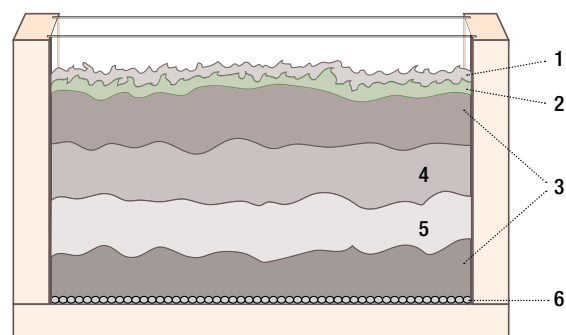
(for more info, see Harlow and Morgan reference below)

Materials required: 2 sheets of plexiglass (10 inches x 10 inches), 3 wooden battens (10 inches x 2 inches x 0.5 inch) and 30 screws.



Using one piece of wood as a base, screw the plexiglass to the exterior of the wood.

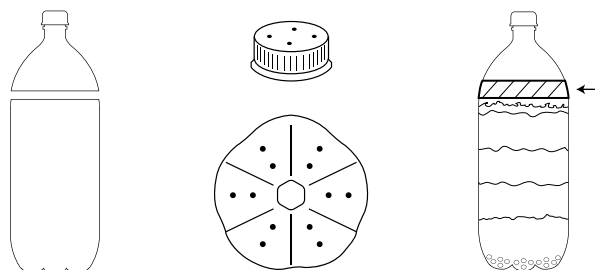
Place each remaining batten inside the plexiglass as a side wall, and screw in place.



Version 2: Pop bottle wormery

(for more info, see Dixon reference below)

Materials required: clear pop bottle, utility knife, hammer, a small nail, tape



Cut off the top of the bottle with the utility knife.

Make small holes in the bottle cap and bottle bottom with the hammer and nail.

Once all of the materials and worms are in the bottle, join the top and the base with tape.

◀ WORMERY INTERIOR

The drawing to the left shows the interior layers of the wormery. The materials can be layered in the same way if using a pop bottle.

- | | |
|-----------------|-----------------|
| 1. dry leaves | 4. mineral soil |
| 2. fresh leaves | 5. sand |
| 3. topsoil | 6. pebbles |

REFERENCES AND RESOURCES

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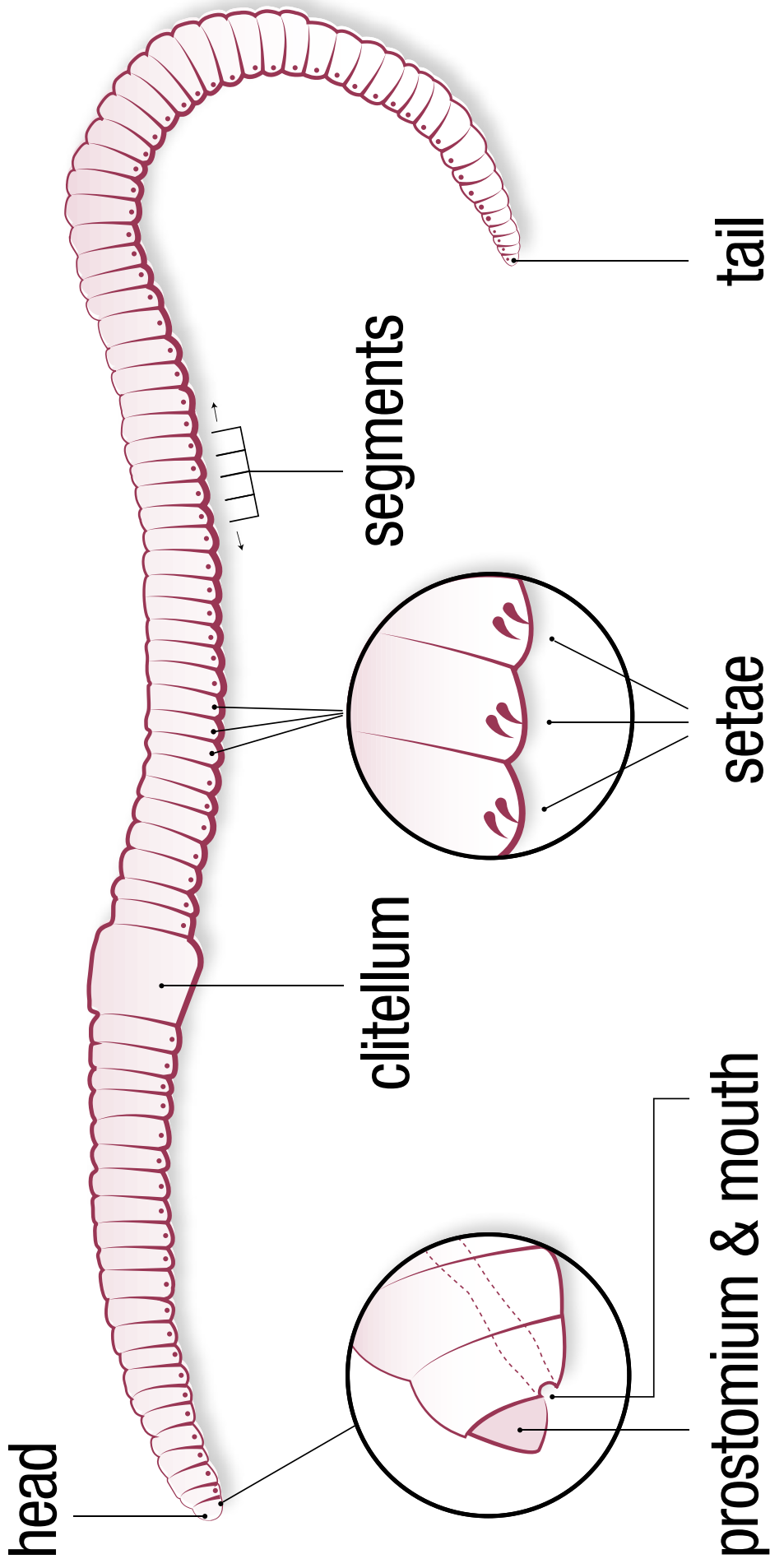
EXTENSIONS

See a video such as "Recycling with Worms" Primary/Intermediate Video #487643 12 minutes. Or "Observation and Care of a Wormery" Primary/Intermediate #480566. 16 minutes. Both available at VSB Media Services.

CREDITS

This lesson is adapted from the Scientist in Residence program (www.scientistinresidence.ca). Lesson developed and written by Catriona Gordon. Design by Lisa Rilkoff

The Earthworm



My Earthworm

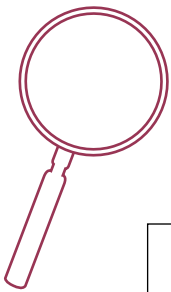
name: _____



My earthworm is

_____ long and

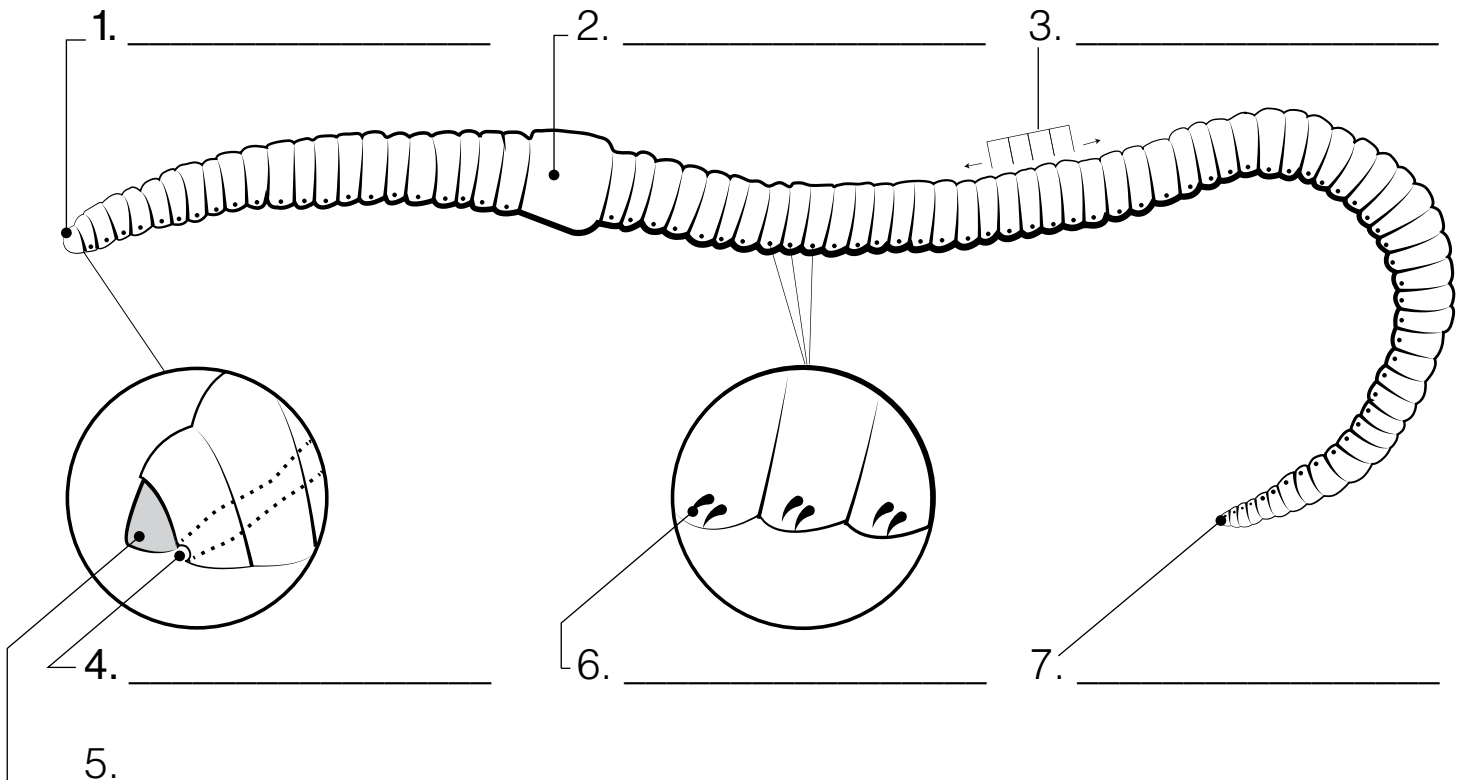
_____ wide.



Look at the earthworm picture.

Write the name of each earthworm part.

head	segments	clitellum	prostomium
tail	setae	mouth	





Draw and label your earthworm. Use these words:

head

segments

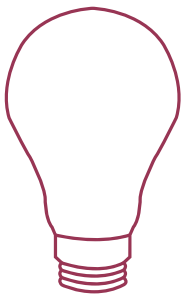
clitellum

prostomium

tail

setae

mouth



My earthworm lives _____.

It eats _____.

Its predators are _____.

Making a Classroom Composter

Grade K to 4
Science
30 to 45 min.



information
for the
teacher



Photo credits (clockwise from top): "Shredded Papers in the Crate" by Tristan Ferne (via Flickr), "Compost" by Lindsay Dee Bunny (via Flickr), "166/365: Compost" by Magic Madzik (via Flickr). all used under Creative Commons License 2.0 (CC-BY-2.0).

Compost is the product of decomposed plant and animal matter. Dead plants and animals are broken down by earthworms, fungi, bacteria, and other soil microorganisms. Compost is often nutrient-rich and is therefore a useful soil amendment for gardens.

vocab

Compost Decomposed plant and animal matter, which is often used by gardeners and farmers to enrich the soil.

Microorganisms Living things that cannot be seen by the naked eye, but can be seen using a microscope. These include bacteria, fungi, nematodes and protozoa.

Fungi Plant-like organisms, with no chlorophyll, which usually use dead plant and animals matter as food. (eg. Mushrooms, molds, yeasts, mildews)

Bacteria One-celled organisms, found almost everywhere on Earth and can only be seen through a microscope

Earthworm A commonly found worm in soils which helps mix and aerate soils by creating tunnels and digesting dead plant material and turning it into humus.

Humus Dark brown rich material composed of organic matter (decomposing dead plants and animals), which increases the fertility of the soil.

Decomposition The process of breaking up into parts eg. Leaves and dead plant and animals change into soil.

What are some examples of compost in nature? The art of composting has been dated back to the ancient Romans, where piles of dead plants and animals were left in a heap for a year, and then spread on fields, as a natural fertilizer. "Natural" composting occurs in any natural environment such as fallen leaves in a forest, and it is nature's method of cycling nutrients. Leaves and other plant material are turned into **humus**, an important component of soil, which then provides nutrients to plants.

How do earthworms, fungi, microorganisms, and worms interact with the compost pile? Most decomposers need water and oxygen to live. It is therefore useful to keep the compost pile moist and turn or aerate it regularly to introduce more oxygen, which speeds up the process of decomposition. In one handful of rich soil there may be up to 5 billion bacteria. Without decomposers to recycle energy and nutrients, we would be buried in dead plant and animal matter, and life would cease on earth.

How do you make a compost pile? To have a successful compost, one can start with a 1:1 ratio of carbon (brown) to nitrogen (green) inputs. Carbon-rich inputs are often brown and dry such as dead leaves, straw, sawdust, shredded newspaper, brown grass clippings. Nitrogen-rich inputs include kitchen or lunch scraps, green leaves, and green grass clippings. If the compost has too much carbon, then decomposition slows down, conversely, if there is too much nitrogen, then you can end up with a smelly pile. A finished compost will have a Carbon:Nitrogen ratio of between 25:1 and 45:1

Part 1 Intro to Composting

Learn about the different types of materials that can be used for compost, and those that should be avoided.



MATERIALS

- Several sets of the picture cards included with this lesson (you'll be splitting the students into groups of 3 or 4, and each group will need one set of cards). You'll need to photocopy and cut these cards prior to the lesson.
 - » **Tip:** Photocopying each set of cards on a different colour of paper will make sorting easier once the cards are cut.

OBJECTIVES

- Introduce and discuss the concept of composting
- Learn about the types of materials that can go into a composter and the types of materials that should stay out.

LESSON

Introductory Discussion

- » What happens to most of our garbage? Does nature produce garbage?
- » Who recycles here? What do you recycle?
- » Does anyone have a composter at home? What does a composter do? What animals live in a composter?
- » What happens in the forest when a tree dies? What happens to forest animals when they die?

Card Sorting Activity - Good and Bad Compost

- Ask the class: What are some good things to put in the compost? What are some things that shouldn't go in the compost? Elicit a couple answers for each question (see the list to the right for examples).
- Divide students into groups of 3 or 4. Explain to the class that each group will get a set of cards. With their group, they should discuss and decide if the item on each card is "good for the compost" or "bad for the compost". Ask the groups to make two piles of cards: a "good" pile and a "bad" pile.
- Hand out the cards and monitor the groups as they do the activity. Once the groups are finished sorting the cards, you can go over the answers with the class (see the list to the right). Ask students why meat, cheese, sugars, breads, and oils are bad for the compost.

Extension - Green and Brown Materials

- Explain to students that a good compost needs two types of materials: green and brown. Green (nitrogen-rich) materials are usually fresh, and brown (carbon-rich) materials are usually dry. The two types of materials work together to create a healthy compost. Too much green results in a wet, smelly compost, and too much brown results in a compost that doesn't break down easily.
- Elicit one example of green waste and one example of brown waste from the students. Get the groups to look at their "good compost" card pile and discuss/guess which items are green materials and which are brown materials. Go over the answers as a class.

GOOD WORM FOOD

NITROGEN-RICH GREEN WASTE*

	fruit peels (i.e. banana, apple)
	teabags
	coffee grounds
	eggshells
	vegetable scraps

CARBON-RICH BROWN WASTE

	shredded newspaper
	shredded cardboard/paper towels/paper bags
	dead leaves
	straw
	soil
	fine wood chips or sawdust (not cedar, treated wood or plywood sawdust, as these contain toxins)

*If food scraps are broken up or cut up, they will decompose faster.

BAD WORM FOOD*

	meat	×
	cheese	×
	sugars	×
	breads	×
	oils and fats	×

*Do **NOT** include in your worm bin. These items will not break down easily and will cause bad smells in a small indoor composter.

MATERIALS

- plastic tub or tote with lid, with drilled holes (1/4 inch) in sides and bottom and top for aeration and drainage
- extra lid for tub to be placed underneath, to catch compost “tea”
- sand
- topsoil or handful of finished compost to inoculate new bin with fungi, bacteria and other microorganisms
- dead leaves
- red wiggler worms from a compost
- compost (food scraps, brown leaves)
- newspaper for shredding
- spritzer or spray bottle to moisten bin
- magnifying glasses and/or stereo microscope
- tool such as a garden hand fork for aeration

OBJECTIVES

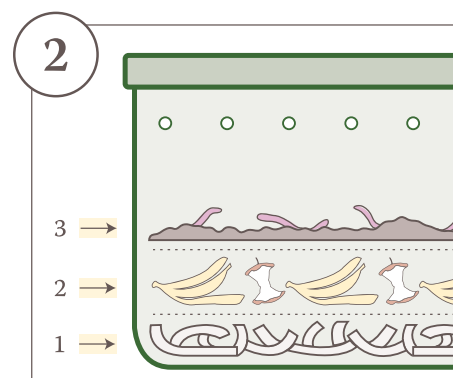
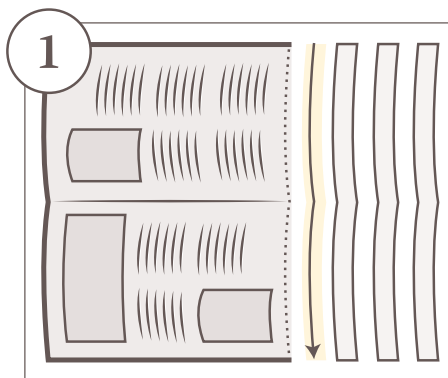
- Learn how to set up a successful classroom composter
- Examine differences between carbon-rich and nitrogen-rich inputs to compost
- Learn about the process of decomposition
- Discuss responsibilities toward the environment
- Take action to lessen one’s environmental footprint

WARNINGS

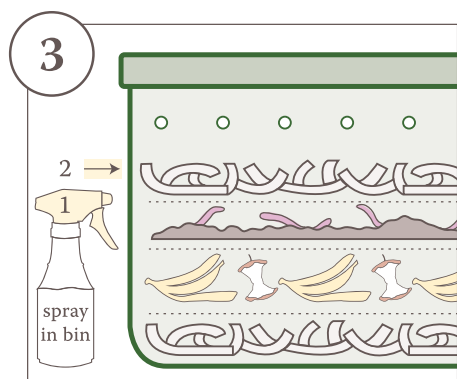
- ! TO AVOID FRUIT FLIES AND SMELLS IN YOUR INDOOR COMPOSTER, MAKE SURE THAT THERE IS ALWAYS A LAYER OF SHREDDED NEWSPAPER ON TOP OF THE COMPOST PILE AND THAT FOOD SCRAPS ARE BURIED.
- ! ONLY ADD MORE COMPOST IF PREVIOUS COMPOST HAS BROKEN DOWN. DO NOT “OVERFEED” YOUR INDOOR COMPOSTER.

LESSON

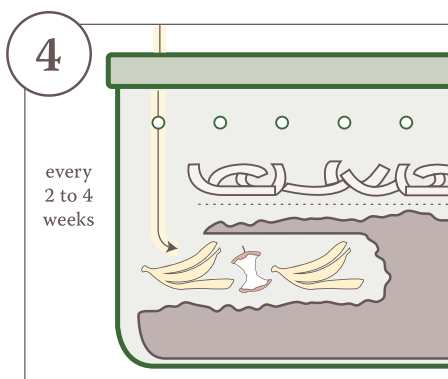
1. Shred newspaper. This activity is often best done on the floor with students sitting in a circle. Each student gets several sheets of newspaper to shred. Shredding is best done if the newspaper is lengthwise. (One way the newspaper shreds easily into strips, the other way it does not. Check beforehand so that you can advise students the easiest way to rip). This process increases surface area, and allows faster decomposition. Strips should be about **2-3 cm wide**.



2. Layer newspaper strips, food scraps, and soil. Strips can be placed at the bottom of the bin until covered. Then add kitchen/lunch scraps. Cover these scraps with some soil and red wiggler worms. Ask students why it is helpful to add some soil (inoculation of fungi and bacteria, as well as grit for worms to use to grind their food).



3. Finish preparing the bin. Moisten bin contents with a spritzer bottle, until damp but not wet. It should have the consistency of a damp sponge. Add more newspaper strips on top and dampen lightly with the spritzer bottle. To avoid fruit flies and smells, make sure that there is always a layer of shredded newspaper on top and that food scraps are buried.



4. Feed your compost bin. Check your classroom composter once every 2-4 weeks and only add more compost if previous compost has broken down. Do not “overfeed” your bin. **When going on summer holidays, place all the contents of your worm bin in an outdoor composter so that worms and other decomposers stay alive.**

Closure Discussion

- » How fast do you think our food scraps will turn into compost?
- » How could we test how long it takes?
- » What things might decompose very quickly?
- » What might take longer to decompose?
- » What items would not decompose?

notes

CHECKLIST: A GOOD COMPOST...

- Has a mixture of nitrogen-rich (green) and carbon-rich (brown) materials.
- Always has a layer of carbon-rich material (i.e. newspaper, dead leaves) at the top of the pile.
- Is not too wet or too dry, and has holes in the bottom of the container to allow excess water to drain out.
- Has access to oxygen. There should be some holes drilled in and near the top of the container to allow air in, and the compost should be turned weekly with a garden fork or other hand tool to assist with air flow.
- Does NOT contain too much kitchen waste at any one time. Start with a small amount of food scraps, and wait for them to break down before adding more.
- Does NOT contain any of the “bad” worm food listed on page 2 of this lesson (meats, cheese, sugars, breads, or oils).

Need help with your compost? The **Compost Hotline** (operated by City Farmer in Vancouver) can answer your questions and assist with troubleshooting. Call 604.736.2250 or email composthotline@telus.net.

references & resources

BOOKS

- Glaser, Linda. *Garbage Helps Our Garden Grow: A Compost Story*. 2010. Millbrook Press, Minneapolis
- Ridley, Sarah. *Minibeasts in the Compost Heap*. 2010. Smart Apple Media, Manako.
- Schuh, Mari, C. *Compost Basics*. 2012 Pebble Plus Science Builders Series. Capstone Press
- Silverman, Buffy. *Composting*. 2008. Heinemann Library. Chicago.

ONLINE

- **City Farmer** (Vancouver's Compost Demonstration Center) provides a wealth of knowledge online and in person on worm and backyard composting. See, for example. <http://www.cityfarmer.org/wormcomp61.html>
- Want to learn more about worms? Here is a good resource: <http://www.wormdigest.org/content/view/200/2/>
- **Metro Vancouver's Guide to Worm Composting** (downloadable brochure):
<http://www.metrovancouver.org/about/publications/Publications/wormcompostbrochure.pdf>

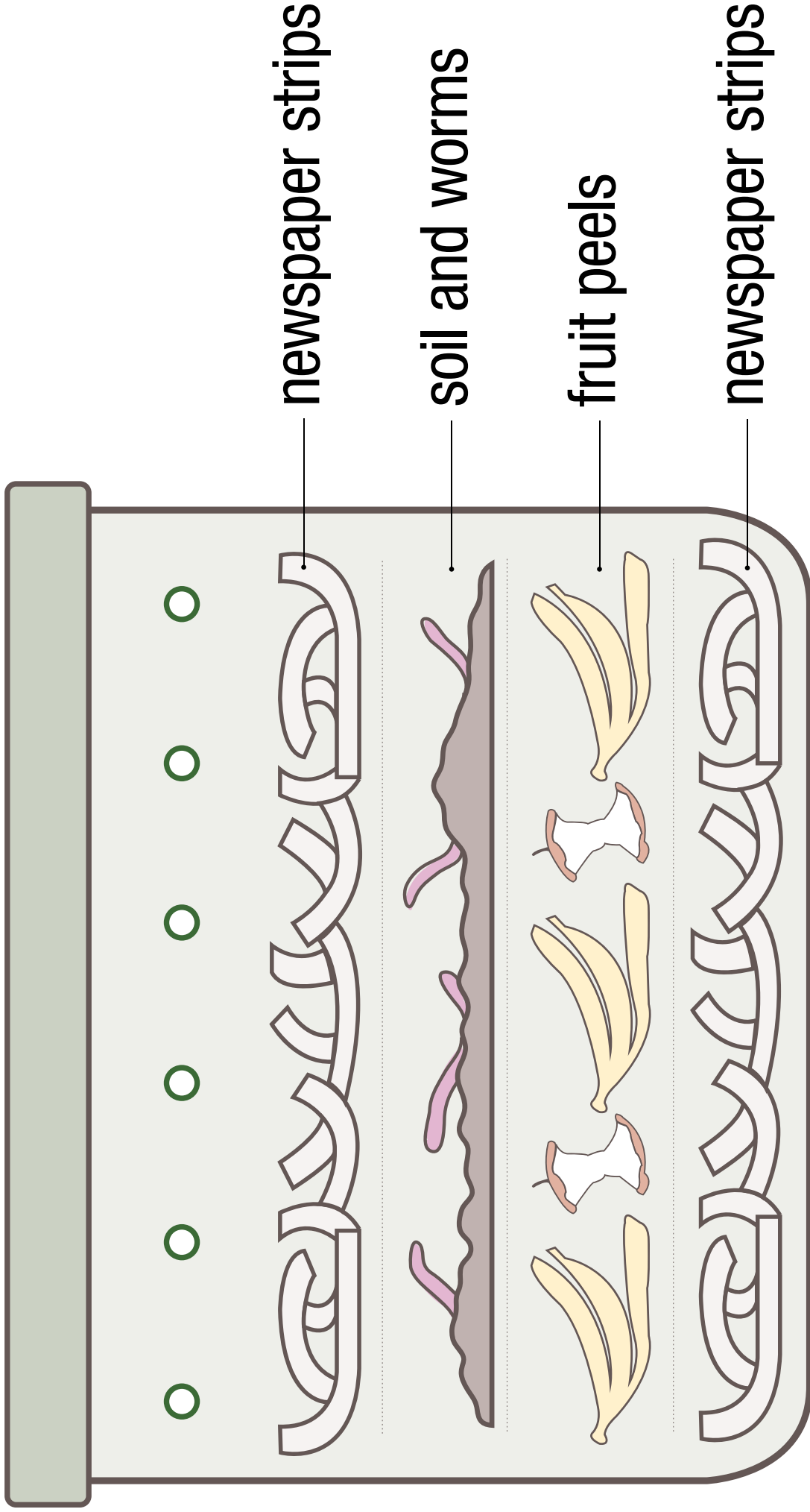
extensions

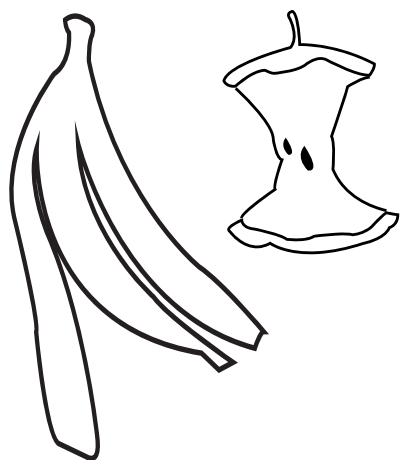
- Talk about reducing waste in the classroom, in students' lunches, and at home. Strive for a litterless lunch.
- Visit a local garbage dump or recycling plant.
 - » **Metro Vancouver Landfill School Tours:**
<http://www.metrovancouver.org/region/teachers/fieldtrips/Pages/FacilityTours.aspx>
call 604.940.3212 to book a free tour
- Look at decomposition up close by placing bread slices in Ziploc bags and placing them in the dark for 1-2 weeks. Observe fungi and bacteria in action.

credits

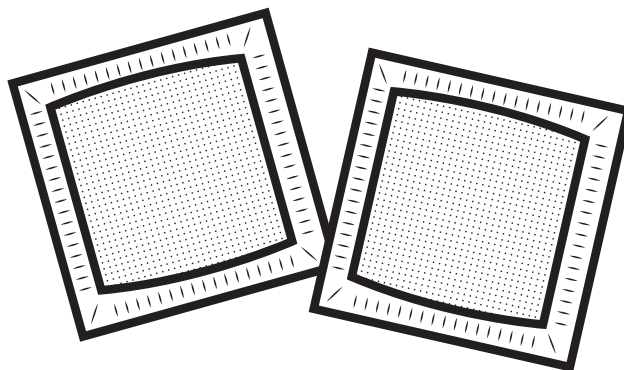
Lesson developed and written by Catriona Gordon. Design by Lisa Rilkoﬀ.

