Lesson #1(a – f) – Teacher Checklist for Plant Structure and Physiology

Expectation Cluster

By the end of this course, students will:

Expectation Code	Expectations
PSP1.01	Illustrate how plants are classified by identifying similar and different characteristics of different types of plants (e.g., make a chart to demonstrate the unique structure and development of plants);
1.02	Describe the structure and physiology of plant tissue;
1.04	Describe the processes of growth and differentiation in plants (e.g., describe the differentiation of germ cells in various tissues; compare meristem cells with elongated cells);
PSP2.01	Apply appropriate sampling procedures when collecting specimens of plants (e.g., collect specimens to illustrate the diversity of fallen cones in a selected coniferous stand); YES!!! Go to this site: http://biology.arizona.edu/sciconn/lessons/barber/plantintro.html See Appendix A
2.07	Distinguish between monocot and dicot plants, using appropriate instruments and sources.

Bottom Line

This lesson consists of SEVEN discovery-activity stations where students explore plant structure, the differentiation of plants and are introduced to transport in plants.

Materials

Teacher Materials	Student Materials

Investigation of Plants – A Discovery Station Activity: ▪ Photocopies of selected diagrams, pictures, etc…from texts ▪ Slides (and/or microviewer slides) of monocot and dicot stems, seeds, and leaves ▪ Slides (and/or microviewer slides) of dicot stems (e.g., Tilia, 1st year, 3rd year and 5th year) ▪ Stained slides of the Allium root tip, chloroplasts in leaves	▪ Student Activity #P1 Worksheet "Investigation of Plants – A Discovery Station Activity" ▪ Mini-test
▪ Live plants with good roots ▪ Petri dish ▪ Water ▪ Food colouring ▪ 3 straws of different diameter ▪ Ruler ▪ A day in the fall, after leaves have fallen from the trees (in order to collect samples of leaves, cones or seeds (in the spring)) ▪ Plastic bags ▪ Gardening gloves	

Safety Concerns –

Lesson Sequence

Day 1	Start the lesson by going outside and collecting samples of FALLEN leaves, cones, and fallen branches. MAKE SURE THAT students don't RIP pieces off living trees. (These items will be used after the station activity).
Day 2	Distribute the Student Activity #P1 Worksheet "Investigation of Plants – A Discovery Station Activity". Explain that the students will be required to complete all the stations and that a MINI-TEST, covering all the stations, will be forthcoming after the activity. *(Depending on the class, time will vary on HOW LONG this activity takes. It should take approximately 2 hours for a thorough, complete exploration.) Have the students practice the proper use of the microscope, focusing on specimens, preparing wet mounts, estimating the size of objects, and DRAWING 'PROPER' BIOLOGICAL DRAWINGS.
Day 3	Mini-test.

Assessment Tools and Strategies

Mini-test at the end of the activity.

Accommodations and Extensions

For root examination, you could have students grow roots from an onion a month before this unit.

Background Information

Due to the nature of this activity (appropriate text references are given and information accompanying slides and/or microviewers are given with each station), there really should be NO NEED for you to take up the answers. The students are to look up the answers themselves and you act as a facilitator to aid in understanding of some of the more complex concepts. At EACH station, you should have textbooks open to the proper information for that station as a reference for the students.

Although the activity is mainly student-centered and does not necessarily require you to teach the whole lesson. You should familiarize yourself at least 2 weeks in advance to go over all the concepts outlined in the activity. This information can be found in any grade 11 or OAC biology text. Specifically, leaf anatomy, monocot and dicot leaves, seeds, cross-sections of monocot and dicot stems, transport of water and nutrients, etc…

Helpful Hints

You might want to have some samples of leaves laminated for later use, White Ash, Paper Birch, Bigtooth Aspen, Chestnut, Flowering Dogwood, Elm, Douglas Fir, Cherry, Hemlock, Magnolia, Pine, Spruce, Willow, etc…

If you just buy green onions, they usually have nice roots that grow if you leave them in water for 3 or 4 days.

Resources

Textbooks:

Any grade 11 biology texts (newer being better because they include mini-labs, investigations, labs, etc…), Nelson Biology 11: Plant Unit "Plants: Anatomy, Growth, and Functions", McGraw-Hill Ryerson. Biology 11: Plant Unit "Plants: Anatomy, Growth, and Functions", Addison Wesley Biology 11: Plant Unit "Plants: Anatomy, Growth, and Functions".

