BC Agriculture in the Classroom Foundation

Lesson Plan:

Plant Something Bee Friendly

Middle School

Bees (honeybees and solitary bee species) are essential pollinators for much of the world's food including many food and forage crops across British Columbia. It has been estimated that honeybees are responsible for the production of $160 million worth of crops in BC every year.

In recent decades, there has been much talk of population declines of pollinator insects, especially in agricultural areas. In this lesson, students learn about some of the threats to bee populations, as well as ways in which they can help support bee populations through planting bee-friendly plants.

Suggested Grade/Subject Levels

Food Studies 7, 8 and 9

Science 6, 7, and 9

Social Studies 6

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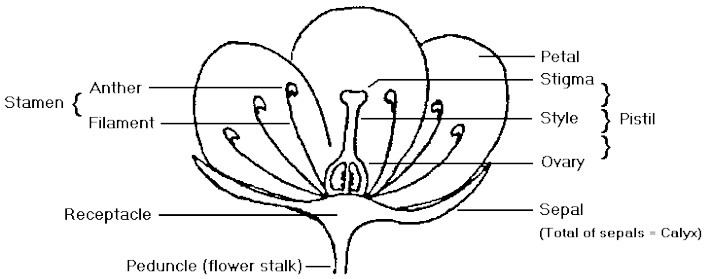
Teacher Guide

Course	Curricular Competencies	Content Connections
Applied Design, Skills and Technologies	• Empathize with potential uses to find issues and uncover needs and potential design opportunities • Identify key features or potential uses and their requirements • Generate potential ideas and add to others' ideas • Evaluate personal, social, and environmental impacts and ethical considerations • Identify and use appropriate tools, technologies and materials for production • Identify how the land, natural resources, and culture influence the development and use of tools and technologies	**Food Studies 7** • Factors in ingredient use, including balanced eating/nutrition, function, and dietary restrictions • Factors in that influence food choices, including cost, availability and family and cultural influences **Food Studies 8** • Social factors that affect food choices, including eating practices • Local food systems **Food Studies 9** • Health, economic and environmental factors that influence availability and choice of food in personal, local and global contexts • Ethical issues related to food systems
Science	• Assess risks and address ethical, cultural and/or environmental issues associated with their proposed methods and those of others • Experience and interpret the local environment • Analyze cause-and-effect relationships • Consider social, ethical and environmental implications of the findings from their own and other's investigation • Contribute to care for self, others, community, and world through individual or collaborative approaches • Contribute to finding solutions to problems at a local and/or global level through inquiry	**Science 6** • Survival needs **Science 7** • Organisms have evolved over time • Survival needs **Science 9** • Sexual reproduction • Sustainability of systems • First Peoples knowledge of interconnectedness and sustainability
Social Studies	• Use social studies inquiry processes and skills to ask questions; gather, interpret, and analyze ideas; and communicate findings and decisions • Assess how prevailing conditions and the actions of individuals or groups affect events, decisions, or developments	**Social Studies 6** • The urbanization and migration of people • International cooperation and responses to global issues

Teacher Background

Broadly speaking, plants are eukaryotic organisms characterized by their ability to produce their own food. While the Plant Kingdom includes mosses, vines, trees, grasses, and ferns, agriculture is almost entirely dependent on angiosperms which provide virtually all plant-based food, as well as a large amount of livestock feed. Angiosperms are distinguished from other seed-producing plants by characteristics such as flowers and the production of fruits that contain the seeds; in fact the term angiosperm actually means enclosed seed (Greek, angio = case or casing, sperm = seed).