The Compost Bin

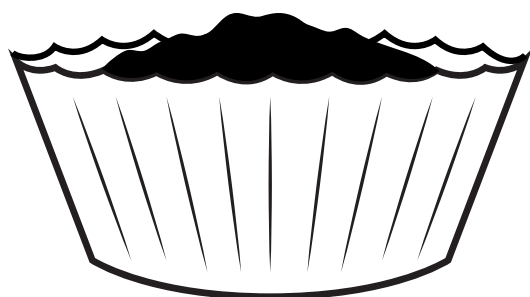




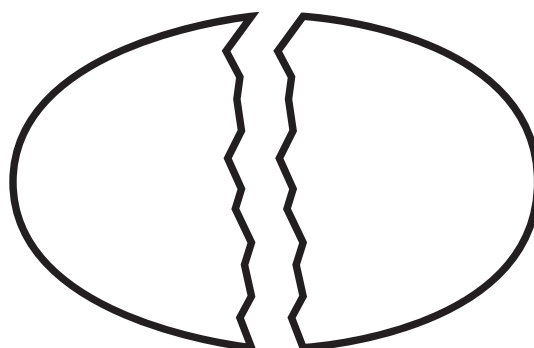
fruit peels



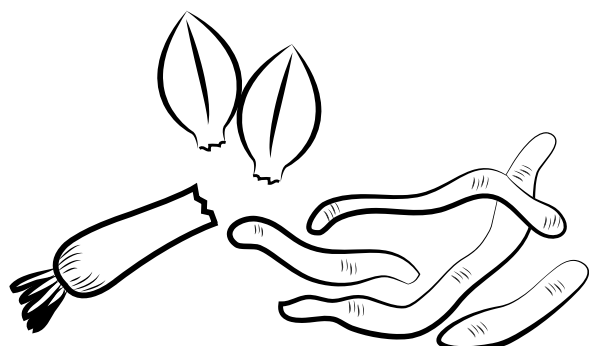
tea bags



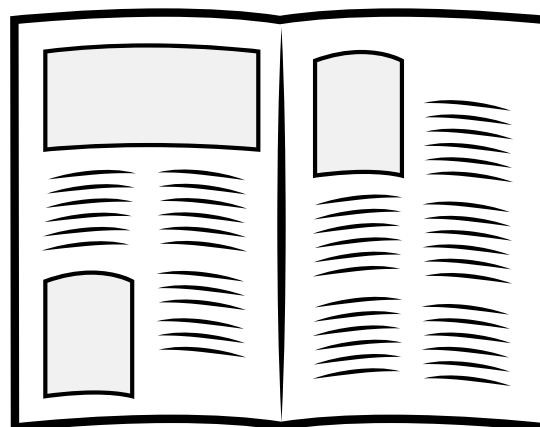
coffee grounds



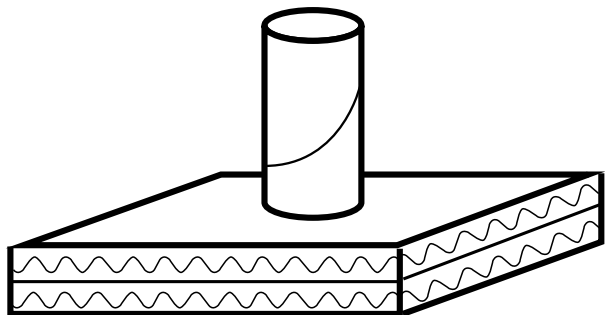
eggshells



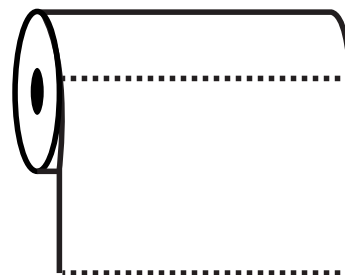
vegetable scraps



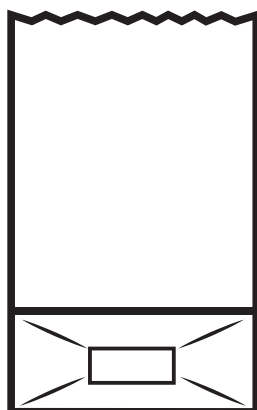
newspaper



cardboard



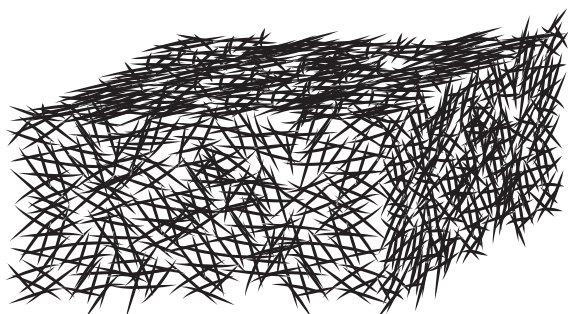
paper towels



paper bags



dead leaves



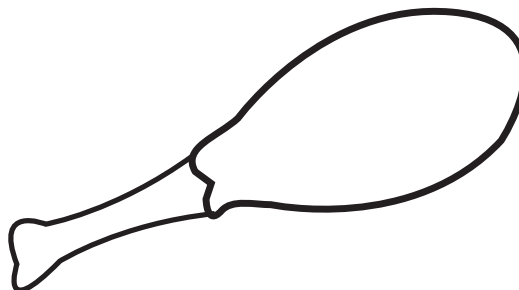
straw



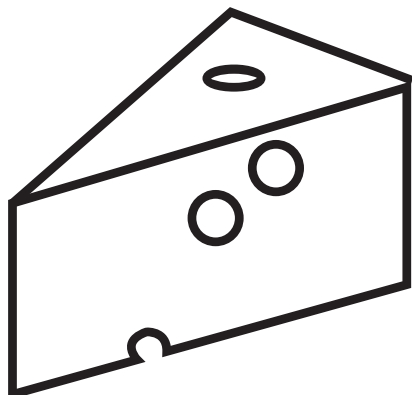
soil



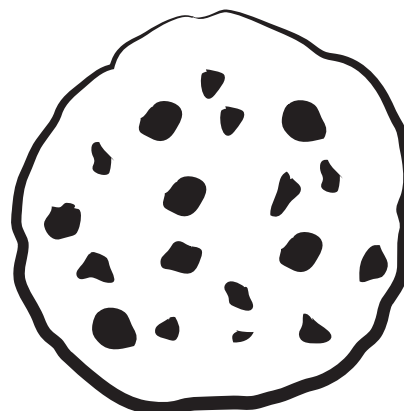
wood chips



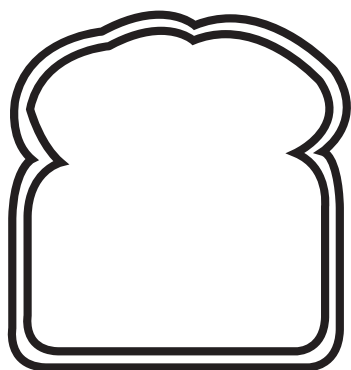
meat



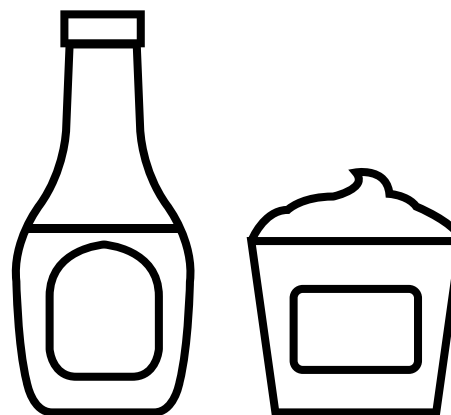
cheese



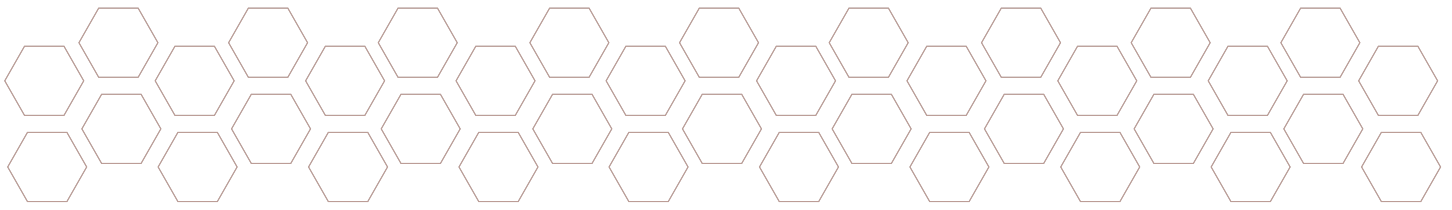
sugars



bread



oils and fats



UNIT 2

SEED TRAVEL & SEED SAVING

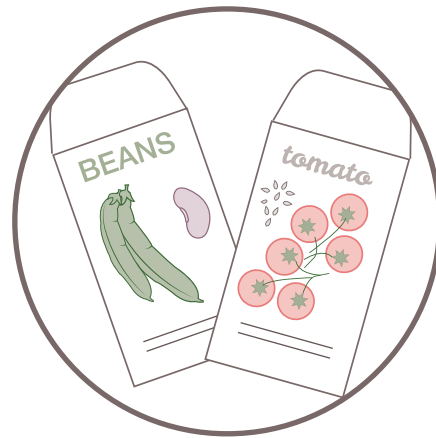
IN THIS UNIT:



4 How Seeds Travel

Explore different **seed dispersal methods**, including water, wind, gravity, ejection and animal dispersal (including human). Investigate **seed adaptations** to ensure dispersal. Learn **why** seeds need to travel.

» *pages 37 to 41*



5 Seed Saving

Learn **how to save seeds** and **why** it is important. Learn **where** seeds are found on a plant and **when** they are best collected. Explore **seed diversity**. Design and create your own **seed package**.

» *pages 42 to 49*

How Seeds Travel

Grade K to 4
Science
1 hour and 30 min



information
for the
teacher

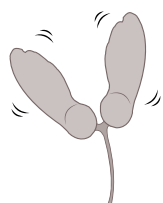


Photo Credit: "Dandelion wish (88/365)" by John Liu (LifeSupercharger on flickr), used under Creative Commons license 2.0 (CC-BY-2.0).

Seeds are the reproductive structure in seed plants, containing a plant embryo. When ripe, seeds travel away from the parent plant in order to establish new colonies and avoid competition for sunlight, nutrients, water, and physical space. Seed dispersal has allowed plants to colonize new habitats and increase species survival.

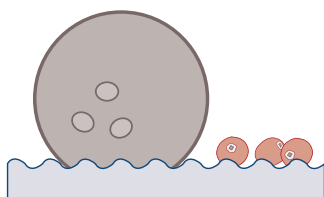
How do seeds travel? Seeds have evolved different methods of dispersal including: wind, water, animal carriers, ejection, and gravity. Seeds such as dandelions and maples have specific adaptations, such as wings and parachutes, which allow them to float through the air. Coconuts are round and have hard seed coats. This allows them to roll down a beach, into the sea and then float on ocean currents for extended periods before they are deposited on new beaches by wave and tide action. Many seeds are found in fruits that are tasty to birds and other animals. Fruits are eaten, and the non-digestible seeds pass through the gut of the animal. Seeds are then deposited in new places in the excrement of animals (which provide free fertilizer for the seed). Other seeds have evolved barbs, or hooks, which attach to animals' fur and can be transported long distances as hitchhikers. Other animals transport seeds and bury them for later consumption, such as acorns and squirrels. Many acorns are forgotten by the squirrels, and are left to germinate. Other seeds, sometimes called "poppers," use ejection or explosive methods to disperse their seeds. Geraniums have pods, which explode open when ripe, ejecting the seeds into the air. Gravity also helps to disperse seeds. Chestnuts, which are heavy and round, fall from the parent tree and roll away, giving the seed a chance to grow a distance from the parent plant. Lastly, one cannot forget the hand of humans in seed dispersal. For thousands of years, humans have collected seeds, traded them, and moved them from one area, country or continent to another, spreading plant species over thousands of kilometers.

TYPES OF SEED DISPERSAL & EXAMPLES OF SEEDS:



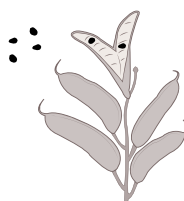
wind

eg. maple and dandelion seeds



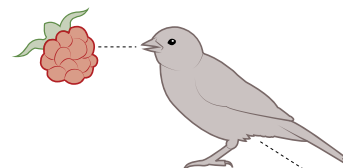
water

eg. coconuts and cranberry seeds



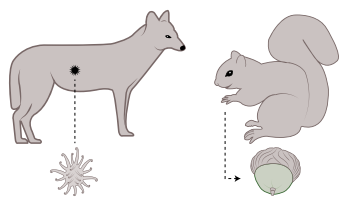
ejection (poppers)

eg. geranium, lupine, and kale seeds



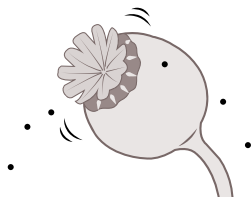
animal droppings

eg. berry seeds



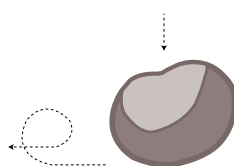
animal carriers

eg. burrs and acorns



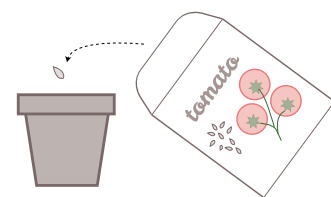
shakers

eg. poppy seeds



drop and roll

eg. horse chestnuts



humans

eg. seeds in seed packages

vocab

Seed Small embryonic plant covered by a seed coat. Means of reproduction in seed plants.

Seed Dispersal The movement or transport of seeds away from the parent plant

Fruit Plant structure that contains the seeds. In flowering plants it is the part of the flower, called the ovary.

Adaptations A trait which helps an organism survive

How Do These Seeds Move?

Explore different seed dispersal methods and adaptations, and learn why seeds need to travel.



MATERIALS

- Collected seeds and fruits with different seed dispersal mechanisms such as:
 - » Lupines, day lilies, broom, geraniums, kale, mustard, and / or radish (ejection)
 - » Poppies (shakers)
 - » Coconut, cranberries, and/or pussy willows (water)
 - » Dandelion, maple, thistle, and/or cottonwood (wind)
 - » Horse chestnuts (conkers) (gravity; drop and roll)
 - » Berries (animal droppings)
 - » Burdock (burrs), geums, and/or acorns (animal carriers)
 - » Seed package with seeds (humans)
- Magnifying glasses or loupes
- Trays to hold a variety of seeds

- Containers of water to hold floating seeds
- Wool socks (to check whether seeds can be carried by animals)
- “How Seeds Travel” activity sheet, one per student

PREPARATION

- Before the lesson, prepare several trays with a variety of seeds with different dispersal methods (one tray for each group)
- Prior to the lesson, classes can go on a seed hunt in a naturalized area, schoolyard or garden to look for seeds with different dispersal mechanisms and bring them back to the classroom.

NOTE

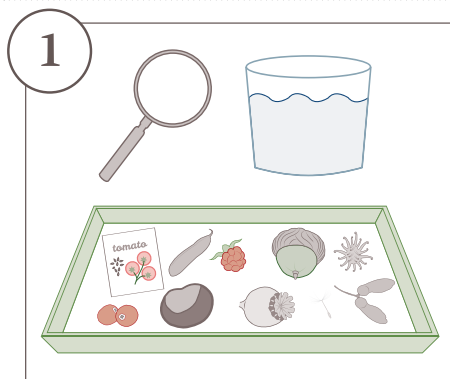
This lesson is best done in the **fall** when seeds are abundant.

Introductory Discussion

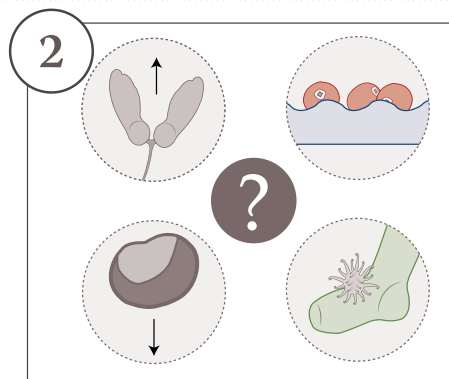
- » How do seeds move from one place to another?
- » Why do you think they need to move? (to avoid competition for resources and to establish new colonies).
- » Can you think of how they might be able to move away from their parent plant?

LESSON

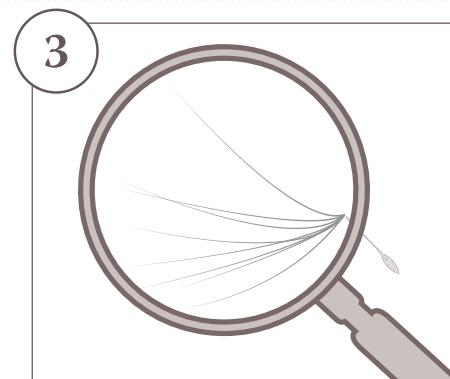
- » Have you ever seen seeds moving? How do they move?
- » Do animals help to move seeds? How? Are there other ways seeds can travel?
- » Do seeds have any parts of them that help them travel? These are called adaptations.
- » Have humans helped to disperse seeds? How?
- » Discuss different categories for seed dispersal: Wind, water, ejection, shakers, gravity (drop and roll), animal carriers, hitchhikers, and humans.



1. Hand out seed trays. Work in pairs or small groups. Give each group: a tray with a variety of seeds on it, a container filled with water, and a magnifying glass or loupe.



2. Discover seed dispersal methods. Let students explore all the seeds on their tray, throwing them up in the air, to see if they can float or fly, or putting them in water (are they boaters?) or dropping them on the floor (do they roll?). Students can try to stick seeds to wool socks, sweaters, or fleece to see if they can be carried by animals. Allow students to categorize all the seeds on their tray, based on the method of seed dispersal.



3. Identify seed adaptations. Using magnifying glasses if needed, ask students to look for adaptations of each seed, which help to let that seed travel (eg. Parachute on dandelion seed, wings on maple seed, tasty fruit of raspberry seed, burrs* or prickles on burdock). Using the activity sheet, allow students to draw and label each seed, showing the seed's dispersal adaptations. Very young students can tape seeds to their sheets.

*A Swiss engineer was interested in why burrs stuck to his clothing and his dog's fur. He looked at the burr under a microscope and found tiny hooks. This inspired him to create Velcro, which imitates the burr's hooks.

Closure Discussion

- » What was your favourite method of seed dispersal?
- » Can you name some adaptations that seeds have to allow them to travel?
- » Why do seeds need to travel?
- » Have you ever helped a seed to travel (think about a garden, or planting seeds in a classroom)?

SEED ADAPTATIONS

an explanation guide

WIND

Dandelion, thistle, and cottonwood seeds have fluffy “parachutes” that help seeds to float. Maple seeds have “helicopters” that spin seeds away from the tree.

SHAKERS

Shakers develop small holes in their seed heads as they dry and the seeds ripen - the ripe seeds can escape from the holes when it is windy.

DROP AND ROLL

Horse chestnuts have a spiky shell that helps them survive the fall from a tree and breaks open when it hits the ground. The roundness of the seeds and the impact from the fall helps the chestnuts roll away from the tree.

ANIMAL DROPPINGS

The taste of berries and fruit is delicious to animals. Also, animals are attracted to the colour of the fruit.

WATER

Coconuts and cranberries both contain pockets of air inside which help them to float.

EXPLOSION

Seed pods have seams that pop open when dried by the sun and jostled by the wind.

ANIMAL CARRIERS

Burrs and geums have small hooks that attach to animal fur. Acorns are big, bulky food for squirrels, so they often have to be dropped or hidden as a squirrel travels.

HUMANS

People use seeds to grow vegetables and flowers in their gardens for food and beauty. Farmers need seeds to grow and sell crops.

references & resources

BOOKS

Aston, Dianna Hutts. 2007. *A Seed is Sleepy*. Chronicle Books, San Francisco.

Carle, Eric. 1987. *The Tiny Seed*. Picture Book Studio, Natick MA.

Lawrence, Ellen. 2013. *From Bird Poop to Wind: How Seeds Get Around*. Bearport Publishers, New York.

Pallotta, Jerry. 2010. *Who Will Plant a Tree?* Sleeping Bear Press, Ann Arbor.

Richards, Jean. 2002. *A Fruit is a Suitcase for Seeds*. Millbrook Press. Brookfield Conn.

ONLINE

- **How Do Seeds Travel** YouTube video for K or grade 1:
<http://www.youtube.com/watch?v=6hcjxaBz8mw>
- **How Do Seeds Travel** slide show (2008) by Sarah Green, San Diego State University:
<http://www.slideshare.net/belleminjuan/how-seeds-travel>
- **Seed Dispersal Mechanisms:**
http://www2.bgfl.org/bgfl2/custom/resources_ftp/client_ftp/ks2/science/plants_pt2/dispersal.htm

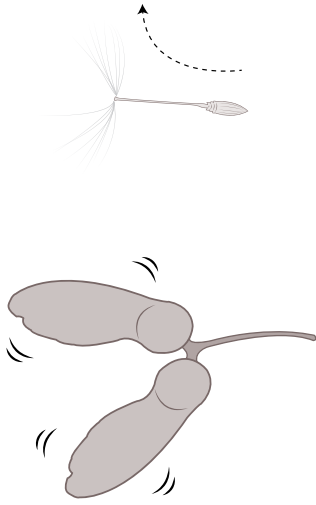
extensions

- Go for a seed/fruit hunt in the neighbourhood or school yard. This is best done in the fall.
- Book a field trip to **Van Dusen Gardens**. Seed Secrets K-Grade 3 offered from Oct-Nov:
<http://vancouver.ca/vandusen/childrenFamilies/schoolPrograms.htm>
- Book a field trip to **UBC Botanical Gardens**: <http://www.botanicalgarden.ubc.ca/school-groups>
- Take a guided walk through a Metro Vancouver regional park. The topic of seeds can be requested as part of the tour:
<http://www.metrovancouver.org/region/teachers/fieldtrips/RegionalParksFieldtrips/Pages/default.aspx>

credits

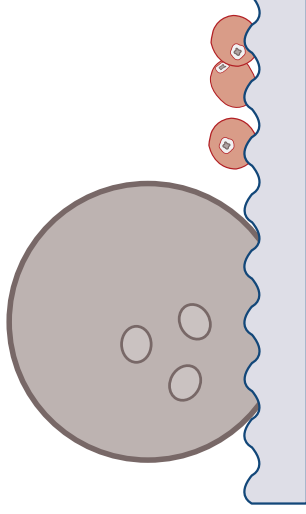
Lesson developed and written by Catriona Gordon. Design by Lisa Rilkoﬀ.

Types of Seed Dispersal



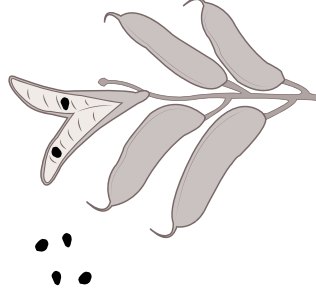
wind

eg. maple and dandelion seeds



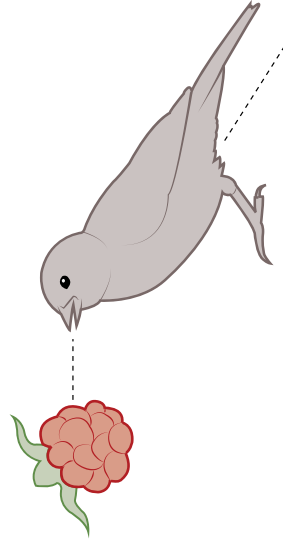
water

eg. coconuts and cranberry seeds



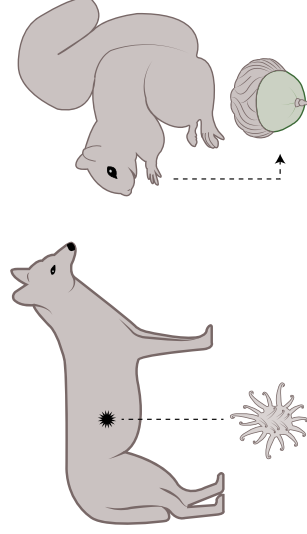
ejection (poppers)

eg. geranium, lupine, and kale seeds



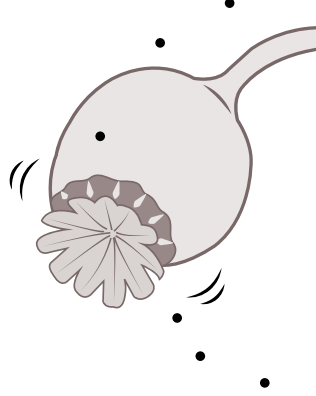
animal droppings

eg. berry seeds



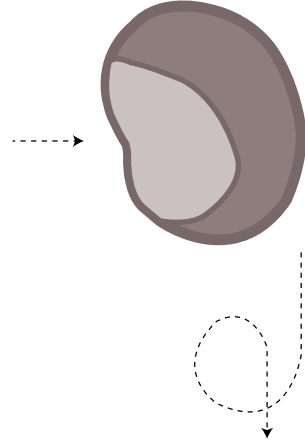
animal carriers

eg. burrs and acorns



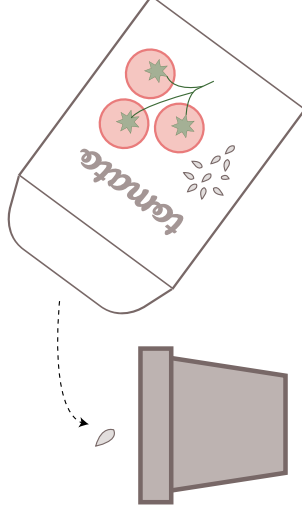
shakers

eg. poppy seeds



drop and roll

eg. horse chestnuts



humans

eg. seeds in seed packages

How Seeds Travel

name: _____



Draw a seed in each box of the chart. Label the part of the seed that helps it to travel.

wind	water	explosion	animal droppings
animal carriers	shakers	drop and roll	humans

information
for the
teacher



Photo Credit: "Seed Saving" by Alex "Skud" Bayley via flickr, used under Creative Commons license 2.0 (CC-BY-2.0).

