Science Unit: *Growing Plants*
Lesson 4: *Microscopy Exercises*

School Year:	2007/208
Developed for:	Charles Dickens Elementary School, Vancouver School District
Developed by:	Shona Ellis (scientist), Paula Naylor and Susan Garber (teachers)
Grade level:	Presented to grades 3, 4, 5; appropriate for grades 2 – 7 with age appropriate modifications.
Duration of lesson:	Two 2 hour sessions
Notes:	This requires cooperation with a university, college, or facility with microscopes and volunteer biologists. This was done on two different visits. A selection of five activities would be appropriate for a 2-2.5 hour lesson.

Objectives

1. To learn how to use dissecting and compound microscopes as well as prepare material for microscopic examination.
2. To explore different aspects of plant life (diversity, interactions with other organisms, and reproduction).
3. To record observations and develop questions about plants.

Background Information

Microscopy is often inaccessible to elementary school children. This workshop gives them the opportunity to investigate the microscopic world of organisms and structures from the botanical world as well as explore what they find interesting.
Reach activity is set up as a station. Each station has specimens plus dissecting and compound microscopes. Addition materials depend on the activity. These activities rely on biology undergraduate students as instruction and supervision are critical.

General Vocabulary

coverslip	Thin piece of glass that goes over the specimen on a microscope slide.
eyepiece	Part of the microscope through which you look.
focus	To adjust the stage so that one can view the detail of the specimen.
forceps	Tweezers.
illumination	Light that is passed through the microscope.
magnification	The size of the appearance of an object
objective lens	Magnifying lens of a microscope.
slide	Piece of glass on which a specimen is placed for microscopic examination.
stage	The part of the microscope on which the slide is placed for viewing.

Materials at each Station

- Dissecting microscopes
- Compound microscopes

- Tray of equipment (sides, coverslips, dropper bottle with water, forceps, probes)

In the Classroom (Laboratory)

Introductory Discussion

1. Welcome to a teaching lab at UBC
    - There are a number of activities set up around the room (give overview)
    - Students are instructed on how the lab activities will be run: Each group will spend 20-15 minutes at an activity and then they will move on to the next.
2. Students will primarily be using observational skills. They can investigate each topic and will draw pictures, write down observations, and come up with some questions for further research.
3. Sectioning and staining techniques are demonstrated at Station 4. Stains (toluidine blue and Potassium iodine) are provided for better visualization. Razor blades are used by one student at a time. Students are supervised by two instructors.

Science Activity

Each student will receive a booklet to draw and record observations (and write any questions). At the first station each group should be shown step-by-step how to make a slide and use the microscopes (except for station 7 which is outside; this station should not be included in the first round if possible). During subsequent stations the activities will be more flexible depending on the interests of the students. The students will stay at the first station for about 35 minutes.

Station 1: Types of Plants

Introduction: Plants are divided into different main categories. The students have already examined flowering plants, conifers, and bryophytes, but do not really have an overview.

Plants mostly live on land and are multicellular (made up of many cells) and photosynthetic (green, converting light energy into chemical energy such as sugars).

Station Vocabulary

conifer

fern

flowering plant

horsetail

moss

pollen cone

rhizome

seed cone

sporangium

spore

Materials: mosses, ferns, horsetail, pine, flowering plant (orchid), “game” cards, dissecting microscopes, equipment trays

Activity:
- categorize plants using “game” cards (recipe cards with the names of the categories of plants)
- introduce ferns: structure (stem = rhizome, leaves, roots),
look for spores and sporangia…where are they? (bottom of the leaf)
- students can explore the material with the dissecting microscopes
(seed cones and pollen cones of pine, flowers, etc are available for dissection) – can review pollination

Station 2: Germinating Spores

Introduction: Explaining the general life history of the fern (introduce the terms sporophyte and gametophyte). Tissue culture is used to grow the spore into the gametophyte (the stage that makes eggs and sperm). The Petri dish has nutrient agar, which give the growing gametophyte minerals as well as provides water. It has been sterilized and should be exposed (opened as little as possible).
Each pair or three students will work together, but each student will have a dish.

Station Vocabulary

agar

gametophyte

incubate

Petri dish

pipette

sporophyte

sterile

tissue culture

vial

Materials:
- vials with spores (mark indicates level of water to be added)
- sterile water
- sterile pipettes
- pipette bulbs
- Petri dishes with nutrient agar
- parafilm to seal Petri dishes
- pen to mark name
- compound and dissecting microscopes
- equipment trays

Activity:
Students will look at spores/sporangia with the dissecting microscope then make a slide of the spores and examine with the compound microscope.

Inoculation of nutrient agar with spores (step-by-step demonstration):
- Water is added to the vial to the level of the mark.
- Mix by sucking into pipette and discharging a few times.
- The solution of spores is drawn up into the pipette and then a portion is expelled onto the agar surface in each of the Petri dishes.
- The Petri dish is slid across the desk in different directions to distribute the spores.
- The Petri dish is sealed with two pieces of parafilm applied separately (parafilm will keep the lid on and allow air circulation).
- The student name is written along edge of dish.