Flowers are the reproductive apparatus of angiosperms, functioning to ensure fertilization of the ovule (egg) by the pollen (sperm), and development of the fruit (containing seeds). There are four main flower parts in angiosperms: sepals, petals, stamen, and pistil. The stamen is considered the male portion of the plant and the pistil is considered to be the female portion:



1. Sepal – green, leaf-like structure that protects the budding flower
2. Petal – colorful and often scented part of the flower that attracts pollinators
3. Stamen – the part of the flower that produces pollen. Consists of:
    a. Filament – stalk that holds up the anther
    b. Anther – sac that contains pollen
4. Pistil – contains the ovary containing the ovule. Consists of:
    a. Stigma – the tip of the carpel that is sticky in order to collect pollen
    b. Style – the slender neck-like portion of the carpel that leads to the ovary
    c. Ovary – structure at the base of the carpel that houses the ovule

Flowers containing all four floral organs are called complete flowers, whereas flowers lacking any one or more of these parts are called incomplete flowers. An example of an incomplete flower would be the flowers of grass plants which lack sepals and petals.

Flowers that contain both stamen and pistil are called perfect flowers and are hermaphroditic (although many have developed strategies to prevent self-fertilizing). Flowers that are missing either stamen or pistils are called imperfect flowers and are unisexual flowers. Imperfect flowers that bear pistils only are considered female flowers, and those that bear stamens only are considered male. In species such as corn, male and female flowers are both found on the same plant, while in other species such as kiwifruit, each plant has only either male or female flowers.

Pollination is the transfer of pollen grains from an anther to a stigma, either within the same flower or between flowers of the same species. Once the pollen adheres to the stigma, it extends a tiny tube, all the way down the style to the ovary. The pollen tube carries the male gamete to meet the female gamete in the ovule, for a process called fertilization. The fertilized ovule goes on to form a seed and the ovary develops into a fruit to protect the seed.

In most cases pollen can't get from the anther to the stigma on its own, so pollination relies on other things to move the pollen. In cases such as grasses and corn, wind is the vector that aids this process. However, three quarters of the world's flowering plants, and about thirty-five percent of the world's food crops depend on pollinators, such as insects, birds, and bats to reproduce.

It is believed that many plants have co-evolved with their pollinators, developing characteristics such as smell, color, and shapes that favor certain pollinators over others. Pollinators are attracted to the flowers in search of food (nectar for energy and pollen for protein), and during their visit, pollen adheres to their body. When they visit a subsequent flower of the same species, the pollen rubs off onto the stigma, thereby pollinating that plant.

Bees (honeybees and solitary bee species) play a key role in the production of many food and forage crops across British Columbia including, alfalfa, apples, blueberries, cherries, cucumbers, kiwifruit, tomatoes, and pumpkins. The tree fruits in the Okanagan and berry crops in the Fraser Valley are very dependent on an abundance of bees when these crops are in bloom. Fruit growers rent large numbers of colonies from beekeepers. It has been estimated that honeybees are responsible for the production of $160 million worth of crops in BC every year.

In recent decades, there has been much talk of population declines of pollinator insects, especially in agricultural areas. There are a number of reasons for the pollinator declines including agriculture activity, exposure to pollutants, habitat fragmentation, pests, and climate change.

An important factor affecting honey bee health is access to adequate nutrition. Without collecting enough good sources of nectar and pollen from flowers during the warmer months, honey bee colonies can face serious challenges during the winter. Large acreages of single crops (monocultures) means that much greater concentrations of pollinators are needed at bloom time, but the area can be forage poor or even deadly to bees for the rest of the season.

To counteract these trends, it's important that both public and private sectors contribute to bee-friendly habitats. Farmers can use bee-friendly cover crops and hedge rows along ditches and berms. Home gardeners and urban landscapers can include bee-friendly plants in residential and commercial landscapes. Teachers and students can plant bee-friendly flowers in their school gardens. Studies have shown that an abundance and diversity of nectar and pollen bearing plants can enhance pollinator populations, and that this in turn supports greater biodiversity and a healthier sustainable environment.