The practice of saving seeds is one of the oldest agricultural practices and has been in existence for the last 10,000 years. Seed plants make seeds to reproduce and grow into new plants. Seeds can be saved for future planting if they are collected and stored correctly. Farmers have passed seeds on through many generations and seed saving is a way to preserve biodiversity. There are seed banks worldwide, which collect and store thousands of plant species and varieties to ensure future planting success and to protect against natural disasters, if seed crops are lost.

What is the difference between open pollinated and hybrid seeds?

Open pollinated seeds are seeds that are pollinated by insects, wind, or other natural methods. These seeds can include heirloom varieties. Open pollinated seeds will have the same characteristics as their parent plants. In contrast, hybrid seeds are the result of controlled pollination, using two different plant varieties, bred by humans for desired plant traits. Seed collected from hybrid plants will not have the same traits as their parent plants. Seed from hybrid plants needs to be repurchased each year.

How do I save seeds? When seed saving, fruits should be completely mature before collecting. Seeds should be dried on paper towels and then stored in a labelled paper bag or paper envelope in a dry cool, dark place. Some of the easiest seeds to save are beans, marigolds, calendula, peas, lettuce, radish, broccoli, and kale. Seeds from fleshy fruits such as cucumbers and pumpkins need to be harvested, cleaned and thoroughly dried before storing. Some seeds require natural special preparations before they can germinate, such as a cold period, scarification, fermentation, or fire, to break through the seed coat and allow germination to occur. Humans have learned to emulate nature by preparing these special conditions to promote germination. For example, tomato seeds need to be fermented before storing. This can be done in a jar with seeds and water, left for a few days to ferment.

For how long can I store saved seeds? Seeds have varying life spans. For example seeds from the onion family usually last only one year, however most vegetable seeds have a three year lifespan or longer. Some seeds have very long life spans, and will delay germination until conditions are optimal. The oldest seed on record to germinate was a 2000 year old Israeli date palm seed! Usually seeds are best used within 1-3 years of harvesting as germination rates tend to decline over time.

vocab

SEEDS

Seed The small embryonic plant covered by a hard seed coat, dormant until conditions are met for germination

Seed Coat A hard covering which encloses a seed and protects it from damage, insects, fungi, fire, dessication, etc.

Germination The sprouting of a seed, when environmental factors are favourable

Delayed Germination When environmental factors are unfavourable for seed germination, seeds remain viable but will not sprout

PLANT GENETICS

Cultivar A plant (or group) which has been selected due to its desirable characteristics, usually a product of plant breeding. Most of our food crops are cultivars, selected for taste, resistance to disease, yield, etc. The word cultivar is a combination of cultivation and variety.

Heirloom Seed Variety An old seed cultivar that often has resistance to local pests, diseases and extremes of weather. They are often over 100 years old and are not commonly used in industrial agriculture.

Open Pollination Natural pollination, which may occur by wind, insects, and birds, in contrast to controlled pollination by humans.

Genetic Diversity Biodiversity based on the genetic characteristics of a species or group of species. By saving seeds from plants, one is preserving genetic diversity.

Part 1 Introduction to Seeds

Learn what individual seeds look like, where they are found on a plant., and when they are best collected.



NOTE: This lesson is best done in the **fall**. Please read through Part 2 before beginning the lesson to get an idea of the timeline and setting required for the activities.

MATERIALS

- Several sets of the picture cards included with this lesson (you'll be splitting the students into groups, and each group will need one set of cards). You'll need to photocopy and cut these cards prior to the lesson.

and / or

- Real seeds, vegetables/fruits, and flowers as listed on the pictures, or examples of seeds that you intend to harvest in Part 2 of this lesson

OBJECTIVES

- Learn why saving seeds is important
- Explore examples of different seeds
- Learn where seeds are found on a plant and when they are best collected

LESSON

Introductory Discussion

- » What is a seed? Why do plants produce seeds? (*To grow into new plants. Seeds are also a food source for animals and humans*)
- » Where can you find seeds? What part of the plant holds the seeds?
- » Why do we need to save seeds?

Matching Seeds with Vegetables, Fruit, and Flowers

1. Put the students in groups. Show the class 1 or 2 different kinds of common seeds (such as bean or sunflower) and ask the students to call out what kind of seed you're showing.
2. Hand each group a set picture cards (or real seeds and fruits, vegetables, and flowers, or a combination), and have groups match the seed to the fruit, vegetable, or flower that it produces. Go over the answers as a class (*see the seed pictures to the upper right of this page*).

Where Do Seeds Grow?

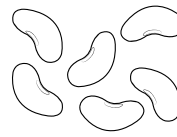
If your school has a garden, you could do this part outdoors. Elicit from students where the seeds grow on different plants. Start with the more obvious plants (like sunflowers or beans) and gradually move to the more difficult ones (like lettuce or radishes). Demonstrate to students how leafy plants go to seed by showing them examples outdoors or in photos, or by drawing pictures on the board. *See the guideline to the right for answers.*

When Is a Good Time to Harvest Seeds?

Draw a timeline on the board and label it with the words Spring, Summer, Fall, Winter. Elicit from students when we plant seeds (Spring), when the seed becomes a big plant (Summer), and when the plant starts to die (Fall). Ask students which season is the best for getting seeds from plants.

- » *Answer: Fall, because the plant is old and all of its energy is going into making seeds. It wants to make seeds before it dies so a new plant can grow next year.*

SEED MATCHING ANSWERS



beans



peas



pumpkin



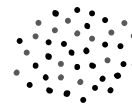
tomato



lettuce



radish



broccoli



sunflower

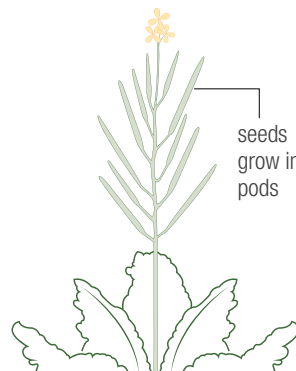


marigold

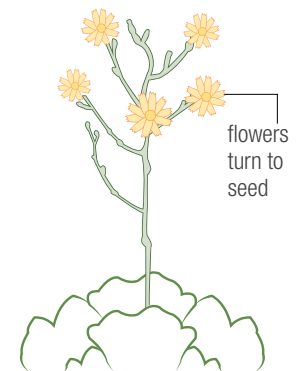
WHERE DO SEEDS GROW?

Seeds can grow...

- inside fruits and vegetables (eg. tomatoes, peppers, pumpkin, squash)
- inside flowers (eg. marigolds, sunflowers)
- inside pods (eg. peas, beans)
- at the top of a plant
 - » this is common with leafy vegetables (eg. lettuce, kale, cabbage, broccoli, chard, beets, and radishes)



Plants such as kale, cabbage, and broccoli grow seed pods on tall stalks. When these seed pods are brown and dry, the seeds inside are ready to be harvested.



Lettuce plants grow flowers on long stalks, and these flowers make seeds. When the flowers are brown and dry, the seeds become fluffy (like dandelions), the seeds are ready to be harvested.

Part 2 Saving Seeds

Learn how to save a variety of seeds and create hand-made seed packages.



MATERIALS

- Dried fruits and/or seeds from the vegetable garden, school yard, or home garden
- Seed packet template included with this lesson (or use old envelopes), one per student
- A few commercial seed packages so that students can see an example of relevant information and the design
- Magnifying glasses
- Seed catalogues with info on vegetable and fruit varieties

OBJECTIVES

- Learn how to save seeds and why it is important
- Explore seed diversity
- Design and create your own seed package

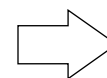
PREPARATION

Before the lesson, you will need to do one of the following:

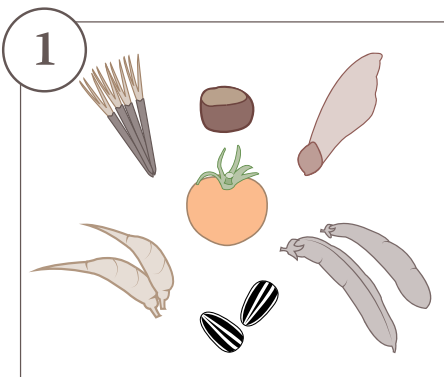
- Find a site (eg. a garden) with plants that have seeds ready to be harvested.
- If no such site is available, you could do the lesson with locally-grown squash, pumpkin, or tomatoes purchased at a farmer's market.
- Alternatively, you could find a site with maple or horse chestnut trees that have dropped some seeds to the ground.

NOTE

See next page for details on how to harvest and save specific seeds and what information to include on the seed package.



LESSON



1. Collect seeds. Go on a seed hunt to look for different seeds around your school garden, schoolyard, vacant lot, back lane or natural area (this is best done in the fall).

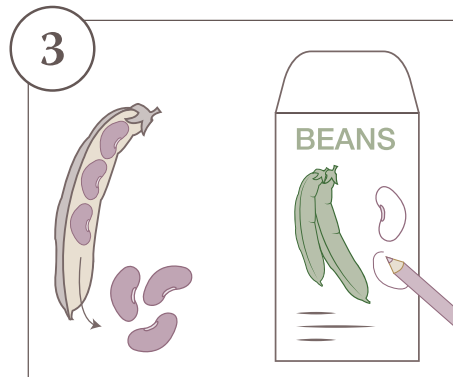
Seeds may be in fleshy fruits, such as a strawberry or raspberry or as hard dry nuts like acorns and chestnuts. Seeds may also be found in pods such as beans and peas. Younger students may like to collect maple

seeds and horse chestnut seeds, which are large and easy to collect. Students with gardens may wish to bring in seeds of their own.

IMPORTANT: All seeds should be fully ripe. This usually means that the plant looks “dead” or brown. Do not collect “green” or unripened seeds, as these may not be viable.

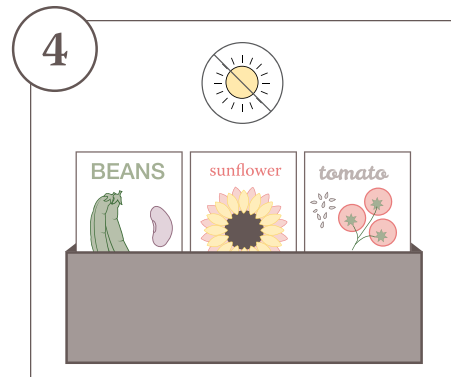


2. Sort seeds and dry them for a class seed collection. Allow at least a week for all seeds to dry before making seed packages and storing seeds. The larger the seeds, the longer it will take for them to dry.



3. Prepare seeds and packets. Give students seed pods, seed heads, or dried flower heads to clean and sort, extracting the seeds and leaving the chaff.

Hand out seed packet templates to each student. Get students to research and design their own seed packet based on the seeds that they have collected.



4. Store seed packages in the classroom in a cool, dark and dry place until spring. Get students to then plant their seeds in April or May.

IMPORTANT: Store seeds in paper bags or paper envelopes. Never store seeds in plastic bags as they can easily mold.

Closure Discussion

- » What advantages are there in collecting our own seeds?
- » How do you think our early ancestors collected and stored seeds?
- » Why were seeds used as currency in ancient civilizations?

SIX EASY PLANTS FOR SEED SAVING

BEANS AND PEAS: Collect pods when they are dry and brown. Do not pick green peas or beans as these seeds are unripe and will be unviable. Once pods are collected, thoroughly dry indoors for up to a week. Once dried get students to open the pods and collect the seeds.

SUNFLOWERS: Choose the biggest, best sunflower head for seed saving. This will ensure great flowers next year. Birds love sunflower seeds and will eat them, even if they are still unripe. To save seeds, cover the seed head in cheesecloth, old nylons or a similar mesh, while still on the plant. This will discourage the birds but allow seeds to develop and mature fully. Once the seeds are dropping out of the seed head into the mesh, cut off the dead flower head carefully. Dry the seed head hanging upside down, indoors for up to a week. Get students to remove all the seeds carefully and let seeds dry for another week. Then store seeds.

PUMPKIN or SQUASH: Get a local ripe pumpkin or squash from a garden or farmer's market or food store. Find out the variety if possible, when you purchase it. Cut it in half. Get students to scoop out all the seeds and remove all the pulp. Wash seeds using a sieve. Once seeds are thoroughly cleaned, dry them on paper towels or plate in a warm spot. Once thoroughly dried, store seeds.

CALENDULA or MARIGOLD: Seeds from these flowers are very easy to save. Let flower heads dry out and brown completely on the plant. Once they look dead, harvest the seed heads and dry indoors, upside down. Once dried, students can pull apart the seed heads to remove seeds.

TOMATO: Tomato seeds need to ferment before they are stored. To do this, collect your best looking very ripe tomatoes (local ripe tomatoes can also be purchased from a farmer's market or local grocery store, again try to find out the variety). Cut tomatoes horizontally and scoop out seeds. Put seeds into a glass jar and cover with up to 1 cup of water. Cover jar with cheesecloth or a J-cloth. Set aside for 2-3 days. Once a layer of mold forms and the tomato seeds start to smell fermented and sink to the bottom of the jar, remove mold. Pour seeds and remaining liquid through a sieve and wash thoroughly. Dry seeds on a paper plate or paper towel for up to a week, in a warm spot.

RADISH: Seeds from radishes are fun and easy to collect. Allow radish plants to flower and go to seed. Once the pods (which look like small pea pods) are fully ripe, dry and brown, harvest the pods. Check on them every day, as pods will open naturally and release their seeds and you may miss them! Allow them to dry indoors and then get students to open the pods to collect the seeds.

OTHER: Other easy seeds to save are sweet pepper, lettuce, fennel, kale, oriental greens such as mizuna, pac choi, and parsley.

INFO TO INCLUDE ON THE SEED PACKAGE

- Year and place of collection
- Plant name and variety if known, otherwise it could be labeled "mystery plant"
- Number of seeds (if too many to count, estimate)
- If able to research growing information, include this also.
 - » Eg. days to germinate, full sun or shade, needs trellising etc.This may be done using a seed catalogue.

references

BOOKS

- Aston, Dianna Hutts. 2007. *A Seed is Sleepy*. Chronicle Books, San Francisco.
- Cooney, Barbara. 1982. *Miss Rumphius*. Viking Press, New York.
- Pattou, Edith. 2001. *Mrs. Spitzer's Garden*. Harcourt, San Diego.
- Richards, Jean. 2002. *A Fruit is a Suitcase for Seeds*. Millbrook Press. Brookfield Conn.

ONLINE

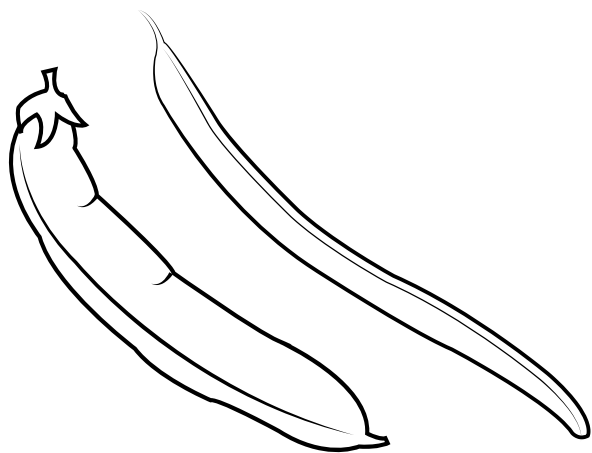
- **Seed and Plant Sanctuary for Canada:** a helpful website <http://www.seedsanctuary.com/articles/seedsaving.cfm>
- **Comox Valley Growers and Seedsavers**
Valuable information about seed saving for different vegetable crops: <http://cvgss.org/seed-saving-101/>

extensions

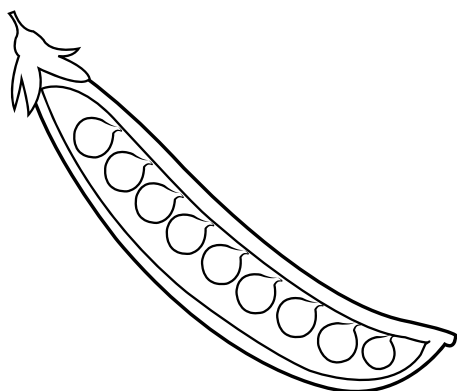
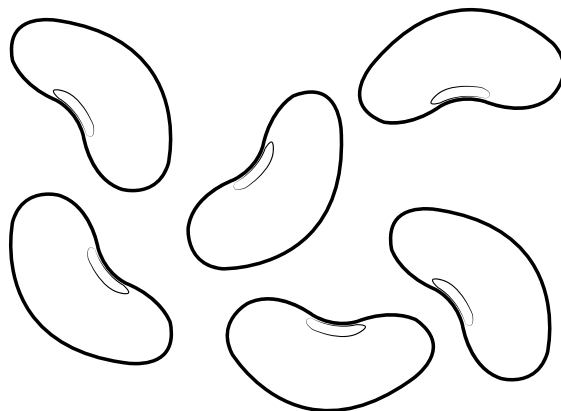
- In the spring, let students plant out their dried seeds and do a germination experiment. Plant 10 seeds and see how many seeds will actually germinate. Record data on a bar graph. Or grow seeds in different planting media (sand, topsoil, different soil types).
- Attend a seed exchange such as Seedy Saturday at **Van Dusen Botanical Gardens**, in Vancouver. <http://vandusengarden.org>
- Check this website for a seed exchange near you: **Seeds of Diversity** <http://www.seeds.ca/ev/events.php>
- Make a seed picture, with glue and a collection of seeds.
- Design a life cycle of your seed.

credits

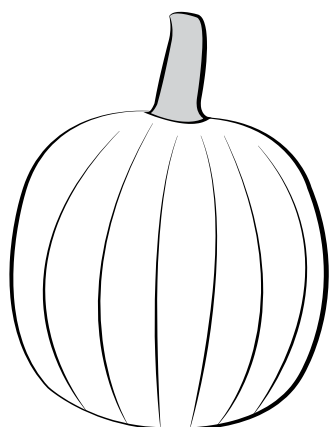
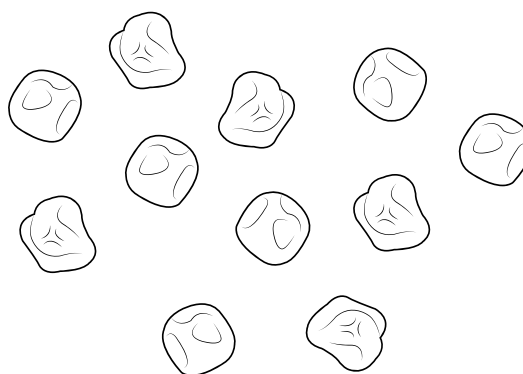
Lesson developed and written by Catriona Gordon.
Design by Lisa Rilko



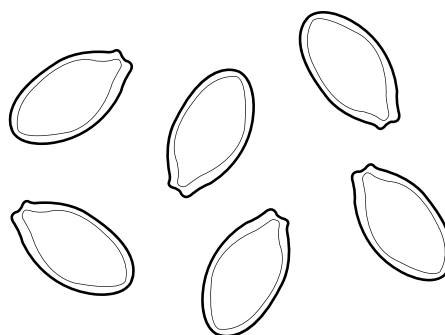
beans

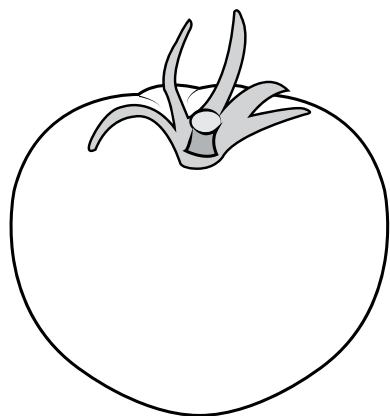


peas

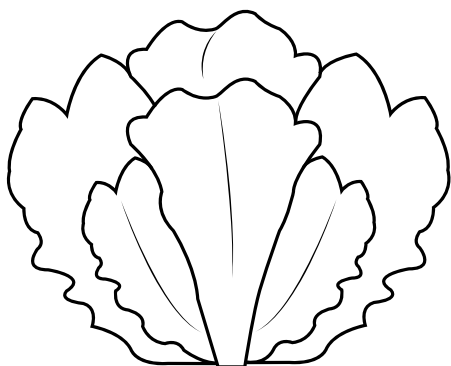
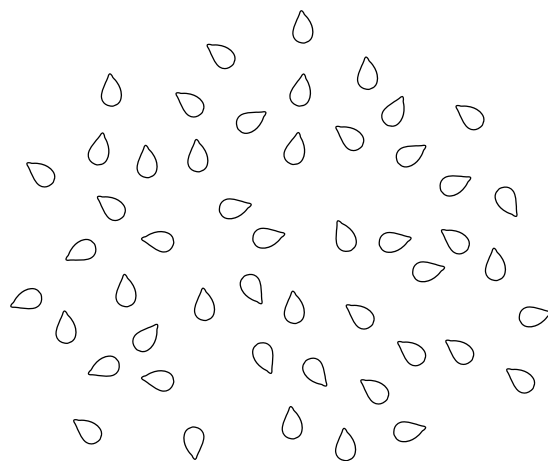


pumpkin

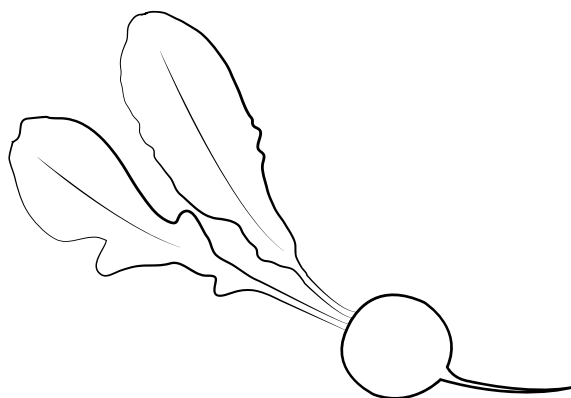
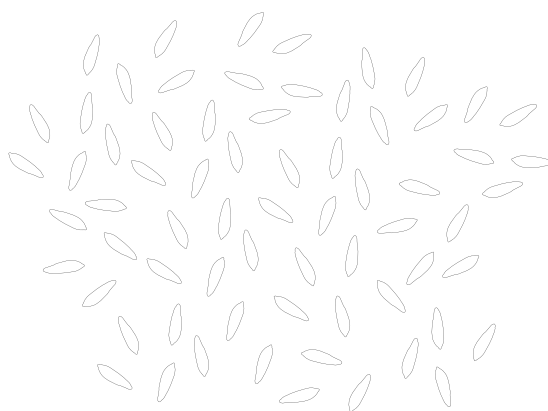




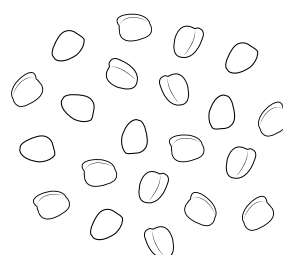
tomato

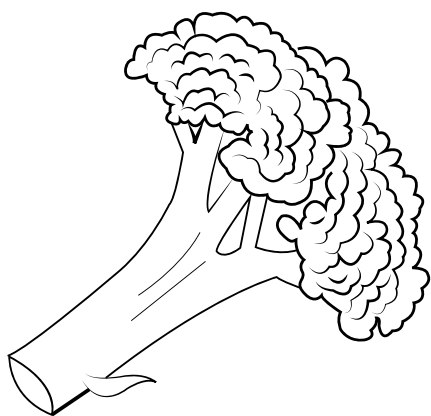


lettuce

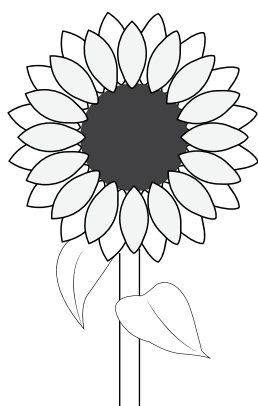
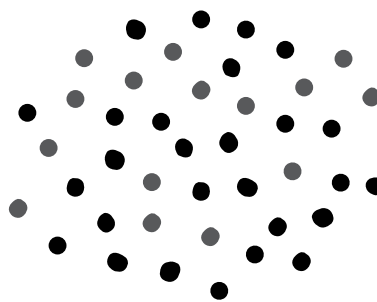