Station 3: Aquatic "Plants"

Introduction: Some organisms are photosynthetic (green) but are not plants! Many are aquatic (live in the water). Some live in the ocean (seaweed) while others live in freshwater (e.g. ponds). Seaweeds are often categorized by colour (red, green, and brown).

Materials:
- mix of microscopic freshwater organisms from culture facility: Haematococcus (motile unicellular green), *Spirogynra* (filanetous green), *Volvox* (multicellular), *Microsterias* (desmid), *Nostoc* (filamentous blue-green bacterium)
- A number of species of seaweeds (combination of browns reds, and greens): *Ulva, Fucus, Laminaria, Nereocystis, Sargassum,* and *Mazzaella.* - *Polysiphonia, Pterosiphonia* for making herbarium specimens.
- herbarium paper cut into strips (bookmark size)
- Algal Herbarium samples from the UBC Herbarium

Activity:
- Examine the microscopic pond organisms first with the dissecting scope, then with the compound microscopes. Pictures of the organisms will be at the station for students to identify the organisms they see.
- A number of different seaweeds are present for them to examine.
- Herbarium samples will show students how organisms are stored for collections. Discuss the importance of collections
- Herbarium paper is cut into strips for students to make a mini herbarium prep of *Polysiphonia/Pterosiphonia* which will later be laminated to make a bookmark. Show students how to arrange the seaweed on the paper. Set aside to dry (be sure the students' names are indicated with each sample). – they will be laminated later (bookmarks)

Attractions: photos of organisms, herbarium samples, frogs (other "pond" organisms).

Station 4: Edible Plants

Introduction: This is a chance to review what the students have already learned about general plant structure (stem, leaves, roots, flowers, fruit). Students categorized plants as fruit vs vegetable in another lesson (they found that there is more than one way to do this…..).

Station Vocabulary

amylase
enzyme
leaf
lignin
photosynthesis
root
starch
stem
sugar
vascular tissue

Materials: Selection of supermarket "vegetables" with a few fruits and a potato, toluidine blue and potassium iodide (IKI) in dropper bottles, game cards

Activity:

- Review the parts of a plant.
- Categorize the plants based on structure: root, stem, leaf, flowers, fruit. Cards with the names of the categories will be used.
- Identify the functions of the plants parts: roots (take up water and anchor), leaves photosynthesis, stems hold leaves up to light and carries water up and sugars down.
- Do plants have a circulatory system? Yes! It is called vascular tissue.
- Demonstrate how to make a cross-section of a stem. Examine unstained with the compound microscope. Stain with toluidine blue, which will stain the cell walls of the conducting cells as well as fibres a baby-blue to green colour. (Lignin is the compound which causes the colour reaction. It gives wood its strength.)

- Discuss why we eat plants. (nutrients and energy)
- Ask where energy comes from. (oils, sugars, and starch)
- What types of energy do we get from the plants on display?
- Microscopic examination of sections of potato unstained and stained with IKI (stains for starch).
- What is starch? (long chains of sugar)
- What happens when we eat starch? (converted to sugar)
- Amylase (an enzyme in our saliva) starts off the process (more is produced in our pancreas so is further digested in the stomach).
- Give each student a cracker and have them chew it without swallowing (eventually they should taste the sweetness of the sugar). Try to get them to do this for five minutes.

Station 5: Hairy Plants

Introduction: Plants have hairs called trichomes. They serve many functions in the plant: prevent desiccation (reflecting light and lowering evaporation), deter herbivory by producing chemicals (many smelly ones), absorb water particularly in epiphytic plants (bromeliads) and attract/trap insects.

Station Vocabulary

bromeliad

trichome

Materials: Compound Microscopes, Dissecting Microscopes, equipment trays (stains), herbs (rosemary, lavender, spearmint, peppermint, lemon balm, thyme), air plants (bromeliads), and *Drosera* (sundew), and any other “hairy” plants

Activity:
- Examine/smell herbs (can students match fragrance to the herb?).
- Microscopic examination of hairs from plants – glandular trichomes are those with bulbs at the ends.
- Epidermal peels not only show trichomes well, but stomata are evident especially when the peel is taken from the lower side of the plant.
- Cross-sections of bromeliads are cool (blades are in reserve and only one used at a time with supervision).

Station 6:Pollination Station

Introduction:
Pollination is accomplished by a number of means: wind, insects, birds, and even bats. The students will have the opportunity to investigate the role of insects as pollinators. The flower must not only attract the pollinator (fragrance, colour, nectary guides), but must reward it for its effort (nectar and pollen). Bee products made from plant material include wax, bee pollen, honey (concentrated nectar), propolis (tree resins), and royal jelly (bee secretions).