Materials

- Flowers (simple flowers with easily identifiable parts such as Gladioli, Lilies, Amaryllis, Daffodils)
- Student handouts:
    - Flower Dissection
    - Pollinator Activity
    - Planning a Bee Friendly Garden
    - My Garden Plan Research
- Petri dishes
- Dissecting microscopes or hand lenses
- Optional: razor blades
- 3 pipe cleaners/participant
- 1 8oz foam or paper cup/participant
- Talcum powder
- Colored chalk (2 or 3 pieces crushed to powder, or several colors of Jell-O powder)
- Transparent tape, 3-4 rolls
- Nails, 5 or 6
- BC Landscape and Nursery Video: https://www.youtube.com/watch?v=zhLDs3fqOMc
- Plant Something BC poster (available for free order at http://www.aitc.ca/bc/resources/posters)
- Class set of Plant Something BC postcards (available for order at http://www.aitc.ca/bc/resources/posters)

Extension Suggestions

- Have students design a comic strip showing the process of pollination
- Have students research what characteristics attract specific pollinators and then design their own flowers to attract their desired pollinator.
- Have students research adaptations that allow for insects to be efficient pollinators and then design and construct their own “super-pollinator”.
- Find pollinator plants in your neighborhood and record the types of pollinators and the number of visits over a certain amount of time.

Activity One

1. Hook – have a bouquet of flowers on your front table as students enter the room. Ask them why plants need flowers?
2. Flower anatomy – Using a projected image of a flower (similar to the one provided in the Teacher Background section) discuss the parts of the flower, complete vs incomplete, perfect vs imperfect.
3. Flower dissection – provide each pair of students with a flower and a dissection handout
    a. Have the students work their way through the flower dissection and answer the questions provided.
    b. Optional: Depending on the level of the students you can either provide them with razor blades to dissect the ovule, or prepare stations with already dissected pollen grains and ovules.

Activity Two

1. Have students discuss the following questions with their partners and then share with the class:
    a. What is pollination?
    b. What are pollinators?
    c. What are some examples of pollinators?
    d. "Who" is the most important pollinator?
    e. What would happen if pollination didn't happen?
2. Activity – Pollination
    a. Have students construct their "insects" and "flowers". Monitor the addition of the "pollen" or coloured powder to ensure that students don't get any on their tape prior to the activity beginning.
    b. When all the students are ready, give them two minutes to move between flowers, dipping their insects into the powder each time they visit a flower.
    c. Have the students complete the responses questions in their notebook, or on a separate piece of paper.

Activity Three

1. Hook: have a variety of fruit and vegetables (that come from plants pollinated by bees) cut for students to taste. While they are eating their snacks, review the concept of pollination from the previous lesson.
2. Have students brainstorm a list of foods that are dependent on help from bees. Create a list on the board. Ask them what their meals would look like in a world without bees. Ask them to brainstorm what types of things might be threatening bee populations.
3. Watch the following video https://www.youtube.com/watch?v=zhLDs3fqOMc
4. Introduce students to the Plant Something BC poster, and provide each student with their own copy of the postcard version.
5. Have students map out a 2 meter by 2 meter garden area using bee friendly plants.

Dissection: Flower Anatomy

Name: _____ Date: _____

Objective

To identify and explain the role of each part of a flower.

Materials

Flower (ex. gladiola, lily, tulip)
Petri dish
Dissecting microscope
Optional: razor blade for dissecting the pistil

Part 1: External Anatomy

1. Lay your specimen on the table and carefully examine it. Draw the side, external view of the flower. Label the stem, receptacle, sepals and petals.

2. Does the stem appear wider at it nears the base of the flower? _____

3. What are the green leaves around the base of the flower called? How many of them are there? What is their function? _____
   _____
   _____

4. How many petals are there in your flower? _____

5. What is the advantage of having colored petals? _____
_____
_____

Part 2: Internal Anatomy

6. Carefully remove enough sepals and petals from your flower so that you can observe the inner parts. Draw this internal view and label stamen, anther, filament, pistil, stigma, style, ovary, and petals.

7. What is the function of the stamen? _____
_____

8. What is the function of the pistil? _____
_____
_____

9. Explain what must occur in order for reproduction happen in the flower? _____
_____
_____
_____

Part 3: The Anther and the Ovary

10. Examine the anther and the ovary under the microscope:
    a. Carefully remove the pistil from your flower. Cut the ovary in half lengthwise using your razor blade and place it in a petri dish.
    b. Carefully remove a single anther from the flower and place it alongside the ovary in the petri dish. Be careful not to allow any of the yellow/orange powder touch your clothes as it can stain.
    c. Optional: use the specimens in the petri dish already prepared by your teacher.