radish

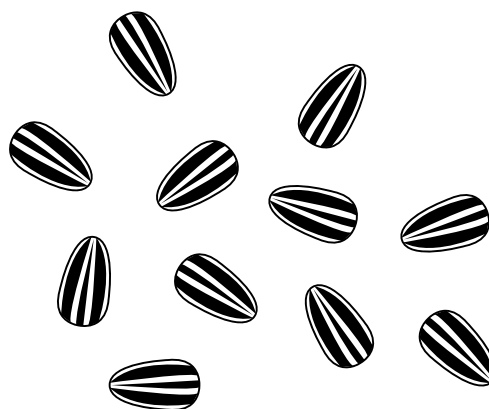




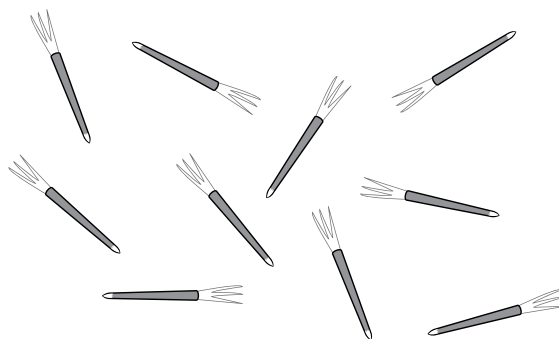
broccoli



sunflower

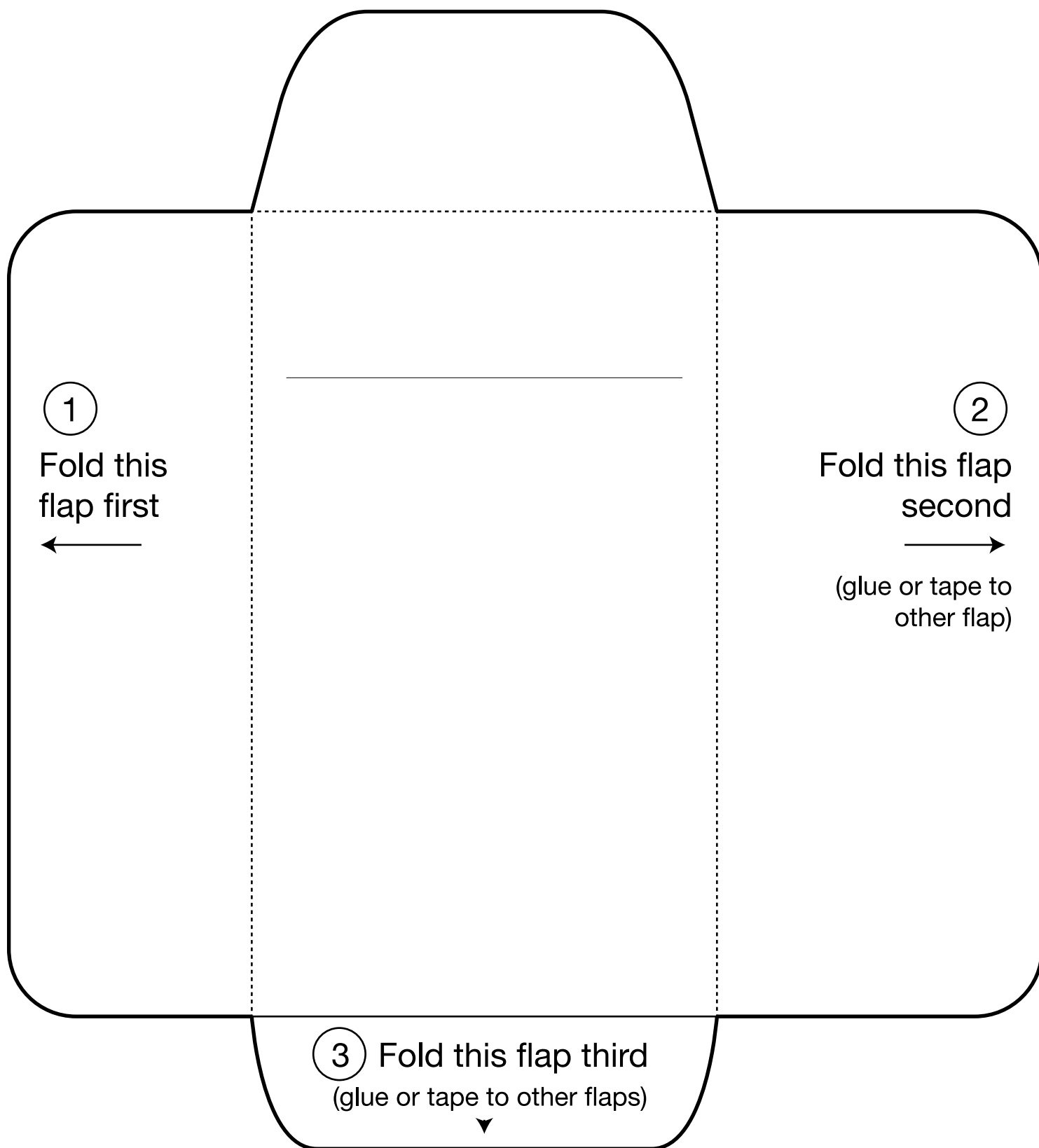


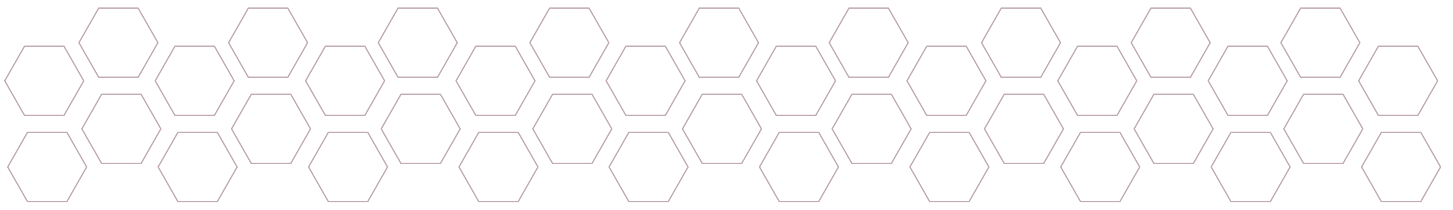
marigold



Seed Packet Template

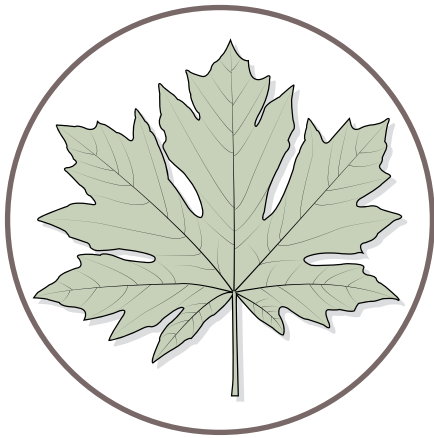
» for use with the Seed Saving lesson





UNIT 3 LEAVES, FLOWERS, & INSECTS

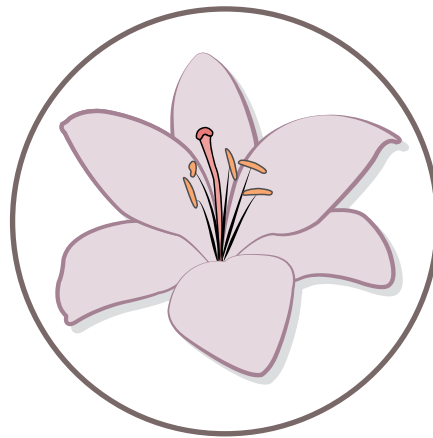
IN THIS UNIT:



6 Leaves and How They Work

Learn **how** leaves work. Discover the diversity of **leaf shapes, colours** and **sizes** and how to categorize them. Explore the basics of **photosynthesis**. Learn about what travels in **leaf veins** and the diversity of leaf venation.

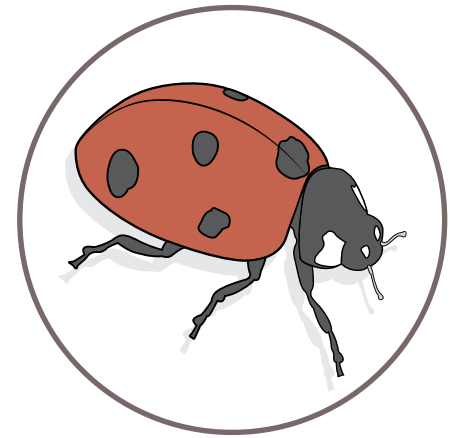
» pages 51 to 64



7 Flowers and Pollinators

Dissect a flower and explore the **parts** and their **functions**. Discover the process and importance of **pollination**. Learn about native and non-native **bees** as well as other pollinators and their role in **food production**.

» pages 65 to 71



8 Insects in the Garden

Learn about the **parts of an insect**, and how an insect differs from an invertebrate and an arthropod. Discover the **beneficial** and **harmful insects** and invertebrates that inhabit the garden. Learn about **safe** and **organic pest management** in the garden.

» pages 72 to 81

Leaves and How They Work

Grade K to 4
Science, Art, Math
1 hour



information
for the
teacher



Photo Credit: "Green leaves in autumn sunshine" by Ben Osteen (ben_osteen on flickr), used under Creative Commons license 2.0 (CC-BY-2.0).

Above: The solar energy captured by these leaves will be combined with CO₂ and water, then converted to food energy for the tree via photosynthesis.

Below: The soft tissues of this leaf have gone through a decomposition process and have been consumed by insects and organisms. The leaf has become a "leaf skeleton," and its system of veins is very easy to see.

Photo Credit: "Leaf Skeleton" by Mark Longair (oosp on flickr), used under Creative Commons license 2.0 (CC-BY-2.0).



Leaves are the "food factories" of most plants. Photosynthesis takes place in the leaves, capturing the sun's energy and turning it into chemical energy, which is then used by the plant. This process involves capturing the sun's energy and combining it with carbon dioxide (from the atmosphere) and water (from the soil) to produce sugars and oxygen. Leaves take in carbon dioxide through the underside of their leaves (stomata) and oxygen exits by the same route. A waxy coating called the cuticle protects the leaf from water loss. Leaves transport water and sugars in their veins to other parts of the plant. Plants have highly diverse leaf shapes and venation patterns, which can be used to help identify species.

Leaves get their green colour by the pigment, chlorophyll, found in the chloroplasts of plant cells. This pigment absorbs light energy from the sun. Leaves can have other pigments which are often masked by the chlorophyll pigment. In the autumn, when deciduous leaves are dying, chlorophyll is broken down, and then the other pigments (xanthophylls, carotene, and anthocyanins) are often visible, giving us the yellow, orange and red colours of fall leaves (see image below).

Photo Credit: "autumn gutter" by Liz West (Muffet on flickr), used under Creative Commons license 2.0 (CC-BY-2.0).



vocab

LEAF PARTS AND PROCESSES

Leaf Flat, usually green part of a plant that grows from a stem or twig. Produces sugars (carbohydrates) via photosynthesis.

Leaf Vein Tubes that can form a branching pattern or parallel pattern and transport food and water in the leaf.

Cuticle A protective waxy coating covering leaves and stems of plants, reducing water loss and damage.

Photosynthesis The process by which plants capture energy from the sun and turn it into food (sugars or carbohydrates).

LEAF PIGMENTS

Pigment A coloured substance found in plants and animals.

Chlorophyll Green pigments found in plants, which help them to convert the sun's energy into food.

Xanthophyll Yellow pigment found in plants.

Carotene Yellow-orange pigment found in plants.

Anthocyanin Red, purple, or blue pigment found in plants.

Part 1: Intro to Leaves

Learn how leaves work and what they look like, and explore the basics of photosynthesis.



MATERIALS

- Photosynthesis poster
- Leaf Types visuals and poster
- Leaf Types flashcards (1 set per group of students. Photocopy the flashcard sheets double-sided so that the answers will appear on the back of each flashcard)

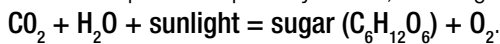
LESSON

Introductory Discussion

- » Why do plants need leaves? What is the function of a leaf? (*little food factories, producing sugars through photosynthesis*).
- » What is in leaves to give them a green colour? (*chloroplasts*) Why do leaves change colour in the fall? (*Chloroplasts die and chlorophyll breaks down, revealing other leaf pigments*).
- » Why do leaves have veins? Do you have veins? What travels in your veins? (*blood*) What do you think travels in the veins of a leaf? (*water and sugars*).

1. Photosynthesis

Review the poster on photosynthesis, focusing on the basic formula:



Allow students to breathe out into their cupped hand, to feel the CO₂ that they exhale. Tell students to breathe in deeply and feel the O₂ entering their bodies. Remind students that plants are the opposite. They “breathe” in CO₂ (what we exhale) and “breathe out” O₂ (what we inhale). Talk about the importance of plants to capture CO₂ (greenhouse gases) and filter our air, and produce O₂.



Maple Syrup: Delicious Photosynthesis!

After Part 2 of this lesson, you can give students a taste of maple syrup (product of photosynthesis, plant sugars, produced in the leaves of maple trees, then stored over winter in the tree).

Discuss how maple syrup is made (people tap maple trees in late winter, collect sap in buckets, then evaporate the water from the sap to get concentrated syrup).

2. Leaf Types

Ask students: Do all leaves look the same? (*no*)

Have students take out a piece of paper and a pencil. Tell students that they have two minutes to quickly brainstorm and draw as many different leaf shapes as they can. After the two minutes are up, they can compare with a partner. Elicit a few examples from students and draw these leaves on the board.

» Leaf Types Visuals

Go over the Leaf Types visuals / poster with the students. Describe the different categories we use when determining a leaf type:

Simple or Compound	A single leaf (simple) vs. a leaf consisting of several leaflets (compound)
Shape	The leaf's overall shape
Margin	The shape of the leaf's outer edges
Venation	The pattern of the veins inside of the leaf

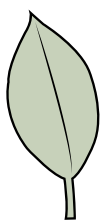
Give students a few minutes to study the different leaf types, and help them pronounce the difficult vocabulary (eg. “lanceolate,” “palmate,” “pinnate”).

» Flashcard Activity

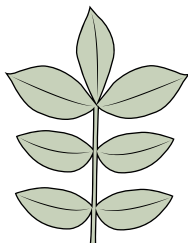
Hand out a set of Leaf Types flashcards to each group of students. Group members can distribute the flashcards evenly between themselves. Each student in the group can take turns holding up a flashcard and quizzing the other members of the group on the leaf type pictured on their card. Each card will have answers on the back (if photocopied double-sided).

LEAF TYPES

SIMPLE & COMPOUND

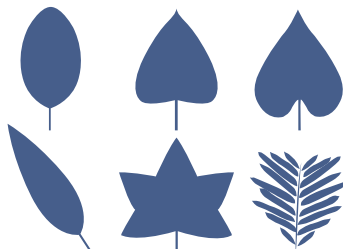


simple



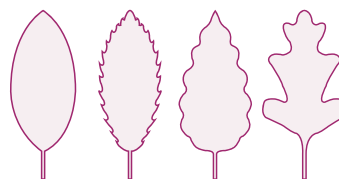
compound

SHAPE



top: oval, triangular, heart-shaped
bottom: lanceolate, palmate, needles

MARGIN



entire toothed wavy lobed

VENATION



parallel pinnate net palmate net

Part 2: Leaf Detectives

Discover the diversity of leaf shapes, colours, and sizes and practice categorizing leaves.



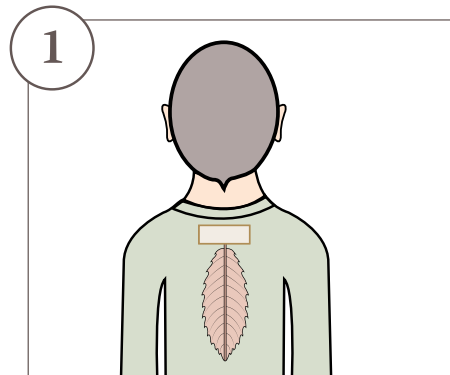
MATERIALS

- An assortment of leaves, compound, simple, toothed, lobed, palmate, needles etc. Ask students to bring in 2-3 leaves each.
- Magnifying glasses
- Dissecting microscopes (if possible)
- Crayons
- Masking Tape
- Leaf skeletons (found in the fall)
- Scrap paper
- Leaf Types poster and worksheet (1 worksheet per student)
- Optional: maple syrup (sap) (an example of sugars, produced by maple leaves by photosynthesis during the previous summer and stored in the trees over winter)
- Spoons to taste maple syrup (plant sugars)

PREPARATION

Before the lesson, you'll need to prepare several assortments of different leaves (one assortment per group of students). Students will sort and draw these leaves on their "Leaf Types" worksheet.

LESSON

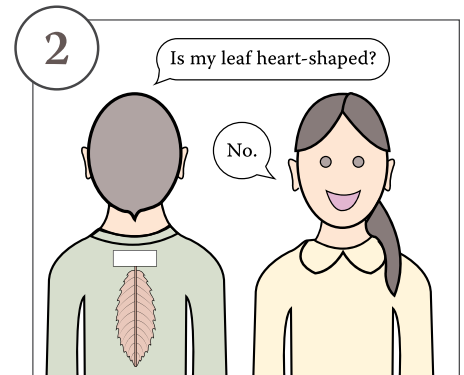


1. Leaf Detectives activity preparation. Students face away from the teacher, and each student gets a mystery leaf stuck on their back. The goal of the game is to get as many clues as possible as to what kind of leaf they have.

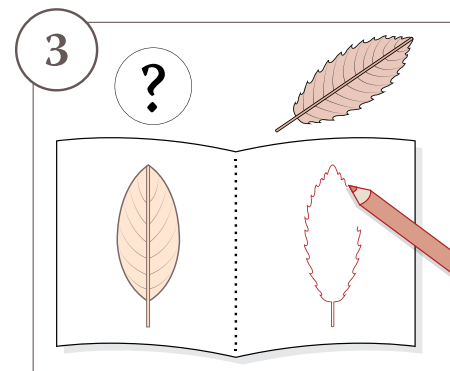
While they are waiting for their turn to have the leaf taped on their back, students can start to brainstorm as to what **yes / no questions** they will ask each other.

Include the following questions:

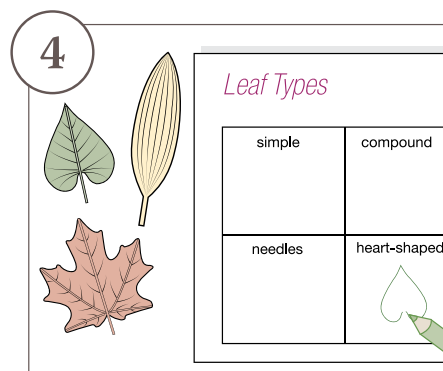
1. **Simple or Compound**
2. **Shape:** lanceolate (shaped like a sword or lance), oval, needle, palmate, triangular, circular, etc.
3. **Margin:** Entire (smooth), toothed, lobed, wavy
4. **Venation:** Parallel or net veins
5. **Colour:** green, yellow, brown, red, orange, purple, grey



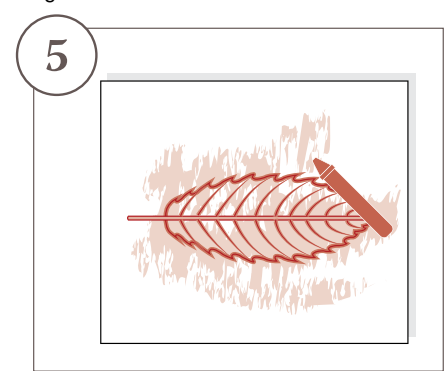
2. Mingle. Rules: Students may ask questions that have a yes or no answer only. Eg. Is my leaf simple? Is my leaf compound? Does my leaf have teeth? Is it yellow? Green? Does it have net veins? Parallel veins? Students can circulate asking each other questions and gathering clues about their leaves.



3. Leaf guesswork. When students think they have enough clues to draw their leaf, hand out a scrap paper folded in half. On one half students will draw what they think they have on their back. Once the drawing is complete, they can then get a buddy to help remove the leaf, and they can then draw the leaf that they actually had. Compare the drawings.



4. Leaf sorting. Hand out examples of many leaves and have students find and draw a leaf for each category on their activity sheets. Hand out leaf skeletons and magnifying glasses. Allow students to look closely at the veins.



5. Leaf rubbings. If time permits, get students to make leaf rubbings using the flat part of their crayon. Place the leaf under a piece of paper and gently rub the crayon lengthwise, over the leaf. Leaf venation and shape will appear.

Closure Discussion

Review: What is the function of a leaf? What travels in a leaf vein? Review leaf shapes, margins, and venation. Give students a taste of maple syrup if desired.

Additional Info and Resources

references & resources

Edwards, Nicola. 2008. *Leaves*. "See How Plants Grow" Series. PowerKids Press, New York.

Farndon, John. 2006. *Leaves*. "World of Plants" Series. Blackbirch Press, Detroit.

Robbins, Ken. 1998. *Autumn Leaves*. Scholastic Press, New York.

extensions

- » Find the area of your leaf by using graph paper and tracing your leaf.
- » For older students, extract leaf pigments by using alcohol and coffee filters. Chlorophyll, xanthophylls, anthocyanins and carotene are often visible.

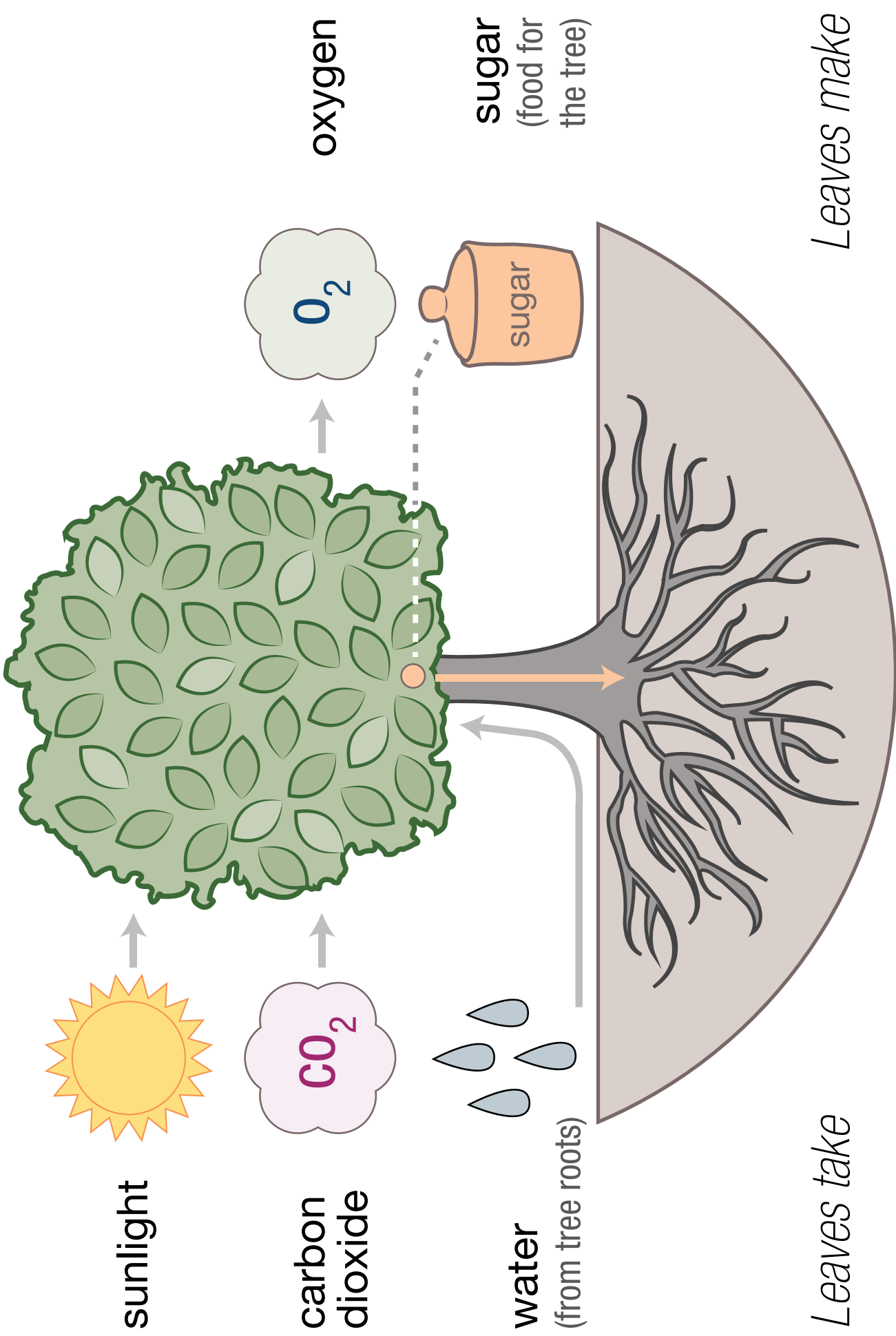
3 websites with good leaf pigment experiments are:

- » Home Science Tools, "Leaf Experiments" page:
<http://www.hometrainingtools.com/leaf-experiments/a/1235/>
- » Kitchen Pantry Scientist, "Plant Chromatography for Kids"
<http://kitchenpantryscientist.com/?p=2401>
- » "Leaf Color Chromatography" YouTube video by Bite Sci-zed
<http://www.youtube.com/watch?v=qH-AJDqsSII>

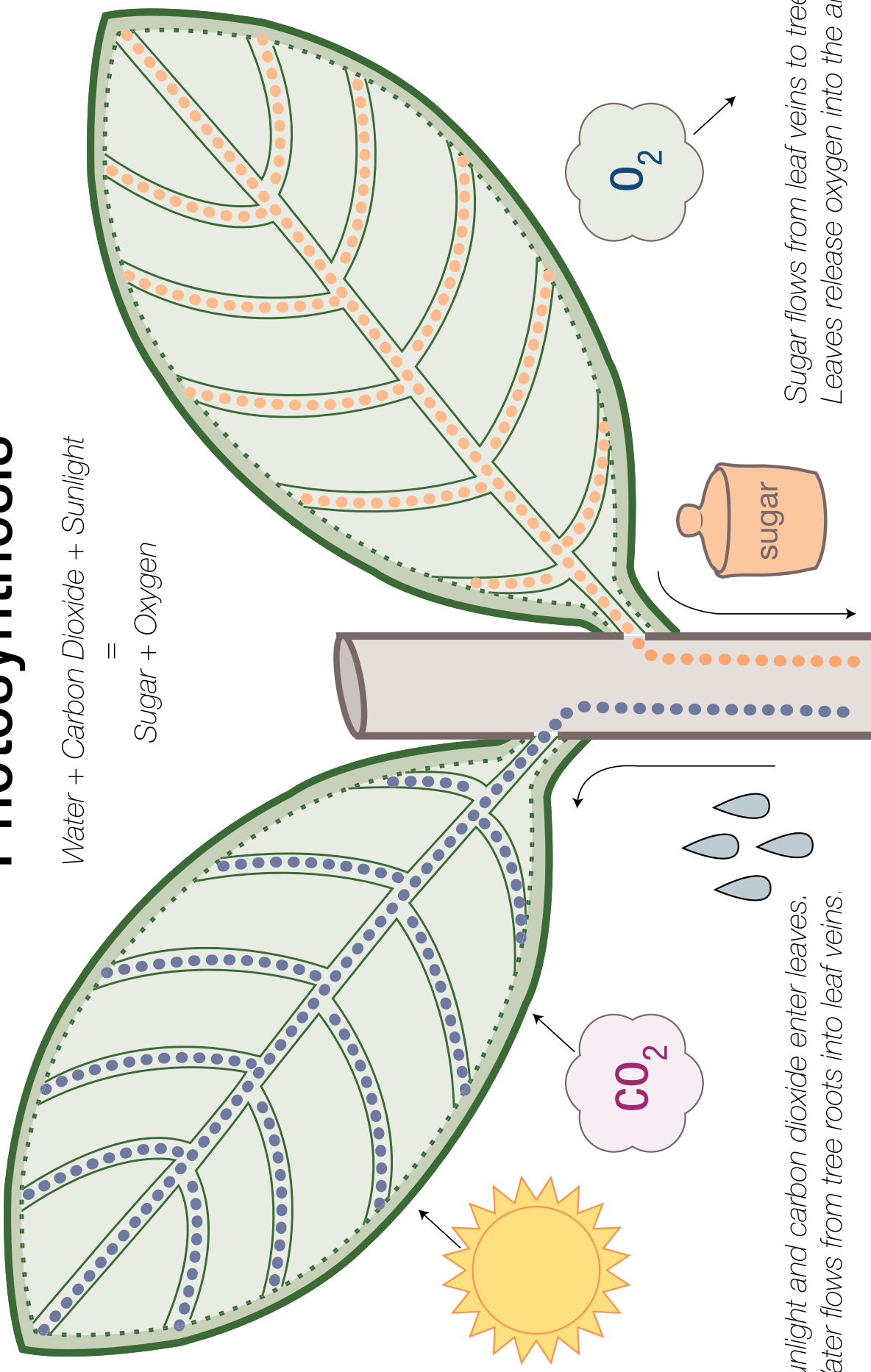
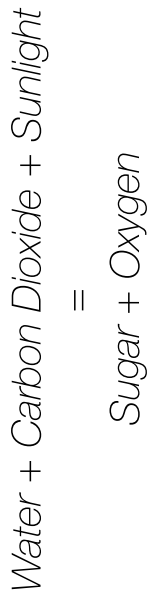
credits

Lesson developed and written by Catriona Gordon. Design by Lisa Rilko

Photosynthesis

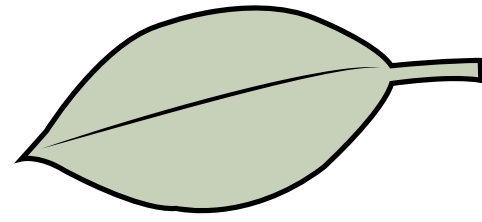


Photosynthesis

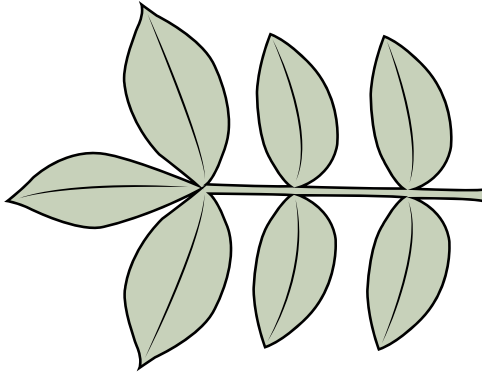


Sunlight and carbon dioxide enter leaves.
Water flows from tree roots into leaf veins.