Websites:

Plants:
http://www.hcs.ohio-state.edu/hort/bio.html - biology of horticulture
http://gened.emc.maricopa.edu/bio/bio181/BIOBK/BioBookPLANTANATII.html -from, of course, the online biobook
http://www.unl.edu/wglider/tutor/plant.htm - excellent pics (light microscope and electron micrographs) and click on tutorial

Slides and Microviewer Slides:

These can be purchased from any science materials company.

Teacher Appendices

Student Activity #P1 Worksheet "Investigation of Plants – A Discovery Station Activity"
Sample mini-test

Student Activity Sheet #3a

HOW TO MAKE A SCIENTIFIC PLANT COLLECTION

MAKING A PLANT PRESS

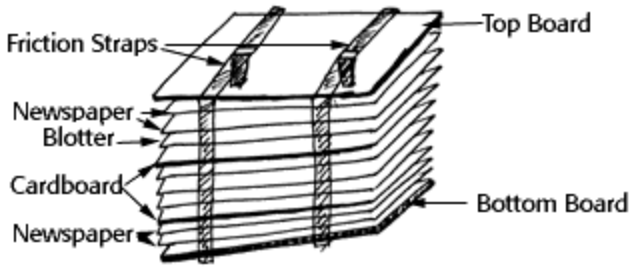
When scientists preserve a specimen of a plant (or part of a plant) they usually flatten it, dry it and mount it on special paper. Preserved in this way the plant specimen can be stored for many years without falling apart.

To get a good preserved specimen, the plant material that is collected in the field must be of good quality. A half-dead, wilted or dry plant does not press well and will not make a good preserved specimen. Select plant material that is growing well, is healthy and is representative of that type of plant growing in the area. When collecting the specimen, cut it to a size that will fit conveniently in the plant press. If the specimen is small enough, it can be pulled from the ground so that the whole plant, roots and all can go into the press. Sometimes a specimen will need to be folded over or trimmed a little to make it fit in the press.

Plants that have been collected need to be pressed as soon as possible. Plants can be kept in a paper or plastic bag for an hour of so, but once they start to wilt they make poor specimens. **Press cut specimens as soon as possible.**

The preservation process begins by flattening the plant specimen in a plant press. A plant press is made of newspapers, cardboard, blotter paper and wood and is held together with nylon straps. See the drawing below:

Plant Press Construction



Work in groups of two and make one plant press for your group. The press should be put together as shown in the diagram above. Materials for your plant press have been cut for you. The wooden pieces are the top and bottom. The cardboard and blotter paper are alternated and strapped into the press. **Do not put any newspapers in the press yet.** They will be used for individual plant specimens and will be placed in the press when the specimens are collected. Place two straps around your press to hold it together. Write the names of the people using the press on the name label.

Student Activity #P1 Worksheet "Investigation of Plants: A Discovery Station Activity"

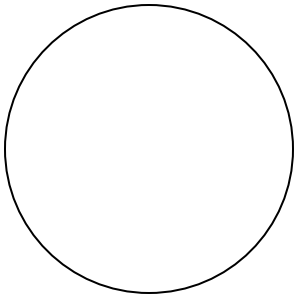
Name: _____ Date: _____

1. STEM ANATOMY: MONOCOTS AND DICOTS

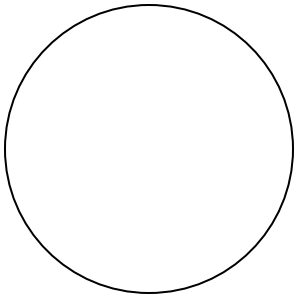
Microviewer Set #210 – slide #	Microscope Slide
6	Monocot and Dicot Stem

a. Review the MICROVIEWER SLIDE and note the MAIN difference in the arrangement of the veins in both the monocot and dicot.

b. Draw a labeled diagram of the MICROSCOPE SLIDE "Monocot and Dicot Stem"



Monocot stem



Dicot stem

2. DICOT STEMS

Microviewer Set #210 – slide #	Microscope Slide
7	Tilia, 1st year and 3rd year or 5th year

a. Review the MICROVIEWER SLIDE and answer the following questions:
   a. What is the cambium?

   b. What does the cambium produce every growth season?

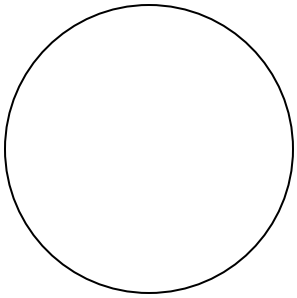
   c. In the slide, where are the oldest rings located?
      i. Near the bark ii. Near the pith

d. In the slide, where are the most recent rings located?