Station Vocabulary

abdomen
bee
butterfly
moth
nectar
nectary guide
pollen sac
proboscis
thorax

Materials:
- pinned insects: bees (honey and bumble), moths, butterflies, hoverflies and an assortment on non-pollinators (beetles, earwigs, etc)
- display of bee products (wax, honey, propolis, royal jelly) if available
- small dishes (Petri dishes work well) with a piece of plasticine in each to support the insects
- flowers (include a grass inflorescence as an example of wind-pollination)
Note: only one compound microscope at this station for a slide of pollen

Activity: Emphasize that samples should be handled with CARE.
- Demonstration of the mouthparts of a butterfly and a bee are set up to show the general shapes of the mouthparts.
- Insects displayed (some are pollinators while others are not). The students will examine these with the microscopes.
- Identify the insects that look like they would make good pollinators (they will mostly look to see how hairy the insect is as well as if they have sucking mouthparts. Mouthparts may be hidden away. Flies have sponging mouthparts, but many of them make effective pollinators. Students should be able to recognize the differences between moths, butterflies and bees)?
- The insects are numbered. Answers and comments about the insects are under numbered cards.
- Students do not have to look at all of them, but should make diagrams of whatever they find interesting.

Station 7: Pollination in Action

Introduction: This outdoor activity can draw on material from other stations as there are a variety of plants to observe. This is an opportunity to see pollinators in action. The flower will give clues about the pollinator. Flowers with long throats often have long-proboscised pollinators. Large composit heads are great for watching butterflies or bees using their proboscis to withdraw nectar. Bees will often have pollen sacs on their legs, some may even have pollinia glued to their backs. Raceme or spike type of inflorescences are pollinated from the bottom toward the top (foxglove, fireweed). The flowers near the bottom often will have receptive stigmata so the incoming pollinator (with pollen from another plant) will make contact here first. In the flowers above the stamens will be releasing pollen so when the pollinator visits those flowers they receive pollen to take to the next receptive stigma at another inflorescence. The

importance of cross-pollination can be introduced. Is there any evidence of nectar thieves (often ants) who make a hole at the base of a flower to get at the pollen. There is so much to see!

Materials: handlenses

Activity: Find plants flowering in the courtyard (salal, *Camassia*, lilac, peonies). (Students can also be asked if they can identify plants that do not make flowers – conifers, ferns, mosses).

Students will record observations of the flower (colour, fragrance, shape, etc). How does the flower attract the pollinator? How does it reward the pollinator? What type of insect do you think would pollinate the flower? Can you see any pollinators? Sit and observe each flower (salal may be a good one to spend some time at). Pollination activity will depend on whether it is sunny/warm or not.

Note: long tubular red flowers are often hummingbird pollinated

Station 8: Carnivourous Plants

Introduction

Not all insect/plant interactions are beneficial to both partners (mutualistic). In places where nutrients are scarce (e.g. bogs) some plants have evolved a different strategy: catching and digesting insects. The plant must attract (colour, fragrance), trap, and digest the prey. The traps are modified leaves. While the leaves are green and photosynthetic (synthesizing sugar) they gain other nutrients (amino acids) from the insect prey.

Different types of Traps:

1. STICKY TRAP – sundews (*Drosera* sp)
Traps insects by attracting them to nectar-looking droplets, which instead act as glue to trap the insects.

2. SNAP TRAP – Venus flytrap (*Dionaea muscipula*)
Trigger hairs on the leaf cause the leaves to close up like a trap.

3. PITFALL TRAP – pitcher plants *(Nepenthes, Sarracenia*)
The insect is attracted to the edge of the trap and falls into a pitcher-shaped leaf. Downward-pointing hairs prevent the insect from climbing back out.

4. FLYPAPER TRAP – butterwort (*Pinguicula*)
The surface of the leaf is slimy with mucilage to which the insects become stuck.

It is important that the plant not trap and kill its pollinators. Flowers of these plants are generally borne high above the traps and attract different types of insects

Station Vocabulary

butterwort

carnivorous

digestive glands

flypaper trap

insectivorous

pitcher plant

pitfall trap

snap trp

sticky trap

sundew

Venus flytrap

Materials:

- "Bog in a bucket" or terrarium of bog plants to display.
- A number of examples of carnivorous plants labeled 1 to 4.
- A sheet describing the different trap types each numbered (to match to labeled specimens).
- 4 dissecting microscopes and 1 compound microscopes

Activity:

- Students match the number(s) labeling the plants to the following types of trap.
- Dissecting and compound microscopes are available to examine each type of trap (and their prey).
- Cross-sections can be made to show digestive glands (*Dioneae* is a good subject).
- Pitcher plants are dissected to recover dead insects.

An additional activity at this station is to have students plant their own insectivourous plants (*Drosera capensis* is an excellent choice as it self-pollinates and does not die back over the winter)

Closure Discussion

1. General discussion on what they found the most interesting and why.
2. What did they learn that they didn't already know?
3. What questions do they want to investigate?

References

1. John Acorn 2001 Bugs of British Columbia Lone Pine Publishing, Washington

2. Peter D'Amato 1998 The Savage Garden: Cultivating Carnivorous Plants Ten Speed Press, Berkeley, California

3. Druehl, Louis 2001 Pacific Seaweeds: A Guide to Common Seaweeds of the Pacific Coast Harbour Publishing, British Columbia

Extension of Lesson Plan

1. Students can revisit their notebooks and discuss or research answers to their questions.