Sugar flows from leaf veins to tree.
Leaves release oxygen into the air.



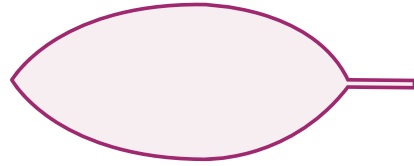
simple



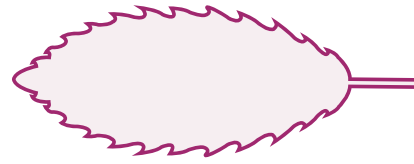
compound

Simple or Compound

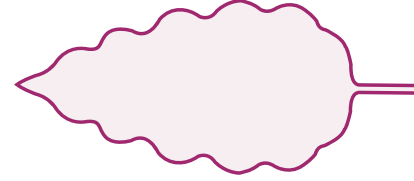
Margin



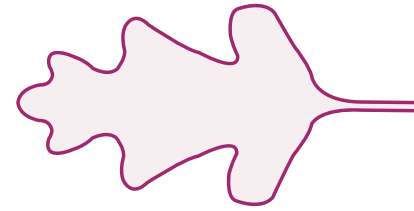
entire



toothed



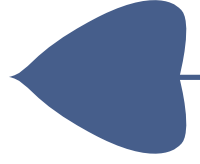
wavy



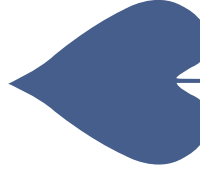
lobed



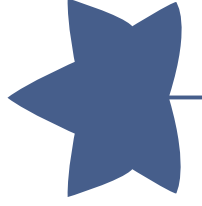
oval



triangular



heart-shaped



palmate



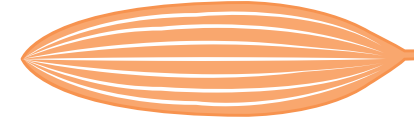
lanceolate



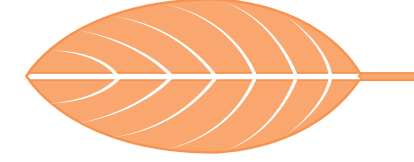
needles

Shape

Venation



parallel

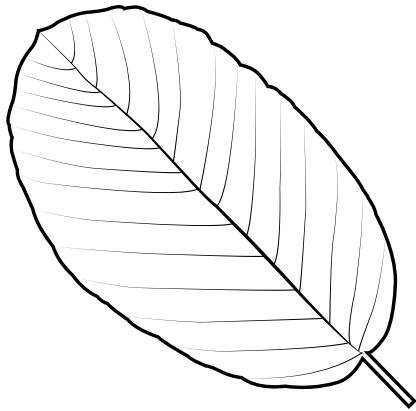


pinnate net

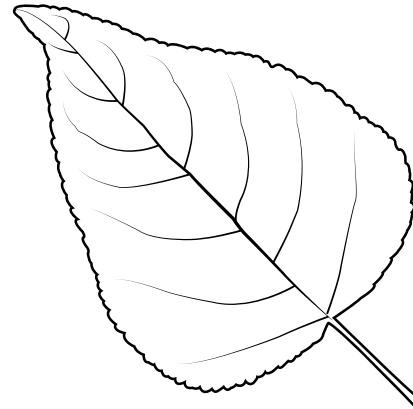


palmate net

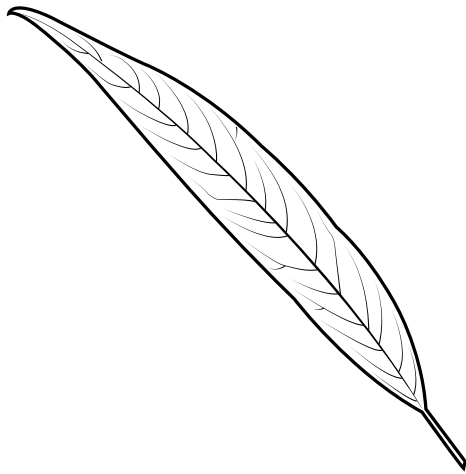
Leaf Types



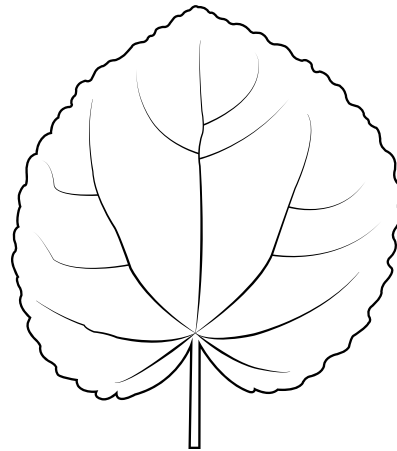
cascara



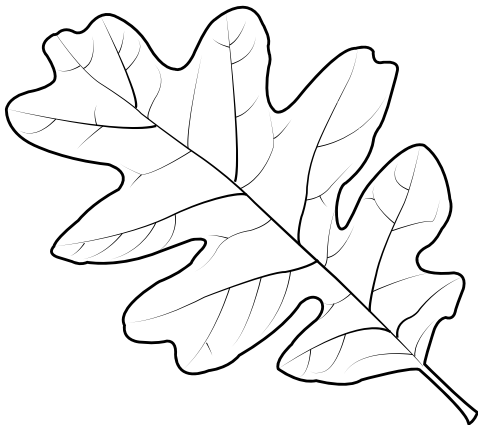
black cottonwood



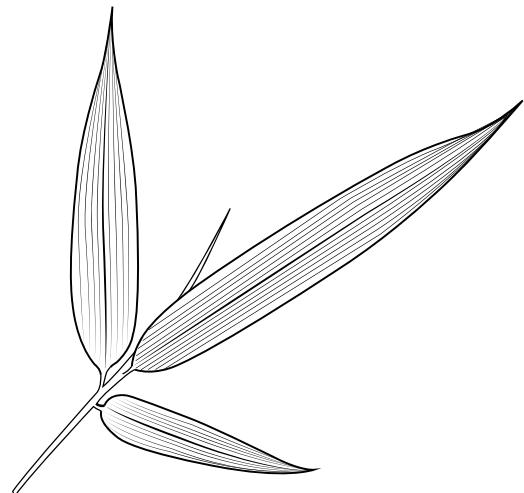
pacific willow



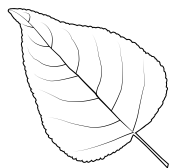
katsura



garry oak

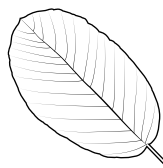


bamboo



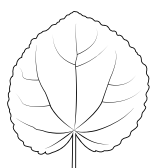
Black Cottonwood

simple or compound?	simple
shape	triangular
margin	toothed (very small, round teeth)
veins	pinnate net



Cascara

simple or compound?	simple
shape	oval
margin	entire
veins	pinnate net



Katsura

simple or compound?	simple
shape	heart-shaped
margin	wavy
veins	palmate net



Pacific Willow

simple or compound?	simple
shape	lanceolate
margin	entire
veins	pinnate net



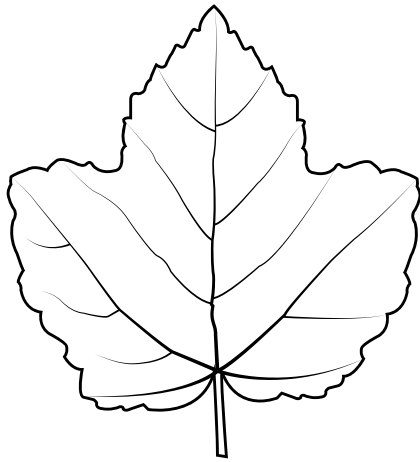
Bamboo

simple or compound?	compound
shape	lanceolate
margin	entire
veins	parallel

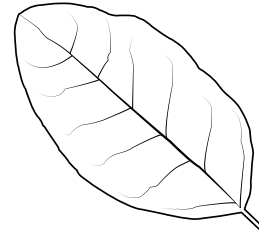


Garry Oak

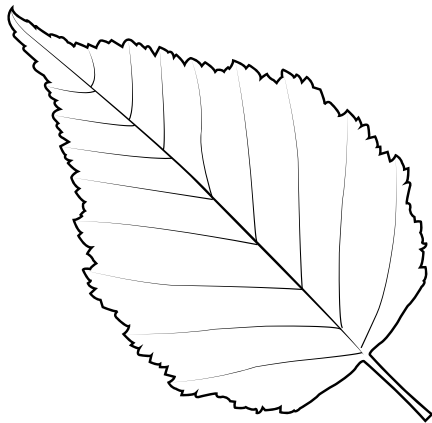
simple or compound?	simple
shape	
margin	lobed
veins	pinnate net



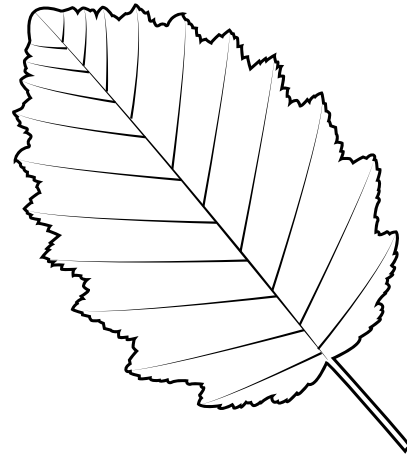
highbush cranberry



red huckleberry



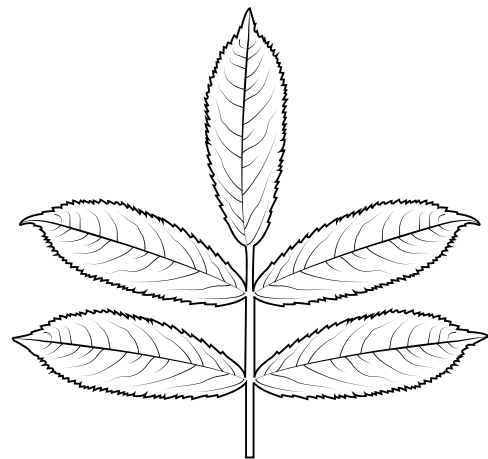
paper birch



red alder



pacific dogwood

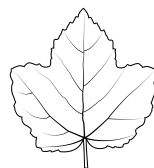


red elderberry



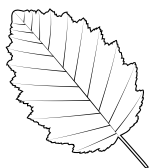
Red Huckleberry

simple or compound?	simple
shape	oval
margin	entire
veins	pinnate net



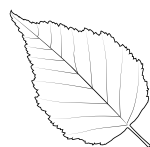
Highbush Cranberry

simple or compound?	simple
shape	palmate
margin	lobed <u>and</u> toothed
veins	palmate net



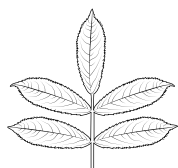
Red Alder

simple or compound?	simple
shape	oval (with a pointed tip)
margin	toothed
veins	pinnate net



Paper Birch

simple or compound?	simple
shape	triangular
margin	toothed
veins	pinnate net



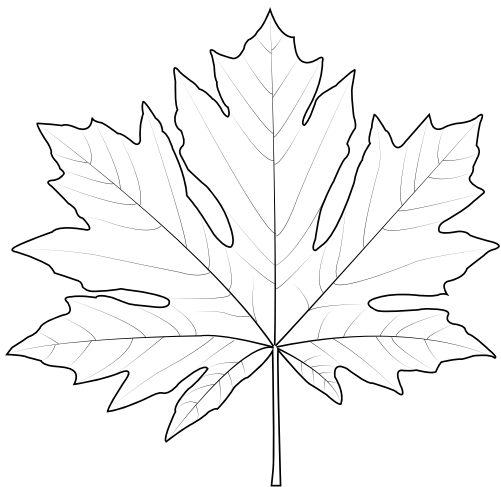
Red Elderberry

simple or compound?	compound
shape	lanceolate
margin	toothed
veins	pinnate net

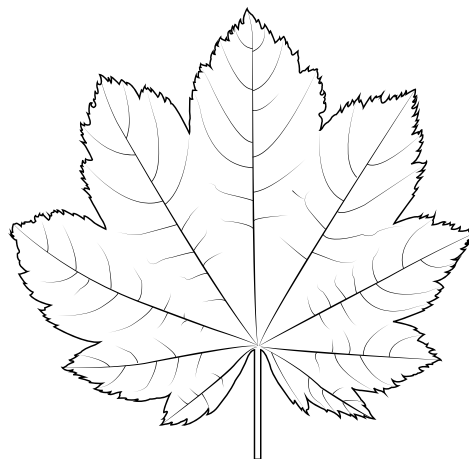


Pacific Dogwood

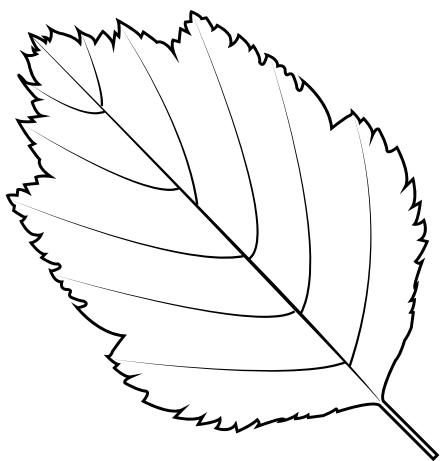
simple or compound?	simple
shape	oval (with a pointed tip)
margin	entire
veins	pinnate net



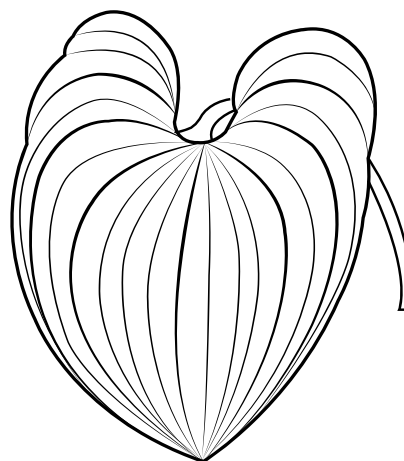
big leaf maple



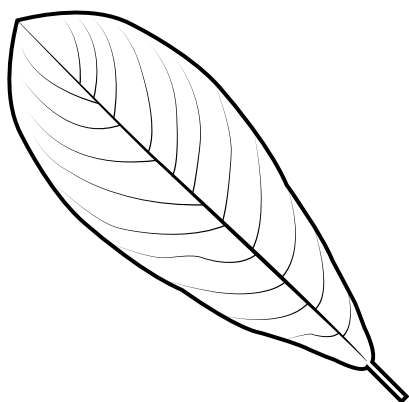
vine maple



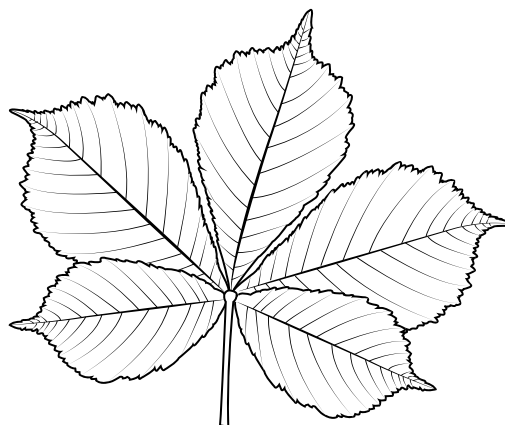
black hawthorn



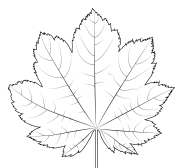
false lily-of-the-valley



sitka willow

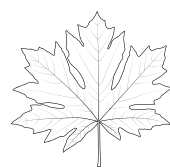


horse chestnut



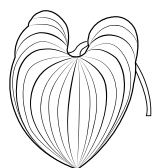
Vine Maple

simple or compound?	simple
shape	palmate
margin	lobed <u>and</u> toothed
veins	palmate net



Big Leaf Maple

simple or compound?	simple
shape	palmate
margin	lobed
veins	palmate net



False Lily-of-the-Valley

simple or compound?	simple
shape	heart-shaped
margin	entire
veins	parallel



Black Hawthorn

simple or compound?	simple
shape	oval
margin	lobed <u>and</u> toothed
veins	pinnate net



Horse Chestnut

simple or compound?	compound
shape	oval (with a pointed tip and a narrow base)
margin	toothed
veins	pinnate net



Sitka Willow

simple or compound?	simple
shape	oval (with a narrow base)
margin	entire
veins	pinnate net

name: _____

Leaf Types



Find leaves that match the leaf types in the chart below. Draw one leaf in each box.

simple	compound	parallel veins	net veins
needles	heart-shaped	palmate	lanceolate

Flowers and Pollinators

» adapted from the Scientist in Residence Program
www.scientistinresidence.ca

Grade K-7
Science, Math, Art
1 hour and 30 min.



information
for the
teacher



Photo credit: "Bee" by blathlean (via flickr), used under Creative Commons license 2.0 (CC-BY-2.0).

What are the basic parts of a flower? Petals are the brightly coloured modified leaves surrounding the reproductive parts of the flower. When still in bud, many flowers have sepals, which protect the petals and interior parts of the flower until they open. Inside the flower are the male (stamens) and female (pistil) reproductive parts of the plant.

What is pollination? In order for fruit and seeds to form, pollen from the male stamens must be transferred to the sticky stigma portion of the female pistil. This is called pollination, and may occur by insects, birds, bats, wind or water. The transfer of pollen to the pistil can occur in the same flower, but most often occurs between 2 different flowers of the same species (cross pollination). Once a pollen grain has landed on the stigma, it must grow a pollen tube down the shaft (style) of the pistil and reach the ovules in the ovary. This is where fertilization occurs as the pollen male sex cells reach the female sex cells in the ovule.

How do bees and other pollinators interact with flowers? Many flowering plants depend on pollinators such as bees to incidentally transfer pollen to the pistil. However, the true goal of the pollinator in visiting a flower is to obtain food in the form of nectar and pollen. Bees have long tongues that can reach the nectaries at the base of some flowers. They also have pollen baskets on their hind legs, which can facilitate transporting pollen back to the hive. The bumblebees' hairy bodies can also carry pollen. The European honeybee is the most common pollinator for commercial crop growers. These growers place a number of hives on their land when their crops are flowering to ensure pollination and fruit set.

Why is the bee population declining? Recently there has been a great decline in honeybees due to various causes, including the use of pesticides, loss of habitat, the varroa mite and poor nutrition. Scientists are still studying the causes of colony collapse disorder, a syndrome where up to 90% of an entire hive dies.

There are more than 350,000 flowering plant species (angiosperms) worldwide and these plants make up over 90% of all plants on earth. Flowers are the reproductive part of the plant, and help to ensure survival of the plant species. Many flowers are brightly coloured and shaped to attract potential pollinators and/or have sweet smells and nectar for further attraction.



Photo Credits (clockwise from top): "Pollen" by Niranjan Patil (outscribe on Flickr), CC-BY-2.0; "Orchard Mason Bee House" by born1945 (Flickr), CC-BY-2.0; "Osmia 4.19.08.w" by Beatriz Moisset (Wikimedia Commons), CC-BY-SA-3.0.

What kind of bees are native to BC? There are over 400 native bee species in B.C. including the orchard mason bee, a solitary blue bee that is a highly efficient pollinator. These bees lay their eggs in a small cavity or hole in trees or buildings. One can make orchard mason bee houses easily with a piece of drilled wood. Orchard farmers and gardeners are now installing bee houses for this native bee near their fruit trees and gardens to help with pollination.

In British Columbia it has been estimated that up to 40% of our food crops are pollinated by bees. Without them we would not have many food crops such as apples, strawberries, plums, beans, peas, etc. We depend on the bees for food for ourselves.

MATERIALS

- Locally sustainably grown flowers (one for each student) collected from a garden or purchased at a floral shop or grocery store.
 - » **Tips:** Lilies and tulips work very well. Flowers that are about to be thrown out work best, as they are very mature and one can see all the flower parts easily. Often shops will give them away free.
- Magnifying glasses
- Dissecting microscopes
- Sharp knife or razor blade (to be used by teacher only)
- Poster of the parts of a flower

OPTIONAL MATERIALS

If you'd like to discuss bees and pollinators with the students in greater depth, here are some suggested visual aids:

- Poster of a bee and its anatomy
- Bee puppet
- Orchard Mason bee house
- Photo of an orchard mason bee and a honey bee

LESSON

Introductory Discussion

- » Why do plants make flowers?
- » Why do bees need flowers? Do you think that the plants need the bees?
- » What are bees/hummingbirds/butterflies doing when they are inside a flower? What do bees eat?
- » How do plants reproduce or make new plants? Where do seeds form?
- » Have you ever looked carefully inside a flower? What did you see?

Using a flower poster and the vocabulary list below, go over the parts of a flower and their functions.

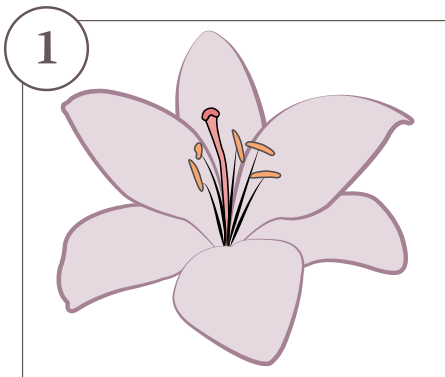
vocab

PARTS OF THE FLOWER

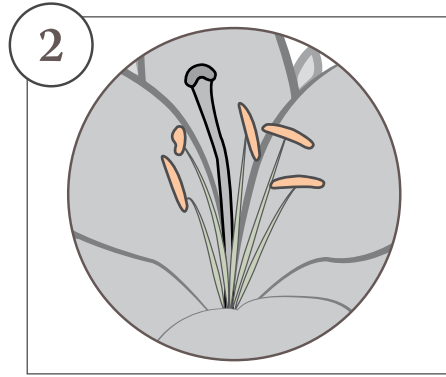
- Sepals** Modified leaves found at the base of flowers, which protect the flower bud until it has opened.
- Petals** Often brightly coloured modified leaves, which surround and protect the reproductive organs of the flower. Often their shape, colour, and nectaries attract pollinators.
- Stamens** Male organs containing pollen grains
- Anthers:** Part of the stamen which contains the pollen
- Filament:** Stalk of the stamen
- Pistil** Female organ of a flower, including the stigma, style and ovary
- Stigma:** The sticky tip of the pistil which acts as a landing pad for the pollen grains
- Style:** The stalk of the pistil, connecting the ovary with the stigma
- Ovary:** Found at the base of the pistil, it is the female reproductive organ containing one or more ovules. After fertilization the ovary will become the fruit with developing seeds inside.
- Ovule:** Contains eggs or female sex cells. Ovules are found inside the ovary. After fertilization, the ovule will develop into a seed.

GENERAL TERMS

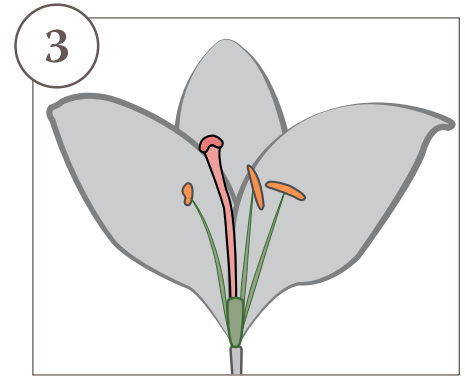
- Flower** Reproductive structure of angiosperm plants (flowering plants) usually with the male, female or both sets of sex organs, often surrounded by a brightly-coloured set of petals
- Pollen** Small grains or powder which contain the male sex cells, found on the anthers of the flower's stamen.
- Pollination** The transfer of pollen grains from the anthers (male) to the stigma (female) in the same or different flowers. Pollination can occur by wind, water, insects, birds or bats.
- Fruit** A developed flower ovary containing seeds. Botanical fruits include apples, oranges, cucumbers, beans etc, many of which are edible.
- Nectar** Flower juice produced by flowers in the nectaries (at the base of the petals), which is an important attractant and source of food for bees, hummingbirds, bats etc.



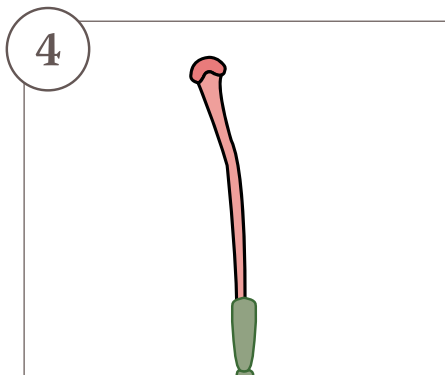
1. Petals and sepals. Give a flower to each student. Ask students to find all of the flower parts. Start with the sepals and petals. Count these and observe their colour, scent and texture.



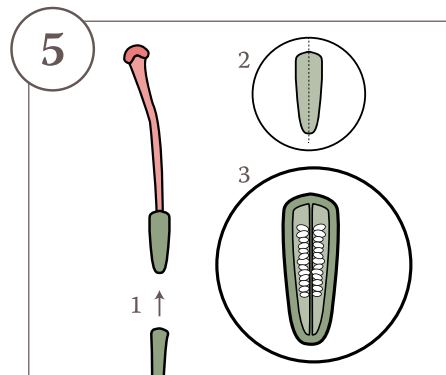
2. Stamens. Find the stamens that contain the pollen, often yellow, orange or black in colour. Count the stamens. Put your finger on the stamens and see if you can get dusty pollen from it. See if you can “paint” with the pollen.



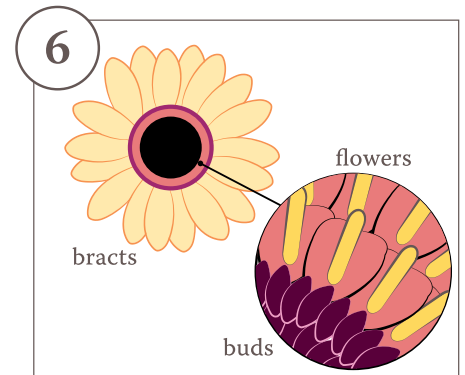
3. Cross-section. Pull off 1-2 petals and draw a cross-section of the flower showing all the parts.



4. Pistil and stigma. After drawing the flower, take off all the petals and stamens, so you are left with just the pistil. Touch the stigma (the sticky pad on top of the pistil, which receives the pollen). If the stigma is sticky then it is ripe and ready to receive a pollen grain.



5. Ovary and ovules. Pull the pistil off the flower. With the help of an adult, slice the pistil open with a knife and find the ovules or eggs. This is best seen on mature flowers. Look under a microscope at the ovules and the pollen grains. Try to look for a nectary (swelling at the base of a petal with droplets of nectar).



6. Compare different flowers. Look at a composite flower such as a sunflower or gerbera, which is made up of many tiny individual flowers, surrounded by bracts (that look like petals).

Compost the parts of your flower to make soil for the next generation of flowers!