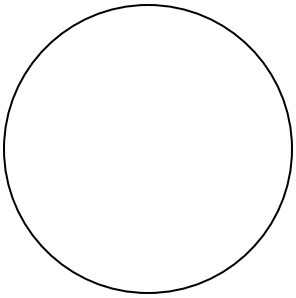
i. Near the bark ii. Near the pith

e. State the direction of growth in a dicot stem.

b. Draw a labeled diagram of the MICROSCOPE SLIDES "Tilia, 1st year and Tilia, 3rd year or 5th year "



1-Year Old



3-Year Old / 5-Year Old

3. ROOT MORPHOLOGY

Specimen	Microscope Slide
Spider Plant root	Allium Root Tip

a. Review the Spider Plant root system and answer the following questions:
   a. What is the difference between a tap root system and a fibrous root system? (Draw a labeled sketch of the two to supplement your explanation)

b. Which root system does the Spider Plant have?

c. How do you know?

d. Almost all roots have a ROOT CAP and ROOT HAIRS. Draw a sketch of the root tip and state the function of the two terms.

Diagram Title:

Structure	Function

b. Obtain the MICROSCOPE SLIDE "Allium Root Tip". Sketch the root tip at the lowest magnification and locate the 4 divisions that you see. Provide a BRIEF explanation of what occurs in each ZONE.

Diagram Title:

4. TRANSPIRATION OF WATER

Materials: petri dish, water, food colouring, 2 straws of different diameter, capillary tube, ruler

Procedure:

a. Obtain a petri dish. Fill in halfway with water. Place 3 drops of food colouring.
b. Obtain 2 straws of different diameter and a capillary tube.
c. Measure the diameters of each straw and record the data on the table below:

d. Hold your index finger over the opening at one end of each straw. Place the other end into the petri dish. Let go of your index finger. Measure and record the height of the water drawn up by the straw.

Observations: Table Title: _____

Straws/measurements	Straw #1	Straw #2	Capillary tube
Diameter			
Height of water			

Conclusions:

Questions:

1. Define the term "Transpiration".

2. What is "bulk flow"?

3. What property of water allows for transpiration to occur in plants?

4. Describe the pathway of water movement from the soil to the atmosphere.

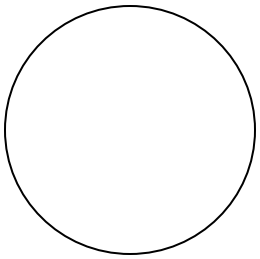
5. Which way does water flow in the plant?

6. How does this mini-lab relate to transpiration and water uptake in plants?

5. TRANSPORT OF CARBOHYDRATES AND THE PHLOEM

Microscope Slide
Chloroplasts, Leaf

a. Identify and draw a labeled diagram of the chloroplast.



b. Which cell organelle is responsible for the production of glucose?

c. What colour is this organelle? What pigment is responsible for this colour?

d. Which cells contain this organelle?

e. Where are these cells located?

f. What are "sinks" referring to in the plant?

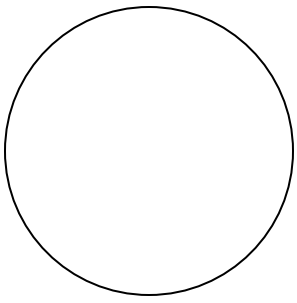
g. Which way does carbohydrates flow in the plant?

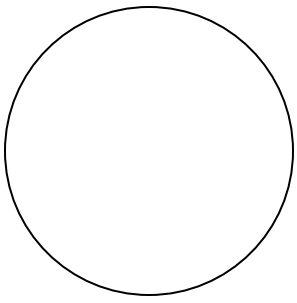
6. SEEDS OF MONOCOTS AND DICOTS

Microviewer Set #210 – slide #
1 and 2

a. Review the MICROVIEWER SLIDE and note the MAIN difference between monocot seeds and dicot seeds.

c. Draw a labeled diagram of the MICROVIEWER SLIDE





Monocot seed Dicot seed

d. Define the term “germination”.

e. What is a COTYLEDON?