11. Can you see individual pollen grains on the anther? Describe their appearance. _____
    _____
    _____

12. What is the function of the pollen? _____
    _____

13. What do you see inside the ovary? _____
    _____

14. What is the function of the ovary? _____
    _____
    _____

15. What does the ovary turn into once the flower is fertilized? _____
    _____
    _____

Discussion Questions

1. What is the biological function of the flower? _____
   _____
   _____

2. How might the pollen be carried from the anther to the stigma? _____
   _____
   _____

3. Was your flower a complete flower? A perfect flower? Explain _____
   _____
   _____
   _____

Activity – Pollination

Objective

To construct a model to show how pollination works.

Materials

- 3 pipe cleaners
- 8oz foam or paper cup
- Talcum powder
- Colored powder
- Transparent tape
- Nail

Procedure

1. Use two of the pipe cleaners to “create an insect”. It must have two wings and two legs and fit easily into the bottom of the cup.
2. Use your cup, third pipe cleaner, and tape to create the flower:
    a. Around one end of the pipe cleaner wrap a piece of tape, sticky side out.
    b. Poke a hole in the bottom of the cup using a nail.
    c. Insert the end of the non-sticky end of the pipe cleaner down through the hole, until the sticky end is parallel with the lip of the cup (this will be the flower’s pistil)
    d. Tape the bottom end of the pipe cleaner to the underside of the cup.
3. Carefully sprinkle a teaspoon of talcum powder and a teaspoon of the colored powder, ensuring not to get any on the sticky end of your “pistil”.
4. Have one partner hold the cup. For 2 minutes, have the other partner “fly” their insect around room, gently visiting other people’s flowers and picking up their powders. It is fine if you brush against the tape in the process.
5. Once the two minutes is up, return to your desk and answer the discussion questions.

Discussion Questions

1. What did the colored powder represent?
2. What happened to the pipe cleaner insect?
3. What happened to the taped pipe cleaner? Are there different colors on the pipe cleaner?
4. If a flower only wanted to “receive” one color of powder, how might it “message” to the pollinators?
5. Use this model to explain how pollen works in nature.

Planning a Bee Friendly Garden

Bees eat two things: nectar because it's loaded with sugar and is a great source of energy, and pollen which provides proteins. Because both nectar and pollen come from flowers, plants only provide food for bees when they're flowering. This is why it's important that you plant a variety of flowers that bloom at different times… so that bees have a constant food source throughout the year.

Choose 2 plants from each season (spring, summer, fall and winter). Keep in mind, you want to provide bees with a continual supply of food, so you may want to choose one from early spring and one from late spring. Use the internet to research the following:

- Common Name
- Latin Name
- Climate/hardiness zone
- Blooming season
- Growing requirements (spacing, depth of seed planting, water, sunlight)

Use the poster and postcards provided, as well as the following websites to find plants that are suitable for our area of BC:

https://plantsomethingbc.ca/bee-friendly-plants/

http://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/animal-production/bees/food-for-bees/bee-forage-plants

Use the handout provided to record your research and design your 2 meter by 2 meter garden plot. Be sure to create a legend in the space provided below your garden plot.

My Garden Plan Research

Name: _____ Date: _____

Common Name: _____ Latin Name: _____

Climate/Hardiness Zone: _____ Blooming Season: _____

Growing requirements: _____

_____

_____

_____

_____

Common Name: _____ Latin Name: _____

Climate/Hardiness Zone: _____ Blooming Season: _____

Growing requirements: _____

_____

_____

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Common Name: _____ Latin Name: _____

Climate/Hardiness Zone: _____ Blooming Season: _____

Growing requirements: _____

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Common Name: _____ Latin Name: _____

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Growing requirements: _____

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Common Name: _____ Latin Name: _____

Climate/Hardiness Zone: _____ Blooming Season: _____

Growing requirements: _____

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My Garden Plan