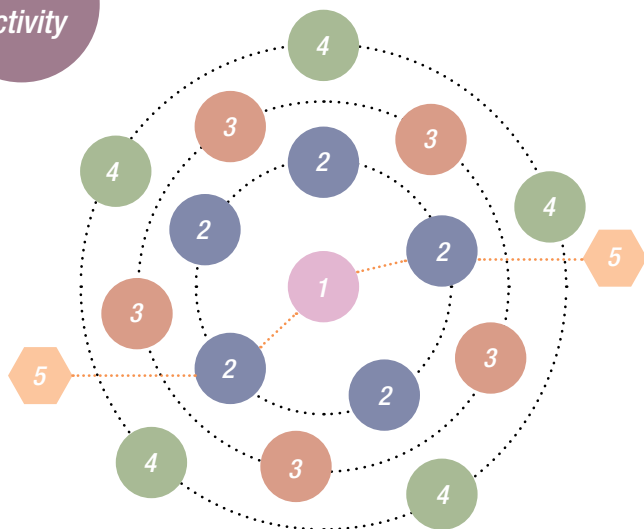
Try the acting activity on the next page if time remains, or simply move on to the closure discussion below.

Closure Discussion

- » Why do plants make flowers? What important job do the pollinators (bees) do?
- » Talk about local pollinators (honey bees, bumblebees, orchard mason bees, butterflies, flies, hummingbirds). Discuss the threats to bees and other important pollinators. What would the world be like without bees?
- » Can you think of any plants that use wind to pollinate? (cereal crops, grass, wheat, corn, rice) Can you think of stinky plants and what may pollinate them?
- » Try to go out to your schoolyard, neighbourhood or community garden and see pollination in action! Check inside a flower and look for honey bees, orchard mason bees or other bees hard at work. Bees can visit up to 2000 flowers a day! That’s a lot of flying around.

Additional Info and Resources

bonus activity



If time allows, act out the parts of a flower on the carpet:

1. Choose one student to be the **pistil**. This student will stand in the center with hands placed on head like a sticky **stigma**.
2. Choose 5 students to be **stamens**. They will stand around the **pistil**, facing outward, with their hands in the air, gently waving them
3. Choose 5-7 students to be **petals**. They will hold hands, facing inward and protect the **stamens** and **pistil** in the center.
4. Choose 5-7 students to be **sepals**. They will encircle the **petals** to protect the flower
5. Choose 1-2 students to be **bees**. They will come and buzz over to visit the flower, collect pollen from the **stamens** and deposit some on the **stigma** (head of the **pistil**). A bee puppet is useful, or a picture of a bee cut out and stuck on a stick or ruler.
6. The **sepals**, **petals**, and **stamens** fall away (fall down on the carpet, leaving only the **pistil**, which will develop into a fruit, disperse its seeds and grow into a new plant.

references & resources

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Helbrough, Emma. 2006. *How Flowers Grow*. Usborne Publishers. London.

Heller, Ruth. 1983. *The Reason For a Flower*. Grosset and Dunlap. New York.

Petersen, Christine. 2009. *Flowers*. Cherry Lake Publishers, Ann Arbor, Mich.

Rene, Ellen. 2009. *Investigating How Flowers Grow: Science Detectives Series*. PowerKids Press. New York.

Spilsbury, Louise. 2006. *Why Do Plants Have Flowers?* Heinemann Publishers. Chicago.

DVD *All About Plant Pollination, Fruit, Flowers and Seeds*. 2006. Schlessinger Media. Wynnewood, Pennsylvania. 23 minutes

ONLINE • Canada Agriculture Museum. **Bees: A Honey of an Idea**. Agricultural website on importance of bees with some great photos.

» The interactive web page: <http://www.agriculture.technomuses.ca/english/bees/>

» Vocabulary and fact sheet about bees: http://www.agriculture.technomuses.ca/english/schoolprograms/agpdf/EAKit_busy_bees/busy_bee_eakit_part8.pdf

• **Orchard Mason Bees**. BC Agriculture Website: http://www.agf.gov.bc.ca/apiculture/factsheets/506_osmia.htm

• Pennsylvania State University Agricultural Sciences. **Information on How to Build an Orchard Mason Bee House**: <http://extension.psu.edu/lawrence/news/2011/how-to-construct-a-sturdy-all-wood-mason-bee-house>

extensions

• Make your own paper flower with all the parts.

• Do a bee dance to tell your friends where there is bee food: <http://sciencenetlinks.com/media/filer/2011/09/27/tf-snl-dances-with-bees.pdf>

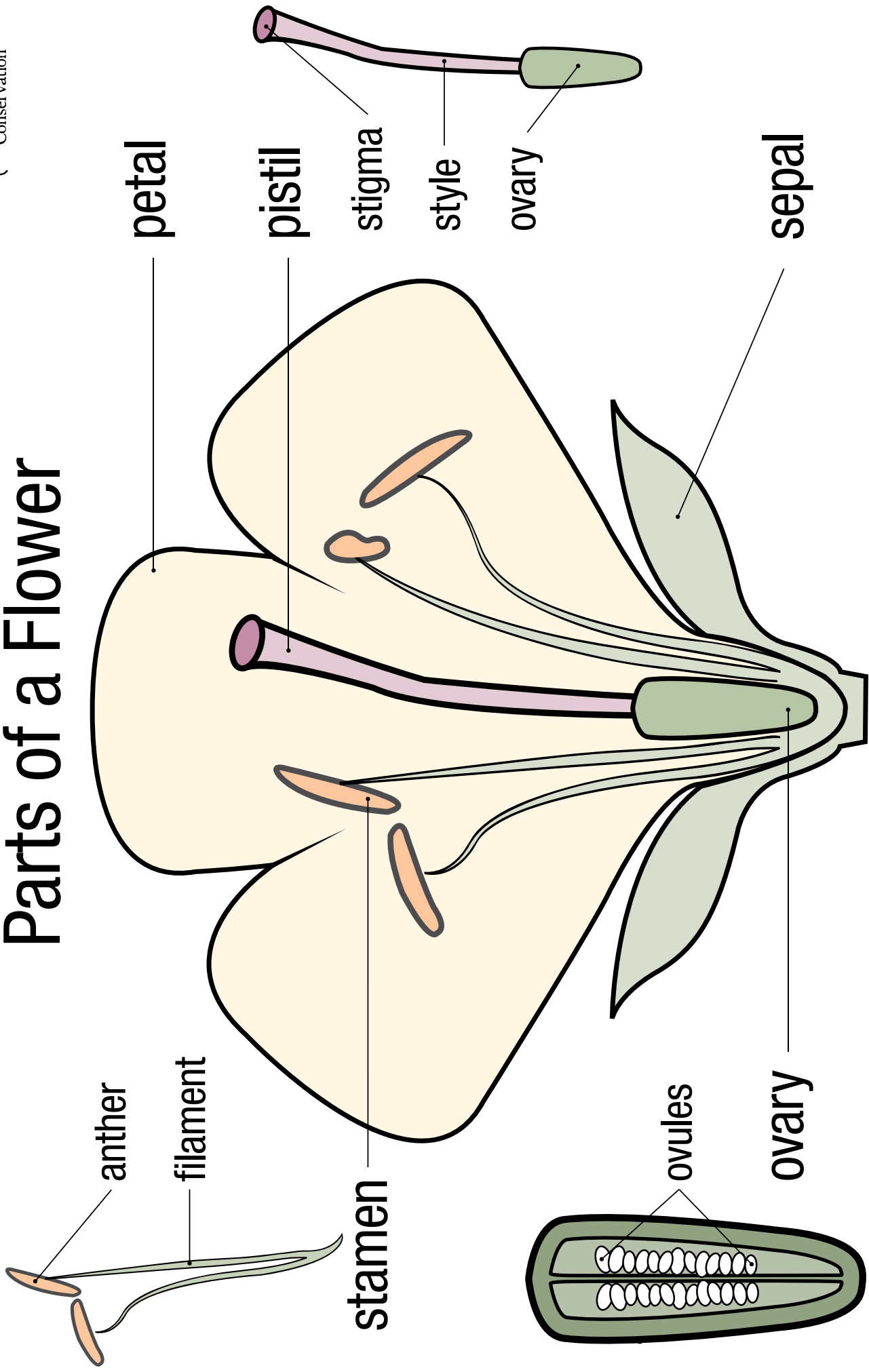
• Go on a flower/pollinator hunt in the neighbourhood or schoolyard, in the spring or early fall.

• Build an orchard mason bee house with a pop bottle, pvc pipe or milk carton: http://lifecyclesproject.ca/resources/downloads/home_for_bees.pdf

credits

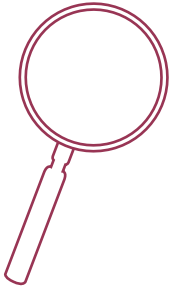
This lesson was adapted from the Scientist in Residence Program: www.scientistinresidence.ca. Lesson developed and written by Catriona Gordon. Design by Lisa Rilko.

Parts of a Flower



Parts of My Flower

name: _____



Look at the flower picture.

Write the name of each flower part.

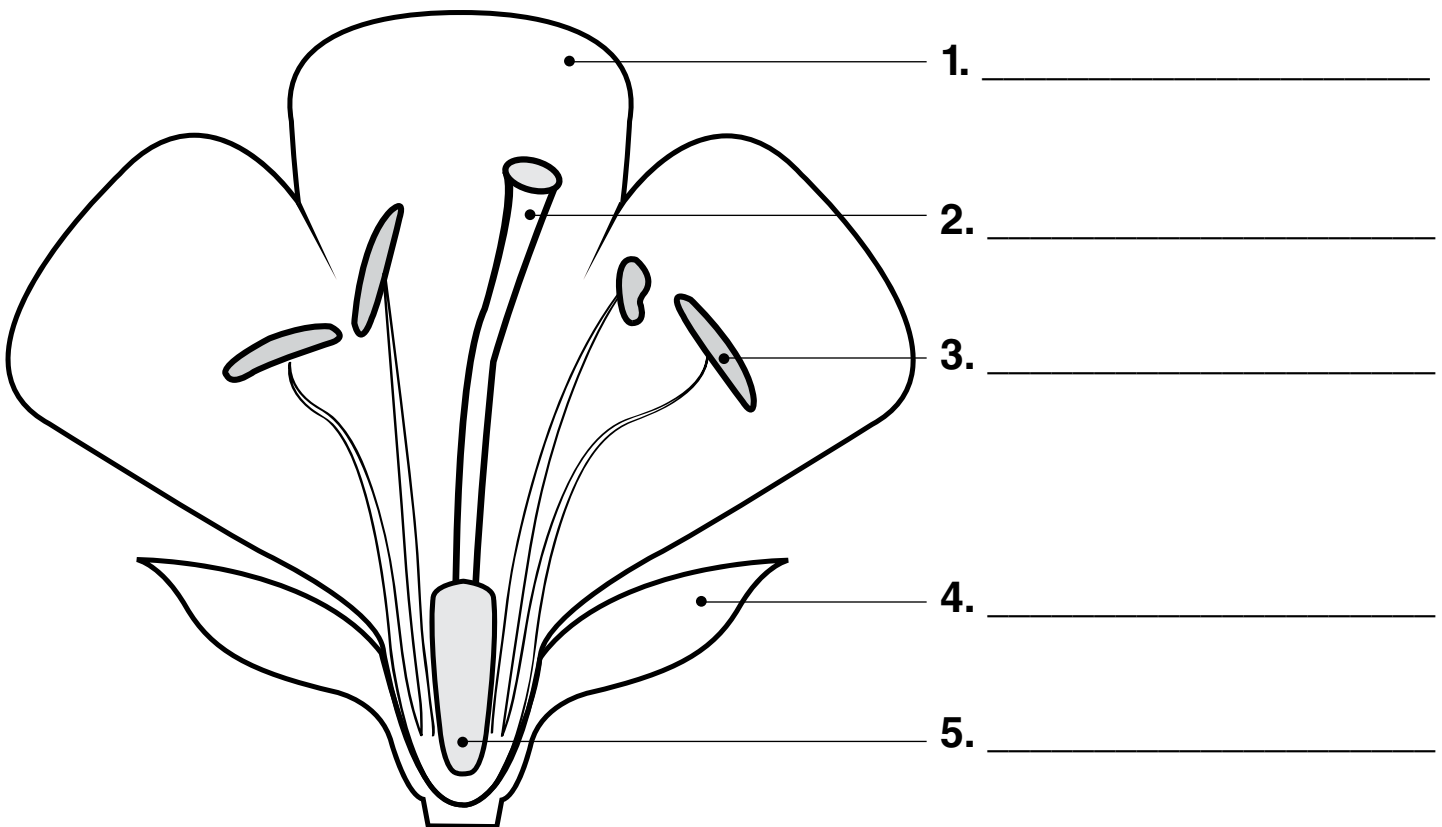
ovary

petal

pistil

sepal

stamen





Draw and label your flower. Use these words:

petal

stamen

pistil

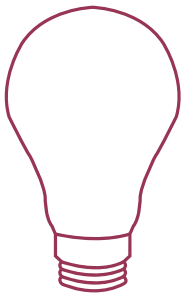
ovary

sepal

pollen

stigma

ovules



Where is the pollen found?

_____.

What forms in the ovary?

_____.

Name four pollinators:

_____.

Insects in the Garden

Grade K to 7
Science, Math, Art
1 hour and 15 min.



information for the teacher



Photo Credit: "Ladybug" by Antonio Picascia (supersum (off) on Flickr), used under Creative Commons license 2.0 (CC-BY-2.0).

Gardeners and farmers depend on insects for pollination, fruit production, recycling and pest control. We would be lost without insects! We call these insects beneficial to humans. However, there are also a handful of insects, which eat or damage our crops or ornamental plants and we could do without those ones! These we call the harmful or pest insects.

What do insects look like? An insect is a small organism with 6 jointed legs, 3 body parts (head, thorax and abdomen), a set of antennae for sensing, smelling and communicating, compound eyes and an exoskeleton which provides rigidity, strength and protection. Over the course of their life, they shed their exoskeletons several times when they outgrow them, much like a snake skin. Insects lack lungs and breathe through small holes in their abdomen called spiracles. Many insects have 2 sets of wings, although in some species wings are completely lacking. Insects have compound eyes, with many lenses, which make trying to catch a fly very difficult!

What is the life cycle of an insect? Most insects start as eggs, and develop into different stages until they become adults via complete or incomplete metamorphosis. When young look the same as adults, they are called nymphs (such as grasshoppers), and when immature insects look completely different from their adult form, they are often called larvae (such as beetles). Some larval forms must go through a pupa, or resting stage where they are transformed by metamorphosis into an adult form (such as a caterpillar turning into a chrysalid and then into a butterfly).

vocab

INSECT BASICS

- Invertebrate** An animal without a backbone
- Insect** A small class of invertebrates with 6 legs, 3 body parts, and an exoskeleton
- Arthropod** An animal which belongs to the Phylum Arthropoda (including insects) with jointed legs and a segmented body (eg. centipedes, grasshoppers, butterflies)
- Pollinator** An organism (often an insect) which carries pollen from one flower to another
- Beneficial Insect** Any number of insect species, which provide humans with valuable services such as pollination or pest control
- Harmful Insect** Any number of insect species that damage agricultural or garden plants/trees
- Entomologist** A scientist who studies insects
- Pooter** A scientific tool used to collect small insects or crustaceans without harming them

INSECT ANATOMY & DEVELOPMENT

- Compound Eye** The eye of an insect or crustacean composed of many lenses
- Thorax** The part of an animal's body between the head and the abdomen
- Abdomen** The third body part of an insect, furthest away from the head, containing many organs
- Larva** Immature, active form of insect, stage between egg and pupa
- Pupa** A resting, immature form of insect, stage between egg or larva and adult
- Metamorphosis** A major developmental change in insects (and other organisms) from an immature to a mature form in two or more stages

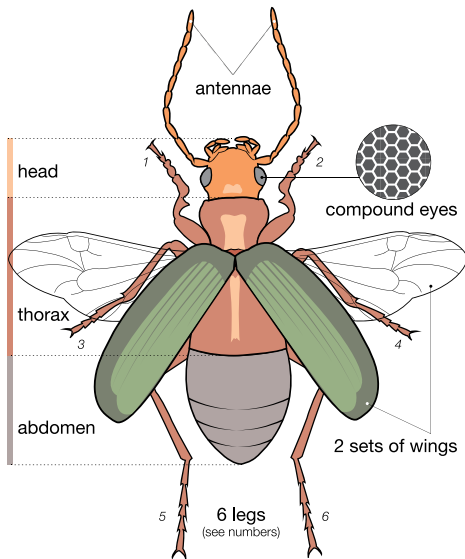
MATERIALS

- “Insects” visual
 - “What Makes an Insect an Insect” visual
 - “Life Stages of Insects” visual
 - “Parts of an Insect” visual
- Insect-catching tools (pooter, white sheet, and plastic cups) to show to students

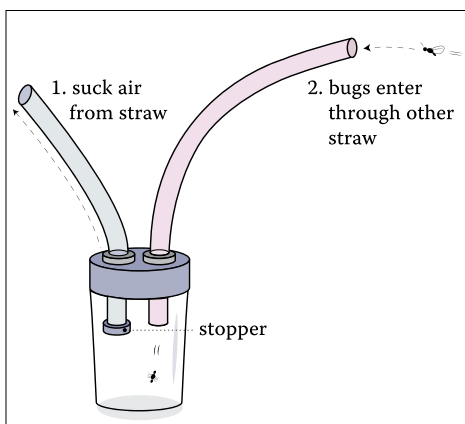
LESSON

Introductory Discussion

1. Show students the unlabelled “Insects” visual. Elicit from students what kind of insect it is (beetle). Ask: What makes an insect an insect? Encourage students to brainstorm 8 things.
2. Once the students have finished their guesswork, show them the “What Makes an Insect an Insect” visual. (Please note that spiracles are holes in the insects’ sides for breathing, and that **not all insects** have 2 sets of wings).
3. Ask students: What is metamorphosis? How does an insect grow up into an adult? Show students the “Life Stages of Insects” visual. Explain the difference between complete and incomplete metamorphosis (see page 1 for details).
4. Once again, show the students the unlabelled “Insect” visual. Ask students to call out 7 body parts (eg. legs, wings, thorax). Show students the “Parts of an Insect” visual to check answers.
5. What insects are beneficial or useful to us? What do they do for us? (pollination, pest control, recycling). Are some insects harmful to us, our gardens, or our plants? Which ones? We will go on an insect hunt and bring some tools to catch them, have a good look at them and then release them, without harming them.

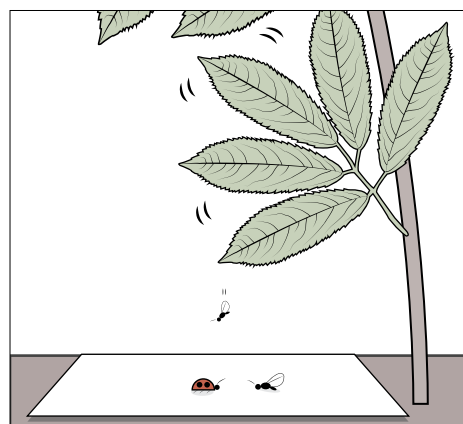


WAYS TO OBSERVE INSECTS



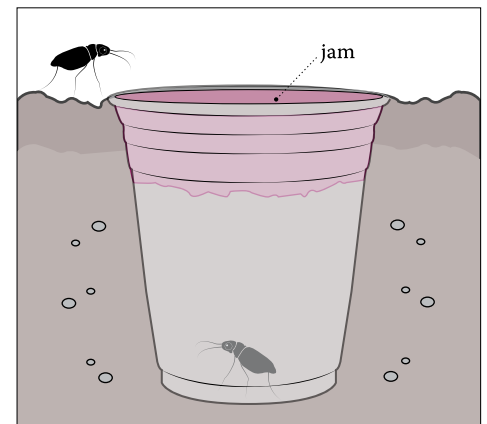
POOTER

Some entomologists (insect scientists) use pooters to catch small insects. Show students what they look like and how to use one, using the short hose to suck and the long hose to “suck up” the insect. Show them the stopper on the short hose, which ensures that no one will swallow a bug by accident



SHAKE AND DROP

Other entomologists go to bushes or plants and put a piece of old sheet or white paper below the branches and then give the branches a firm shake. Many small insects will drop onto the sheet/paper and then pooters or bug jars can be used to collect and study them.



PITFALL TRAPS

Set plastic cups into the ground so the top of the cup is level with the top of the soil, and smear the inside top of the cup with a layer of jam or peanut butter. Leave overnight. This pit trap will attract beetles and other insects. They try and reach the jam or peanut butter and fall into the cup, unharmed. Collect the insects, have a close look for identification and then release.

Part 2 Collecting Insects

Distinguish between beneficial and harmful insects and explore organic pest control methods.



MATERIALS

- Pooters
- Magnifying glasses
- Dissecting microscopes
- Large white paper, sheets or old white pillowcases
- Petri dishes or bug jars
- Large plastic cups (for pitfall traps)
- Jam or peanut butter (for pitfall traps)
- Insect field guides or identification books
- “Garden Insects” handout (photocopied in colour, if possible)
- “How to Control Pests” visual

PREPARATION

- Prior to the lesson, find an outdoor area where you can take the students to look for insects
- If possible, set up some pitfall traps (see bottom of page 2 for a description) in your chosen outdoor area the afternoon before the lesson
- Idea: colour copy and laminate a class set of the “Garden Insects” handout, and use this set in future classes.

NOTE

This activity is best done in early fall or late spring.

LESSON

1. Collect Insects. Go on a bug hunt around the school, in the school garden, park, or down the back lanes – any naturalized area. Bring tools including pooters, white sheets or paper, bug jars and/or petri dishes. If you are able, then set out some pitfall traps the afternoon before. Use identification guides or online resources to identify your insects. Try to categorize them as beneficial or harmful. (Remember, most insects are not harmful!)

2. If your school has a garden, check it for insects. Remember to look both on the top and the underside of the leaves. Check fruit trees if your school has an orchard. Try to identify whether your garden insect is harmful or beneficial. If you have an infestation of pest insects (make sure you have identified them correctly) try some organic pest control methods listed on the next page.

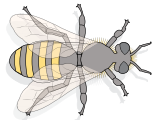
3. Introduce organic pest control methods. Put students in groups and show them the “How to Control Pests” visual. Alternately, you can bring in and show some real pest control objects (eg. garlic, sticky traps, etc.). Ask groups to discuss and guess how each object helps to control pests. Go over the answers (see next page) as a class.

Closure Discussion

What important jobs do insects do for us? What would our world look like without insects? How can we help conserve the insects that are beneficial or not harmful? (Habitat conservation, planting more plants, trees, bushes).

A GUIDE TO GARDEN INSECTS

BENEFICIAL INSECTS



bees
pollinators



butterflies
pollinators



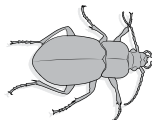
ladybugs
eat aphids; pest control



hoverflies
pollinators and pest control



green lacewing
eat thrips; pest control



ground beetles
predators; pest control

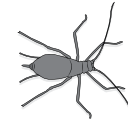


parasitoid wasps
parasitic on many different pests, including cabbage loopers, etc.

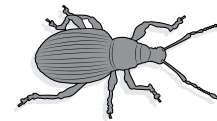


spiders
(not insects)
predators; pest control

HARMFUL INSECTS



aphids
suck plant sap



black vine weevil
adults feed on leaves and larvae feed on roots



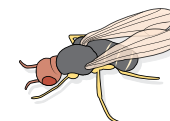
whiteflies
feed on leaves



cutworms
actually moth larvae; feed on plants, especially young stems of seedlings, cutting them down



cabbage loopers
voracious leaf eaters



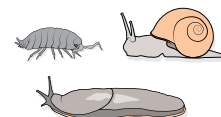
carrot rust fly
larvae burrow into carrots and other crops, eating the roots



root maggots
feed on roots of many garden crops



codling moths
also known as the apple worm; larvae feed on apples



slugs, snails, woodlice
(not insects)
feed on tender new growth of plants

Additional Info and Resources

PEST CONTROL

a guide to organic methods

Physical removal: Pick off or squish insects between your fingers. This works well for cabbage loopers, aphids, and other caterpillars.

Sticky traps: Sticky yellow plastic cards, non poisonous, insects are attracted by the colour and/or scent, then get trapped by the glue. Sticky traps can be purchased at a garden center. These are useful with whitefly, aphids, codling moths.

Companion Planting: Growing specific plants/crops together to ward off harmful pests, particularly those larvae that feed on roots (eg. garlic and marigolds), or to attract beneficial insects that will feast on the harmful pests (eg. fennel attracts ladybugs that eat aphids). See Garden Design lesson for more information on companion planting.

Water spray: Get out the hose and blast those insects! This works for some aphids, whiteflies and thrips.

Biocontrol: Use other insects/organisms such as ladybugs, predatory nematodes, or BTK (Bacterial insecticide *Bacillus thuringiensis* variety *kurstaki*). Biocontrol organisms can be purchased at a garden center at specific times of the year. Check with a pest specialist.

Garlic spray: Make a garlic spray with 6 cloves of crushed garlic, steeped in boiling water. Let sit overnight, and then spray on plants. If you need more strength add crushed chili peppers, a few drops of vegetable oil or a few drops of dish soap in your mixture.

references & resources

BOOKS

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Elmhirst, Janice Ferne. 2008. *Garden Bugs of British Columbia: Gardening to Attract, Repel and Control*. Lone Pine Publishing, Edmonton.

Olkowski, William, Sheila Daar and Helga Olkowski. 1991. *Common Sense Pest Control*. Taunton Press, Newtown CT.

Zim, Herbert S. 2001. *Insects: A Guide to Familiar American Insects*. St. Martin's Press, New York.

ONLINE

University of Illinois Extension Integrated Pest Management Insect Fact Sheets

<http://ipm.illinois.edu/insects.html>

“Garden Bugs: Friend or Foe?” Vancouver Sun article by Steve Whysall

<http://www.vancouversun.com/life/Garden+bugs+Friend/6569570/story.html>

The Bug Lady website – info on good and bad insects, as well as natural pest control methods

<http://thebuglady.ca/>

BugFacts.net – illustrated insect identification and information tool

<http://www.bugfacts.net/insects.php>

InsectIdentification.org

<http://insectidentification.org/>

Biodiversity in Your Backyard classroom activities – first activity is “Making a Pooter”

<http://www.w5online.co.uk/fs/doc/EducResource/biodiversity%20in%20your%20Backyard/Classroom%20activities%20for%20CPD%20day.pdf>

“Make your own insect pooter!” webpage

http://www.bugsed.com/fact_sheets/make_own_pooter.html

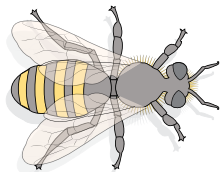
- Build your own insect with three body parts, 6 jointed legs, antennae etc. using cardboard, pipe cleaners, modeling clay etc. Design the mouthparts, to reflect what and how your insect eats.
- Make garlic spray (instructions above) as an insect repellent and try it out on an aphid infestation in the garden!

extensions

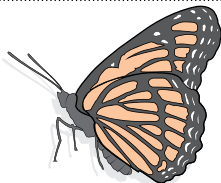
credits

Lesson developed and written by Catriona Gordon. Design by Lisa Rilkoﬀ.

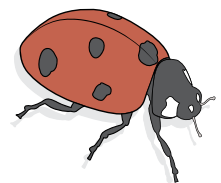
Beneficial Insects *(good for the garden)*



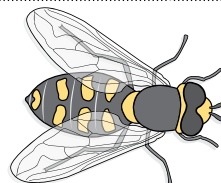
bees
pollinators



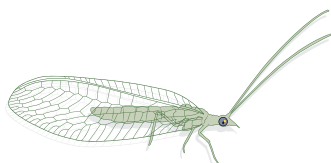
butterflies
pollinators



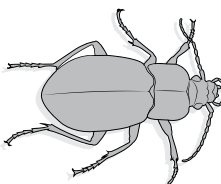
ladybugs
eat aphids; pest control



hoverflies
pollinators and pest control



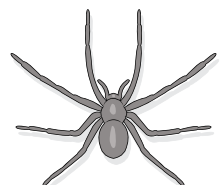
green lacewing
eat thrips; pest control



ground beetles
predators; pest control

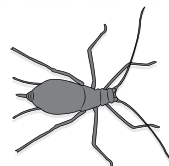


parasitoid wasps
parasitic on many different agricultural pests, including cabbage loopers, etc.

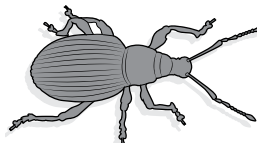


spiders (not insects)
predators; pest control

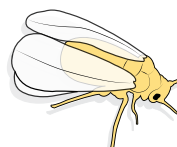
Harmful Insects *(bad for the garden)*



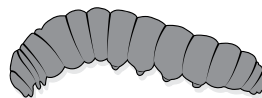
aphids
suck plant sap



black vine weevil
adults feed on leaves and larvae feed on roots



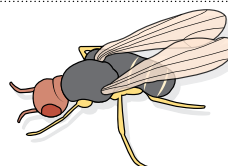
whiteflies
feed on leaves



cutworms
actually moth larvae; feed on plants, especially young stems of seedlings, cutting them down



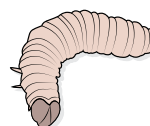
cabbage loopers
voracious leaf eaters



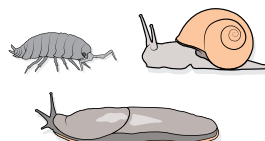
carrot rust fly
larvae burrow into carrots and other crops, eating the roots



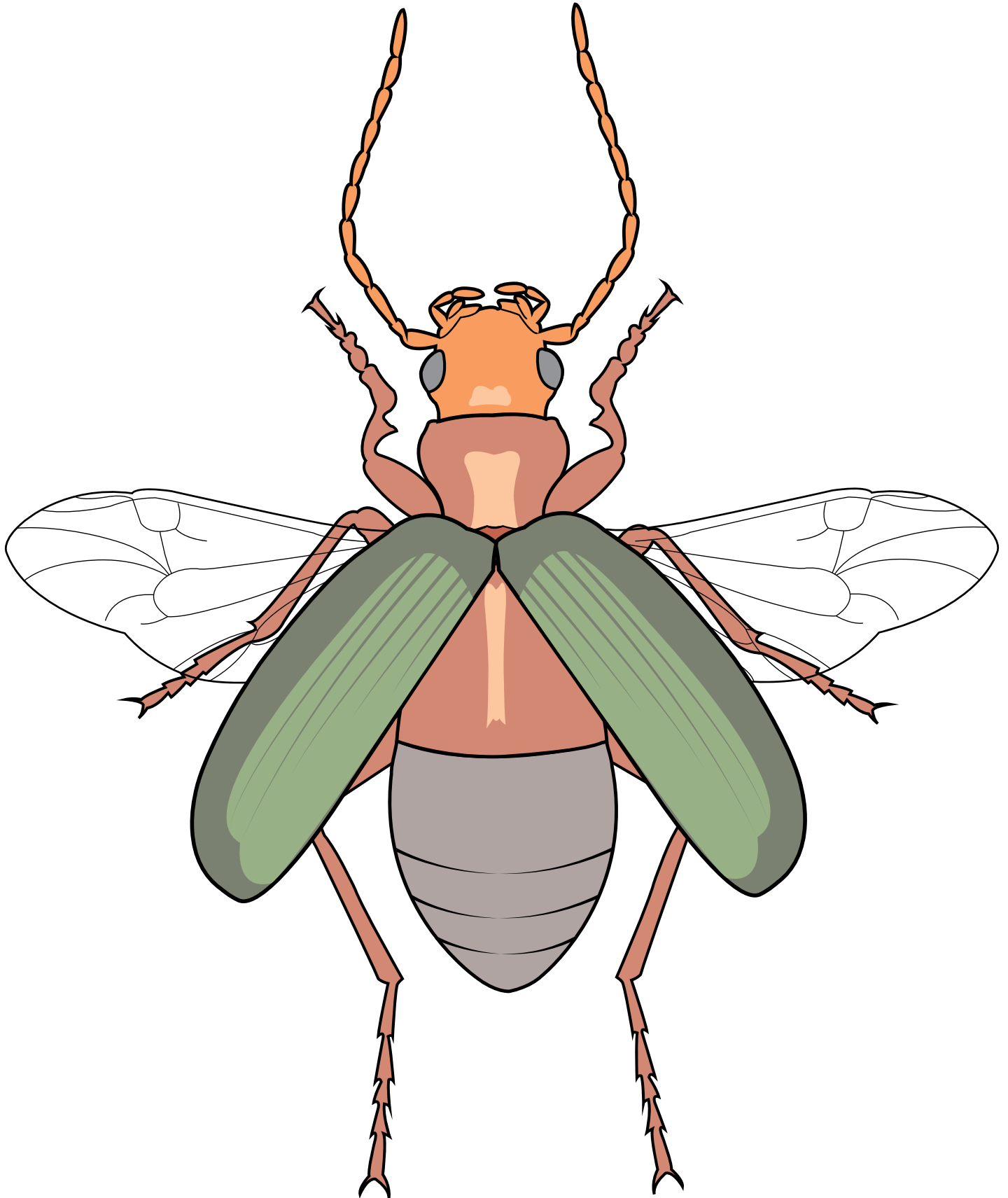
root maggots
feed on roots of many garden crops



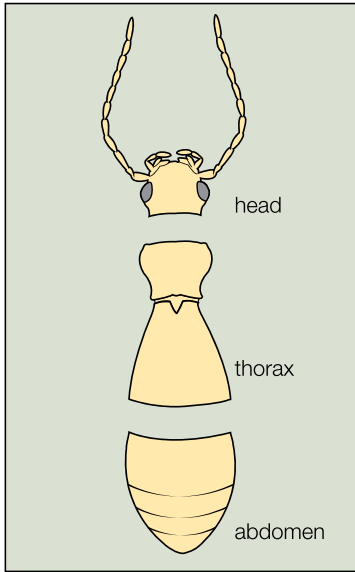
codling moths
also known as the apple worm; larvae feed on apples



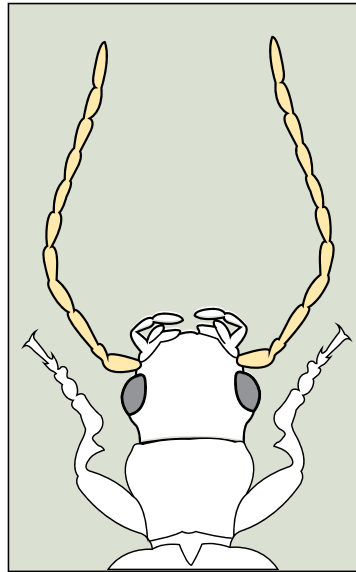
slugs, snails, woodlice (not insects)
feed on tender new growth of plants



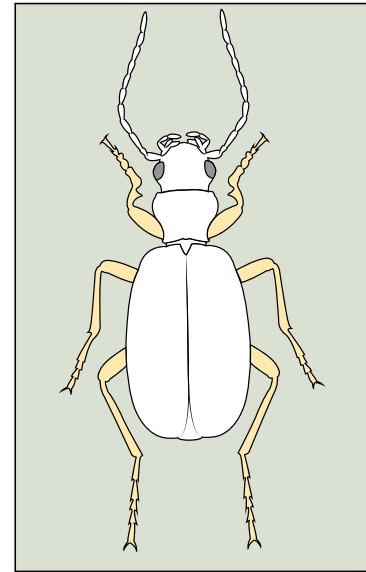
What makes an insect an insect?



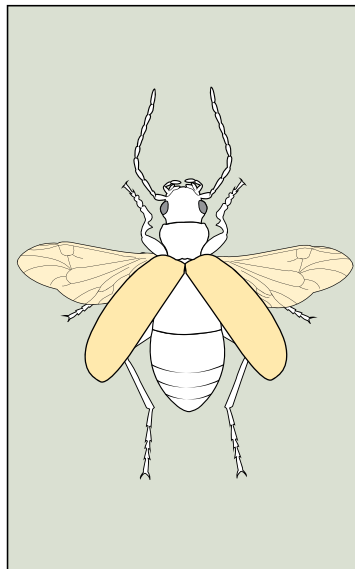
3 body parts



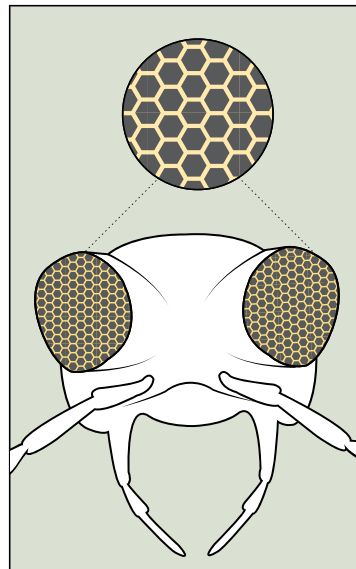
antennae



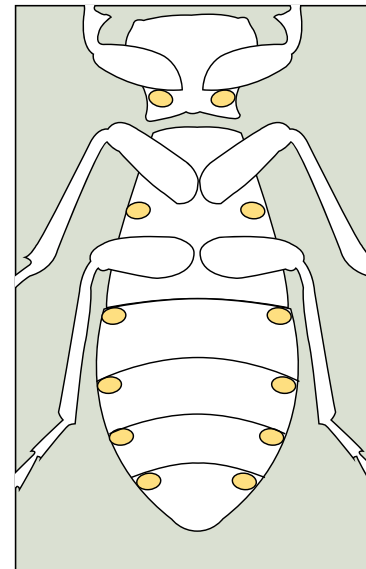
6 jointed legs



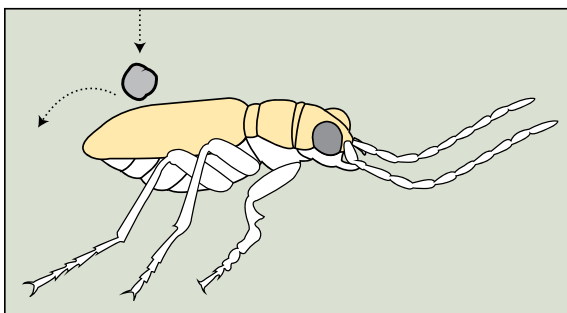
2 sets of wings



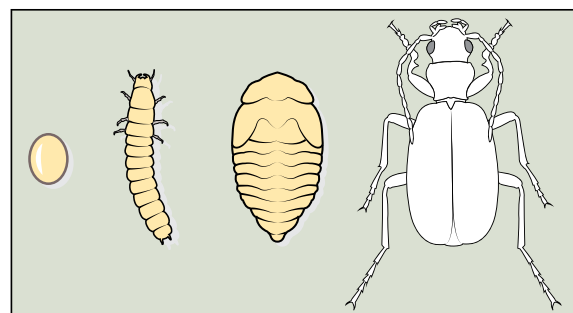
compound eyes



spiracles

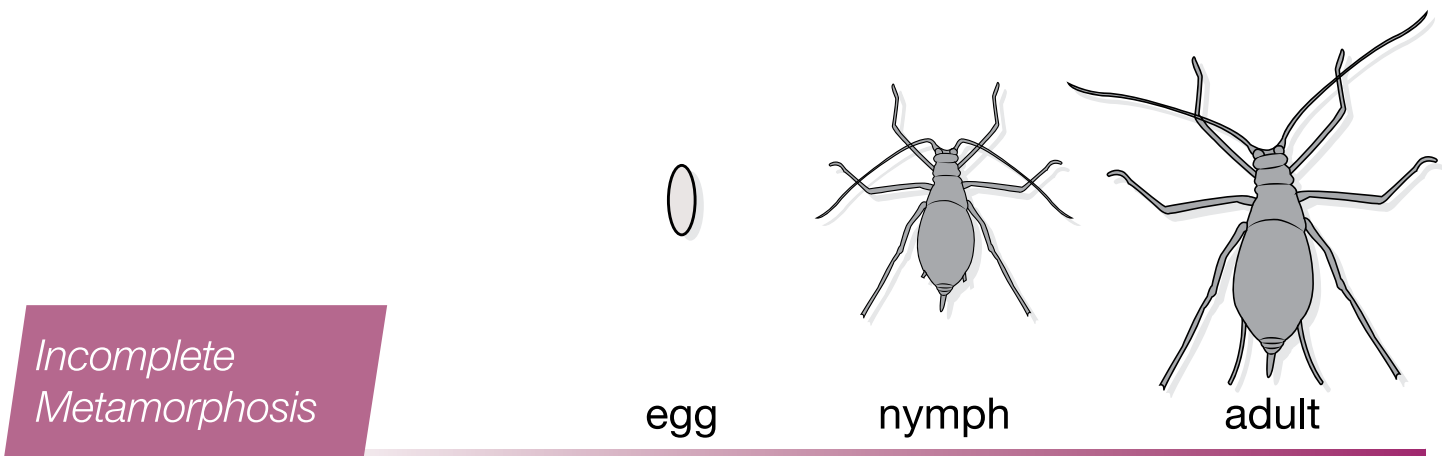
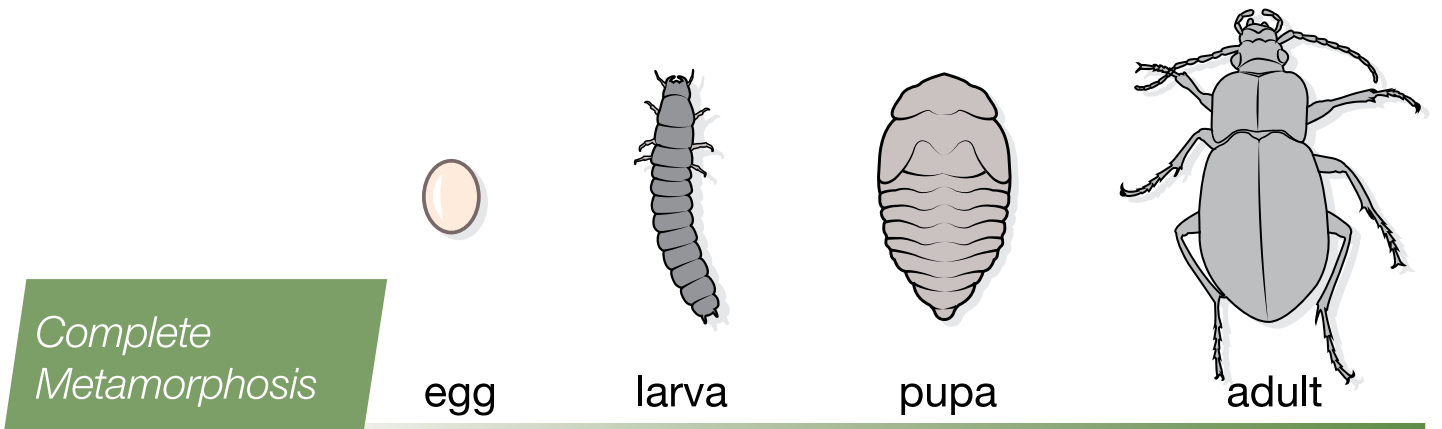


exoskeleton

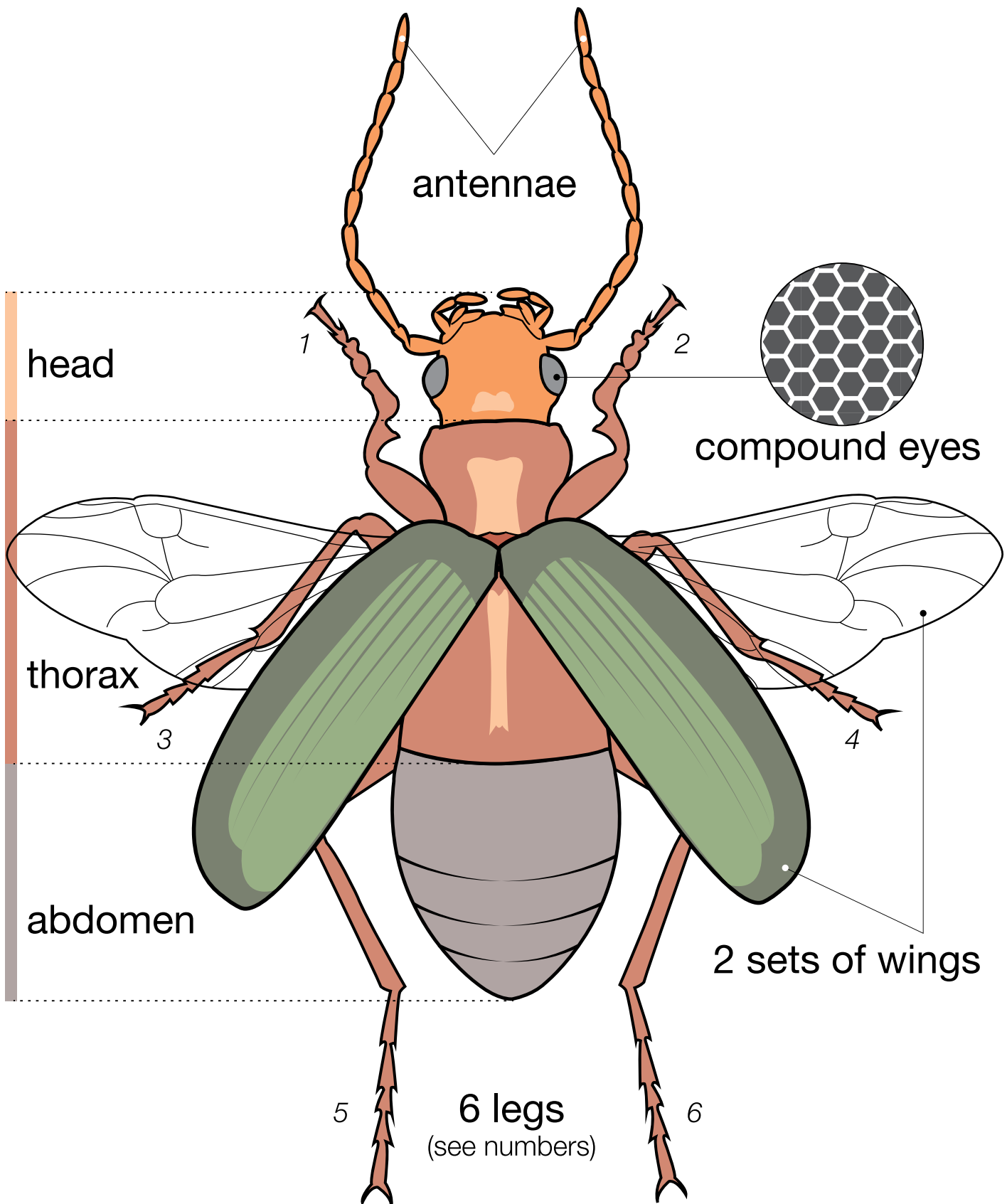


metamorphosis

What is metamorphosis?

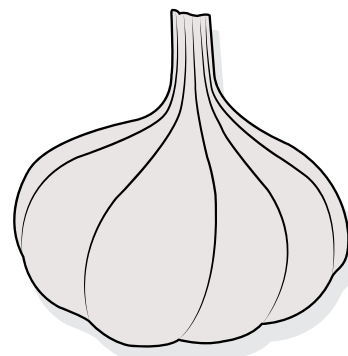
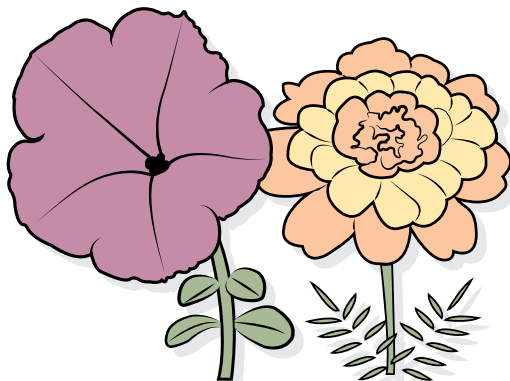
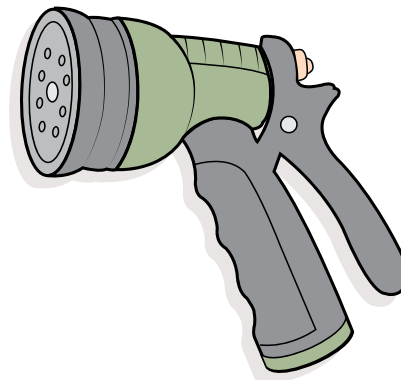
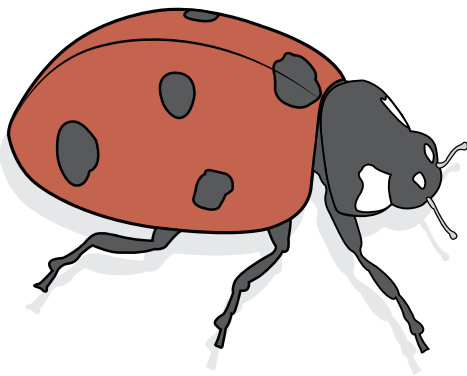
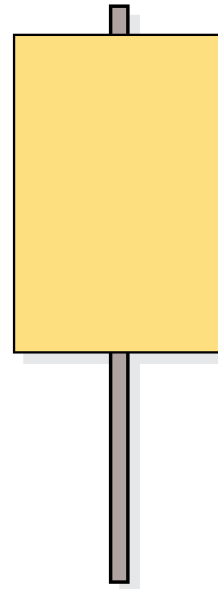
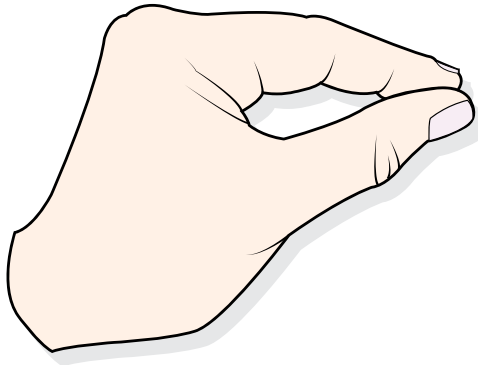


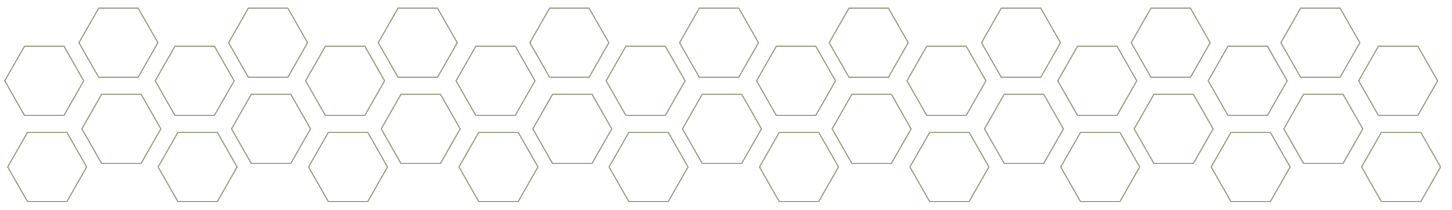
Parts of an Insect



How to Control Pests

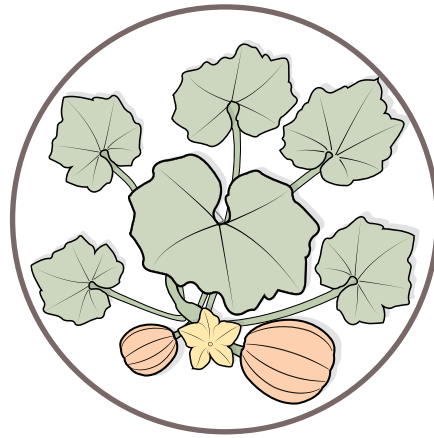
How do these things help to control "bad" insects?





UNIT 4 GARDEN PLANNING & DESIGN

IN THIS UNIT:



9 *Food Garden Planning and Design*

Learn about what constitutes a **good food garden site**. Learn how to **plan** and **design** a food garden, incorporating **paths**, **trellises**, appropriate **plant spacing** and **companion planting**. Explore the concept of **crop rotation** and learn about its importance in organic gardening. Create a **garden plan** on paper.

» *pages 83 to 90*

Food Garden Planning and Design

Grade K to 7
Science, Art, Math
1 hour and 20 min.



information
for the
teacher



Photo Credit: "Upper Garden, 3 beds" by Patrick Breen (pdbreen on flickr), image reversed, used under Creative Commons license 2.0 (CC-BY-2.0).

Above: A garden design that consists of three raised beds. Note that each garden bed is only three feet wide, and thus narrow enough for a person to reach into the centre of the garden when standing beside the bed. Trellises have been placed at the back of each raised bed to support the tomato and squash plants that have been planted there, while the smaller crops sit at the front of the beds.

Below: Cabbage plants that have been grown in a raised bed. Note the marigold flowers in the garden. Marigolds, which have a natural pesticide in their roots, are a good companion flower for some vegetables.

Photo Credit: "Winter Harvest: Cabbage" by Korye Logan (KoryeLogan on flickr), used under Creative Commons license 2.0 (CC-BY-2.0).



What should I consider when planning a garden? When talking about garden planning and design, the first question is always where to site a food garden. For food gardens in B.C., the site should be south facing, with full sun exposure, and with easy access to water. Another equally important aspect is access to plants without walking on the garden. Is the garden in boxes, or raised beds? Where will the paths go, and can you reach all parts of the garden from a path, walkway or stepping stone?

Which crops can I plant together? When designing a garden it is useful to use companion planting as a practice. Some crops grow best when situated in close proximity to another crop. This may be because one crop attracts pollinators more easily, or because they may deter harmful garden pests. Some crops such as beans and peas produce nitrogen, a much-needed essential nutrient, which is often found in limited amounts in soils. Other crops provide shade and support to those crops that need them. The First Nations' "Three Sisters Garden" is a prime example of sustainable companion planting, where beans, squash and corn were planted together: the corn provided the trellis for the beans, the squash provided a living mulch to keep weeds down and keep soil moisture levels high, and the beans provided added nitrogen for the other 2 crops. This lesson can be adapted to any age.

Below: A box of vegetables with carrots planted in the middle and onions companion-planted around. Carrot root fly is attracted to the smell of carrots, and the heavily-scented onions help to confuse these pests and keep them away.

Photo Credit: "Take that! You pesky carrot fly varmints!" by Karen Blakeman (karenblakeman on flickr), used under Creative Commons license 2.0 (CC-BY-2.0).



vocab

Annual Plants which complete their life cycle in one year, and die at the end of the season (eg. lettuce, corn, radishes).

Perennial Plants which live longer than 2 years (eg. trees, bushes, berries, rhubarb).

Companion Planting The planting of different crops in close proximity to increase crop productivity by assisting in nutrient uptake, controlling pests, increasing pollination or beneficial insects. It is a useful organic gardening or agricultural practice.

Crop Rotation Growing dissimilar food crops sequentially to avoid a build up of pathogens in the soil, and to reduce nutrient loss.

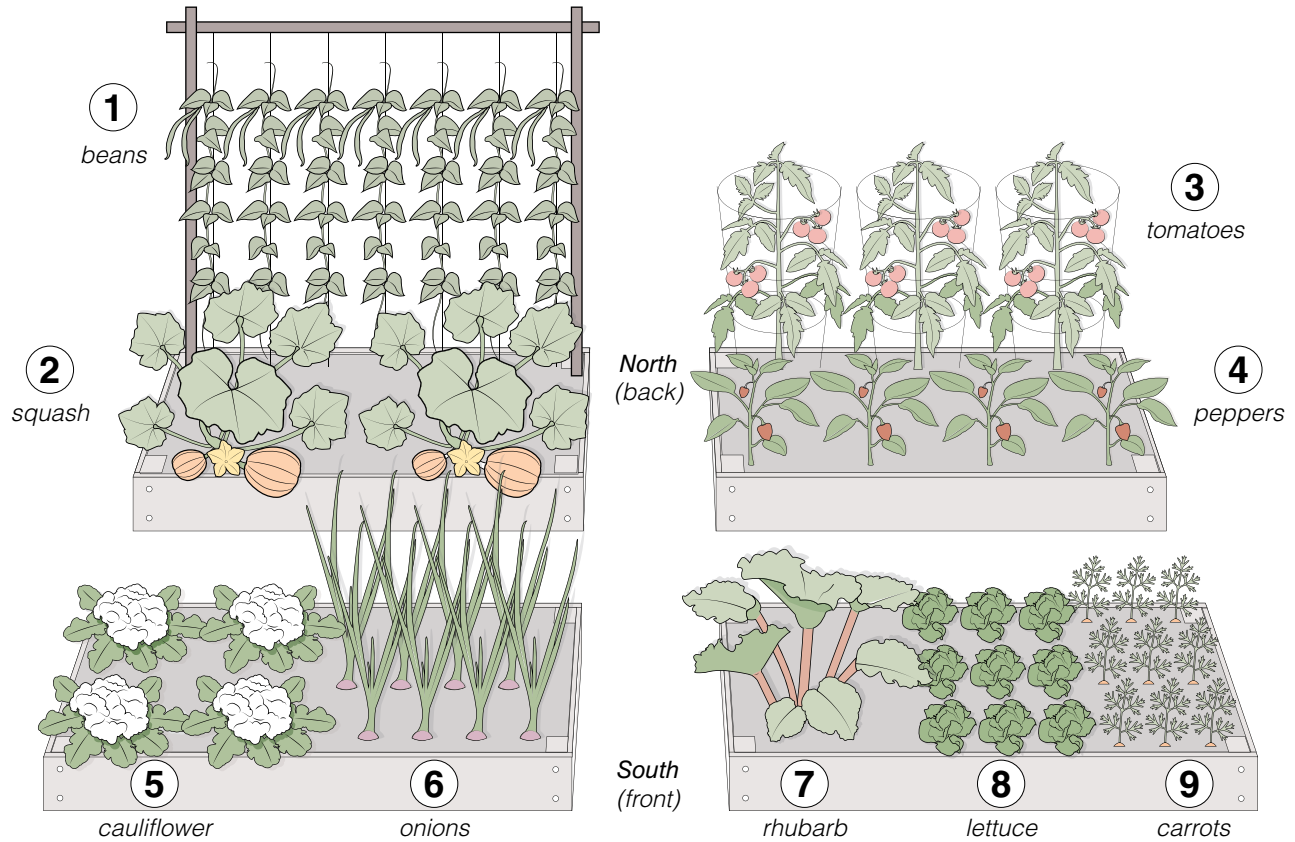
Part 1: Intro to Garden Design

Learn about what constitutes a good food garden site and how to plan and design a garden.



MATERIALS

- “What’s Growing in the Garden” handout (1 per student)
- “Companion Planting” handout (1 per student, to be used in both parts of this lesson)



LESSON

Introductory Discussion

Who has a garden at home? Who grows food at home? We are going to design our own ideal food garden.

Give the “What’s Growing...” handout to the students and have them do the vegetable matching activity (see answers above). Use the picture to lead the following discussion:

1. Initial considerations: What might we need to think about before we start? (Location, full sun, water source, size, soil requirements). Where will our garden go? What shape do we want to make our garden? How should we reach our plants without stepping on them? (Raised beds, paths, stepping stones, garden boxes).

Look at the garden picture.

- » What direction does the garden face? (*south*)
- » How can people step around the plants in the garden? (*plants are in raised beds with pathways in between*)

2. Plant size: Some plants grow very large and some stay quite small.

Look at the garden picture.

- » Are there some plants that take up a lot of space? (*rhubarb, squash*)
- » Which plants are tall? (*beans, tomatoes*)
Which plants are short? (*lettuce, carrots*)
- » Are the tall plants or the short plants at the back (north side) of the garden? (*tall ones*)
- » Why do you think this is? (*so that all plants get equal sunlight*)

3. Supports for plants: Some plants, such as peas and beans, are vines that need a trellis or fence to grow up.

Look at the garden picture.

- » Can you see some examples of supports? (*bean trellis, tomato cages*)
- » Can you think of any other vegetable crops that might need support when growing? (*peas, cucumbers, squash*)

4. Perennials and annuals: Talk about the difference between perennials and annuals. Perennial plants live for more than 2 years. Most vegetable crops are annuals, and live for only one season. In your garden beds, you may wish to designate a portion of your garden for perennial plants such as herbs, berries, rhubarb, and asparagus.

Look at the garden picture.

- » Can you see any perennial plants? (*rhubarb*)

5. Companion planting: With intermediate students, introduce the idea of companion planting. Some plants grow well together, and some do not. Hand out the companion planting chart included with this lesson.

Look at the garden picture.

- » Can you see any examples of companion planting? (*beans/squash, tomatoes/peppers, cauliflower/onions, carrots/lettuce*)

Part 2: Planning a Garden

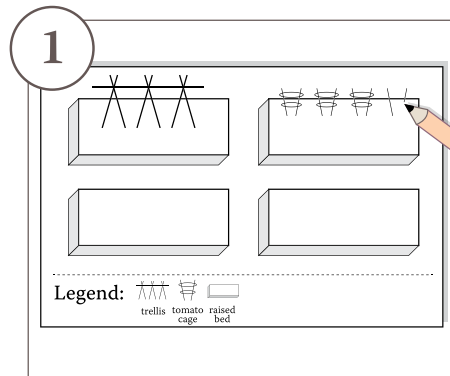
Create a garden plan on paper.
Learn about crop rotation and
its importance in gardening.



MATERIALS

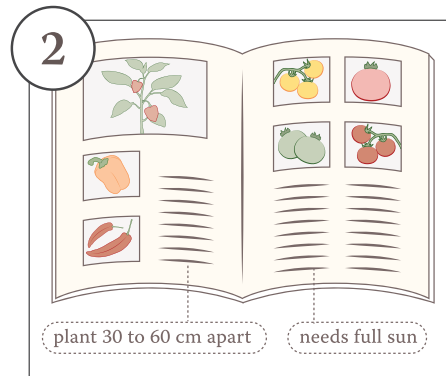
- Large 11 x 17 white paper (one sheet per student)
- Graph paper for older students (optional)
- Pencils, crayons, felt pens or pencil crayons
- Rulers
- Seed catalogues
- Seed packets (empty ones are good, so students can read how big the plants will grow)
- Garden design reference books from library
- “Food Plants for the Garden” worksheet (1 per student)
- “A Garden Plan” picture – show to students as an example

LESSON

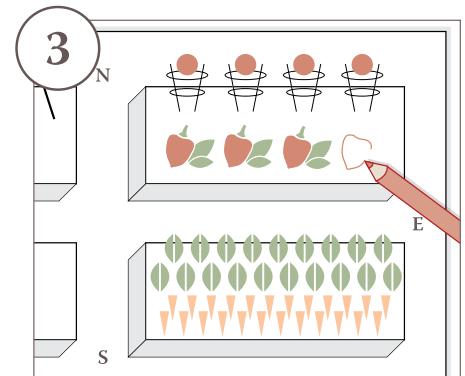


1. Create an outline of the garden.

Each student will receive a large 11 x 17 piece of white paper. Using a pencil, sketch out the garden shape and size on the paper. Include trellises, pathways, stepping stones. Use symbols and pictures of vegetables on your design plan and leave space for a legend.

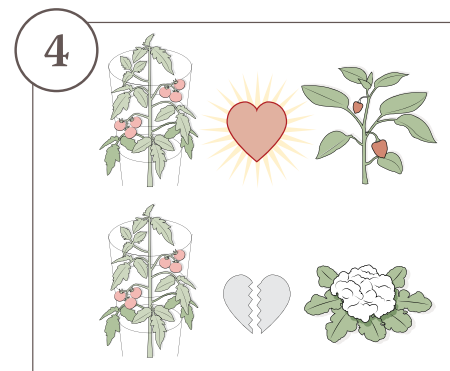


2. Research food plants. Using seed catalogues, garden books, or seed packets choose the vegetables and fruits you would like to grow in your garden. Research each one to see what their planting requirements are. Do they need support? Do they grow very large? Do they need full sun, or are they best grown in partial shade, under the leaves of another larger plant? Students can record their findings on the “Food Plants for the Garden” worksheet.

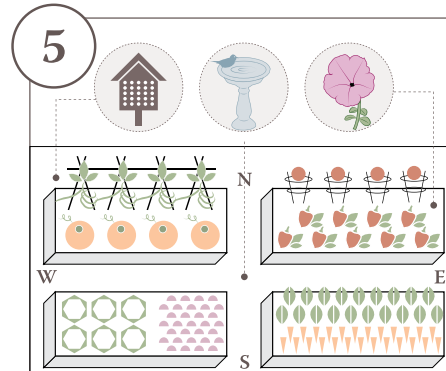


3. Draw vegetables in the garden.

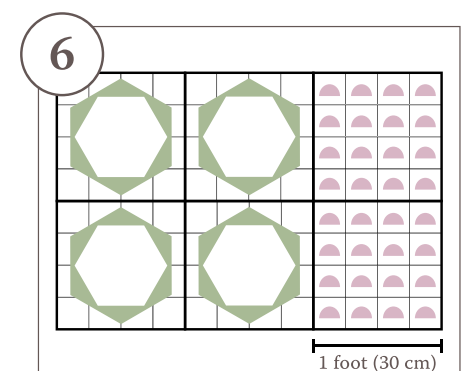
Put cardinal points on the garden design. Trellises and tall plants such as corn and sunflowers should be placed at the back (north side) of the design, whereas short plants such as carrots and lettuce should be placed at the front (southside) of the design to ensure that all crops have full sun.



4. Companion planting. Using the chart handout, use the practice of companion planting while designing your garden. Which crops grow best with which crops? Which ones should be grown apart?



5.a. Add other garden elements. Younger students can focus on a strictly conceptual design. Elements such as bee houses, bird baths and pollinator flowers could also be added to the designs.



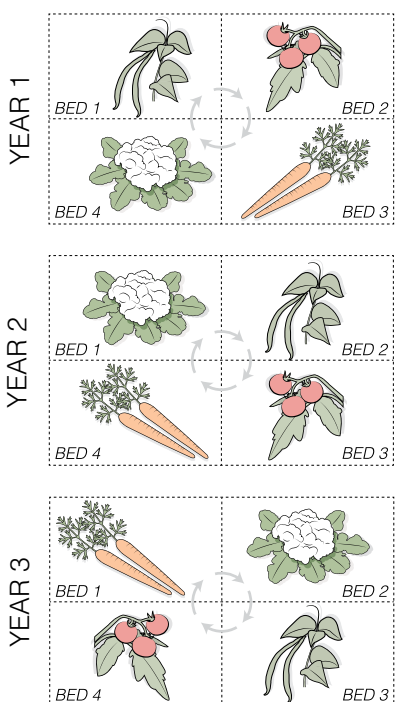
5.b. Scale drawing / crop rotation. For older students, one can introduce the idea of scale drawing and use graph paper for their garden design. Introduce the concept of crop rotation (see notes on next page). If they were to plant their gardens the year after, what changes would they make to their garden design?

When students are finished, they can share the different designs with each other. Ask students: what are the main ideas we need to think about when we draw up a garden design?

CROP ROTATION

an explanation guide

Crop rotation is changing crop location every year so you are not growing the same thing in the same garden bed each year. Why rotate crops?



- Crop rotation reduces the build up of pests and disease in the soil. Each crop family is susceptible to a similar set of weaknesses (eg. tomatoes and potatoes can experience blight, peas can experience root rot) which can remain in the soil into the next year and beyond. By rotating crop families, you are putting the plant in a different area of soil and thus reducing the risk of disease and pests.
- Crop rotation keeps the soil from becoming exhausted of certain nutrients. Every crop takes different quantities of nutrients (N, P, K) and micro-elements (Ca, Mg, S, B, Cu, Fe etc) and from different soil depths (based on root length). Varying the crops will make the best use of your soil. Some crops, such as beans and peas, add nitrogen into the soil. Other crops, such as tomatoes, take a lot of nitrogen from the soil. Therefore, a site planted with tomatoes in year one will benefit from a nitrogen-replenishing bean crop grown in the same spot in year two.
- Rotating crops will reduce weeds. Foliage of some plants is dense, reducing weeds, while other crops are less dense and more weeds can grow.
- **NOTE:** When practicing crop rotation, keep similar plants together so they can have the same soil treatment (eg. carrots need NO compost or fertilizer, otherwise they fork).

references
&
resources

BOOKS

Bartholomew, Mel. 2005. **All New Square Foot Gardening**. Cool Springs Press: Franklin, Tennessee.

» This book outlines the "square foot" gardening method. It would be a great starting point for developing a mathematical perimeter and area lesson around garden design, or to introduce scale drawing using graph paper.

Bellamy, Andrea. 2010. **Sugar Snaps and Strawberries**. Timber Press: Portland, Oregon.

» This book gives an overview of many gardening topics (eg. soils, plants, composting) with a focus on small-space food gardening. It would be a great introductory resource for teachers who are new to gardening.

Cohen, Whitney and John Fisher. 2012. **Gardening Projects for Kids**. Timber Press: Portland, Oregon.

» This book has instructions for many fun gardening activities to do with kids (eg. making mosaic stepping stones, plant markers from rocks, bird houses from gourds, etc). A great resource for finding lesson extensions.

ONLINE

- **Vegetable Garden Layouts:**

<http://www.squidoo.com/VegetableGardenLayout>

- **Crop Rotation:**

http://www.gardenorganic.org.uk/schools_organic_network/leaflets/CropRotation.pdf

- **Companion Planting:**

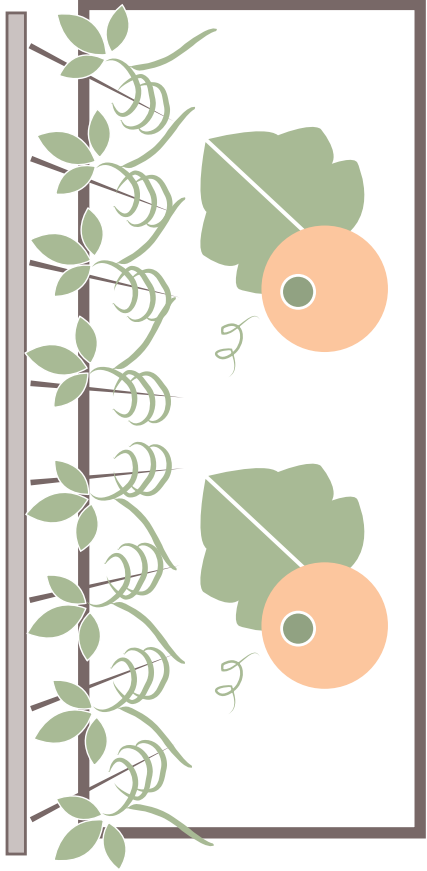
http://www.howtogardenadvice.com/garden_info/companion_gardening.html

<http://www.companionplanting.net/ListofCompanionPlants.html>

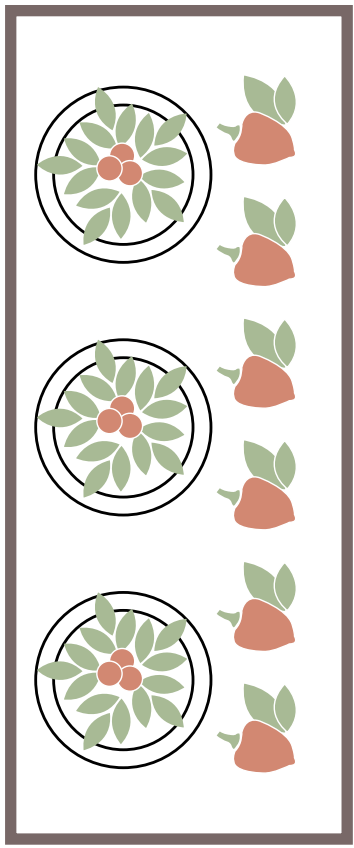
credits

Lesson developed and written by Catriona Gordon. Design by Lisa Rilkoﬀ.

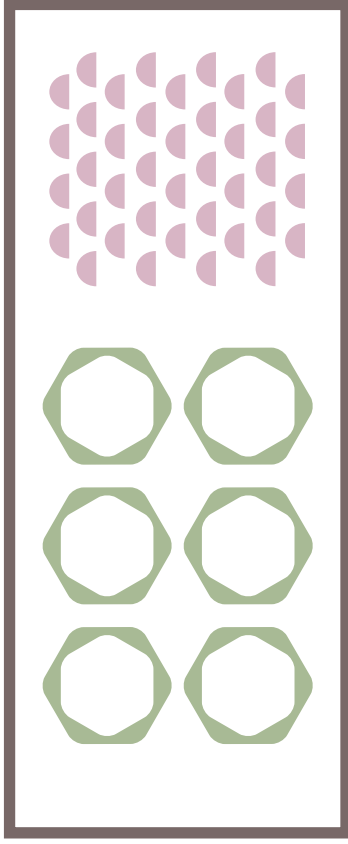
A Garden Plan



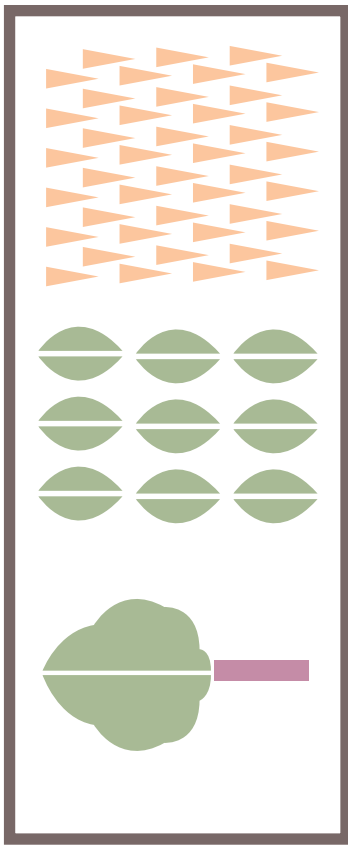
N



W



E



S

Legend



raised bed



trellis



tomato cage



beans



carrots



cauliflower



lettuce



onions



peppers



rhubarb



squash



tomatoes

Companion Planting

	Companions (helps or is helped by)	Not Friends (don't plant together)
Beans	Lettuce Corn Carrots Radish Eggplant	<i>Sunflowers</i> <i>Onions</i> <i>Beets</i>
Beets and Chard	Lettuce Onions	<i>Beans</i> <i>Tomatoes</i>
Broccoli and Kale	Onions	<i>Tomatoes</i> <i>Peppers</i>
Carrots	Peas Tomatoes Lettuce Beans	<i>Radish</i> <i>Dill</i>
Corn	Beans Peas Sunflowers Cucumbers Nasturtiums	<i>Tomato</i>
Cucumber, Zucchini, Squash, and Melons	Radishes Peas Carrots	<i>Tomato</i>
Eggplant	Beans Peppers Marigolds	
Lettuce	Radishes Beans Carrots	<i>Cabbage</i> <i>Parsley</i> <i>Celery</i>
Onions	Tomatoes Kale Carrots	<i>Beans</i> <i>Peas</i>
Peppers	Tomatoes Petunias	<i>Beans</i> <i>Kale</i>
Peas	Carrots	
Potatoes		<i>Tomatoes</i> <i>Cucumbers</i> <i>Sunflowers</i>
Spinach	Peas Beans	
Tomatoes	Peppers Basil Carrots Parsley Nasturtiums	<i>Corn</i> <i>Peas</i> <i>Potatoes</i> <i>Broccoli / Kale</i> <i>Beets / Chard</i>

This is a brief list of companion plants. Companion plants assist in the growth of plants by attracting beneficial insects, repelling harmful insects, being the “fall guy” by getting eaten by the “bad bugs”, providing nutrients, or giving shade and support.

Flower Power

Did you know that flowers can help your vegetable garden?



Marigolds produce a natural pesticide in their roots, repelling nematodes and other root pests. Marigolds are companions of *peppers*, *cucumbers*, *zucchini*, *squash*, *broccoli*, and *kale*.



Petunias are a “trap crop.” They attract pests away from food crops. Petunias are companions of *cucumbers*, *zucchini* and *squash*.



Nasturtiums are a good “trap crop” and are one of the best at attracting predatory insects. Nasturtiums are companions of *cucumber*, *zucchini*, *squash*, *beans*, *tomatoes*, and *broccoli*.

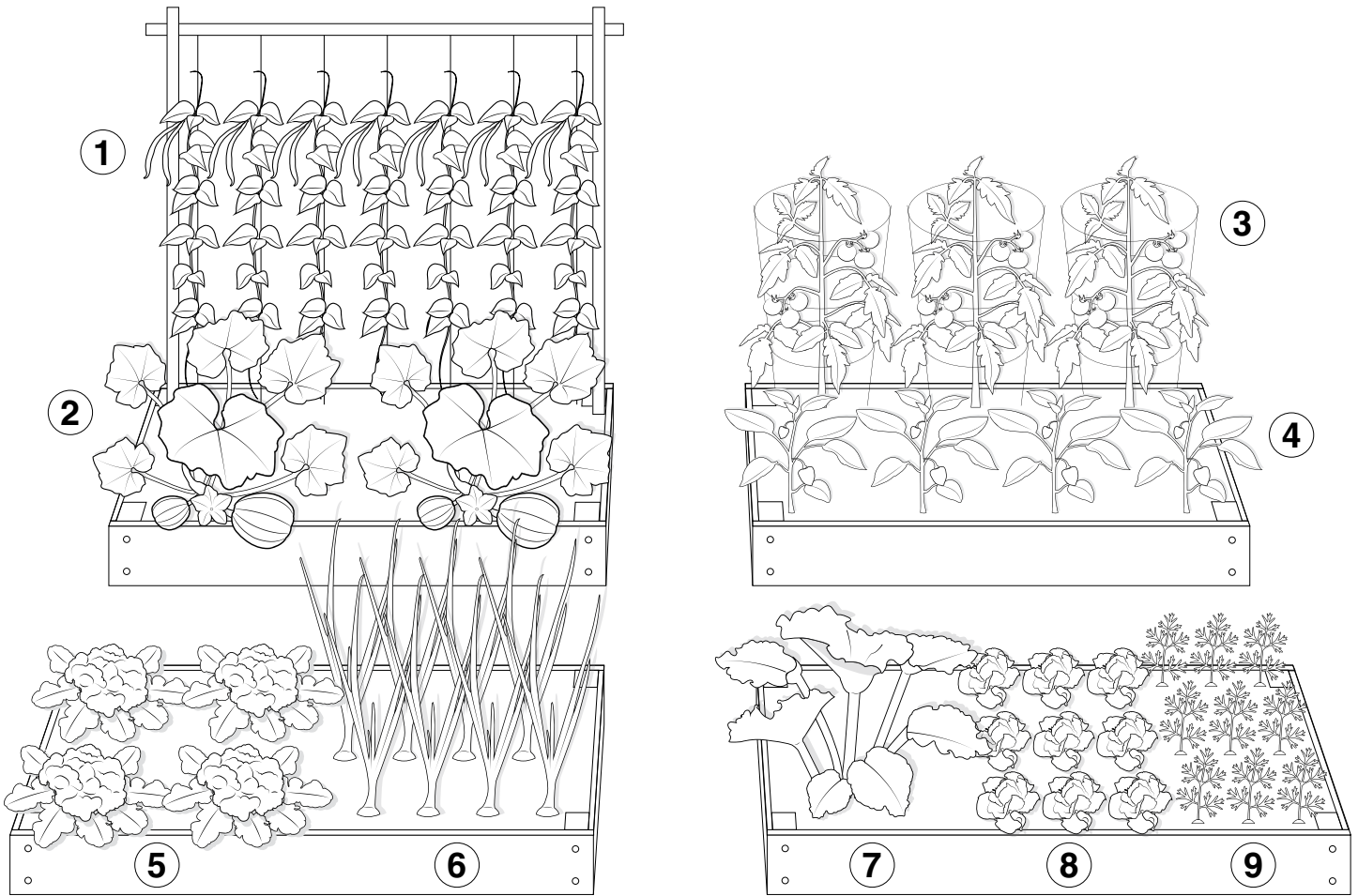


Sunflowers are a good “trap crop” for aphids. Sunflowers are companions of *corn* and *tomatoes*.

What's Growing in the Garden?



Look at the garden picture. Can you name all the vegetables?
Write the numbers beside the words below.



1 beans

___ lettuce

___ rhubarb

___ carrots

___ onions

___ squash

___ cauliflower

___ peppers

___ tomatoes

Food Plants for the Garden

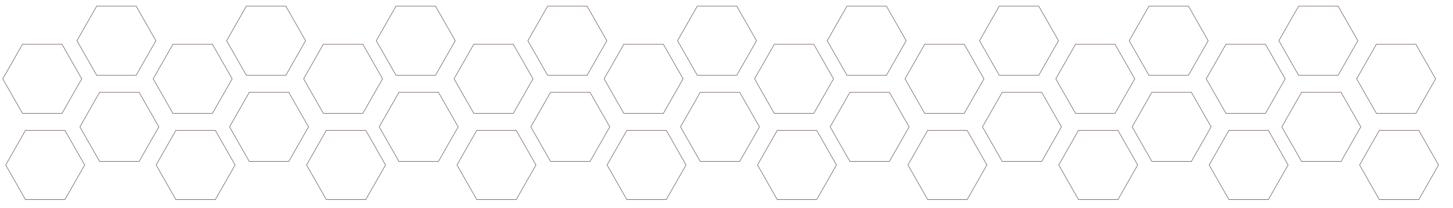
name: _____

.....



Look at seed catalogues and packages. Choose some plants you'd like to grow in your garden.
Write some information about your plants in the chart below.

Type of plant	How big does it get?	How much space does it need?	Does it need support? (i.e. a trellis)	How much sun does it need?
eg. pole beans	2.5 metres tall	plants should be 7-10 cm apart	yes	likes full sun, but can have some shade



Healthy Cities are Our Future

Founded in 1969, The Society Promoting Environmental Conservation (SPEC) is a non-profit charitable organization that addresses environmental issues in British Columbia, with a particular focus on urban communities in the Lower Mainland and the Georgia Basin. Through our public education programs and advocacy work, SPEC works hard to raise awareness on environmental issues and encourage policies and practices that lead to urban sustainability. We believe that by working together with citizens, government and industry we can reach our goal of creating a truly healthy, liveable environment.

SPEC is currently engaged in exciting projects that focus on sustainable food, green energy, waste reduction, and land & water conservation. To get involved or to learn about membership opportunities, feel free to get in touch:



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