7. LEAF: MONOCOT AND DICOT LEAVES

Microviewer Set #210 – slide #	Microscope Slide
4 and 5	Monocot and Dicot Leaf

a. Review the MICROVIEWER SLIDE and note the MAIN difference in the arrangement of the veins in both the monocot and the dicot leaf. (Draw a labeled sketch of the two to supplement your explanation)

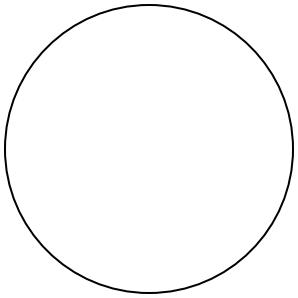
b. Draw a labeled diagram of the MICROSCOPE SLIDES “Monocot and Dicot Leaf”

Monocot Leaf (cross section) Dicot Leaf (cross section)

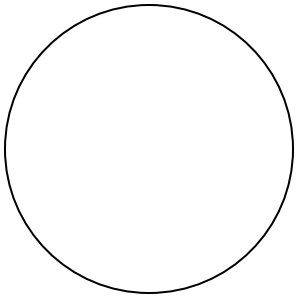
Sample Mini-Test for Student Activity #P1 Worksheet "Investigation of Plants: A Discovery Station Activity"

Part A: Drawings

1. Sketch a Draw a labeled diagram of the monocot and dicot stems



Monocot stem



Dicot stem

2. State the MAJOR difference between the two diagrams in question 1.

Part B: Short Answer

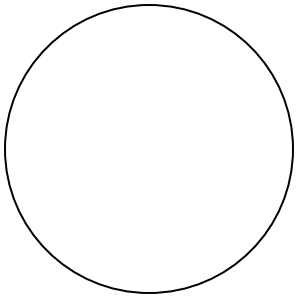
1. Compare and contrast the transport of water and nutrients in a vascular plant.

2. Other than the difference highlighted in question #2 of Part A, make a table that states 4 other differences between monocots and dicots.

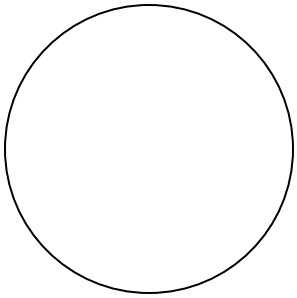
Answers to Sample Mini-Test for Student Activity #P1 Worksheet "Investigation of Plants: A Discovery Station Activity"

Part A: Drawings – answers vary

1. Sketch a Draw a labeled diagram of the monocot and dicot stems



Monocot stem



Dicot stem

2. State the MAJOR difference between the two diagrams in question 1.

The vascular bundles in the monocot are distributed randomly throughout the stem whereas, those in the dicot are arranged in a ring.

Part B: Short Answer

1. Compare and contrast the transport of water and nutrients in a vascular plant.

Water and dissolved materials travel in the xylem from the roots to the leaves of the plant, whereas, complex chemical nutrients travel in the phloem from the leaves, throughout the plant (in all directions) to the roots.

Both are transported via the vessel system of the plant.

2. Other than the difference highlighted in question #2 of Part A, make a table that states 4 other differences between monocots and dicots.

	Seed leaves	Flower parts	Mature leaves	Roots	Examples
Monocot	One cotyledon	Multiples of three	Narrow leaves Parallel veins	Fibrous root system	Orchids, wheat, rice

Dicot	Two cotyledon	Multiples of four or five	Broad leaves Branching veins	Tap root system	Oak and maple trees, cacti, sunflowers

HOW TO MAKE A SCIENTIFIC PLANT COLLECTION

OBJECTIVE: Students will learn how plant specimens are pressed, mounted and labeled by observing several herbarium specimens of preserved plants. Students will then work in groups of two to construct their own plant presses from materials that have already been cut to size by the teacher.

NOTE: Do not expect students to cut the materials for the plant press unless you have a large table-type paper cutter and plan to make a lesson out of measuring and cutting.

BACKGROUND: When scientists preserve a specimen of a plant (or part of a plant) they usually flatten it, dry it, and mount it on special paper. Preserved in this way the plant specimen can be stored for many years without falling apart.

Students need to be taught to select specimen material that clearly represents the plant they are collecting. Picking a few leaves or flowers usually does not give a representative picture of a plant. Pieces of specimen plant material need to be large enough to show the characteristics of normal growth and development. Taking a branch, stem or even the entire plant may be required to get a good specimen. Plants that show unnatural growth, damage or deterioration will not be good specimens when dried and mounted. **Stress the need to collect good specimens.**

Once a good specimen is collected, the specimen is flattened in a plant press. A plant press is made of newspapers, cardboard, blotter paper and wood and is held together with two straps.

Out in the field students may experience some difficulty placing plants in the plant press, especially on a windy day. Some of these problems can be controlled by leaving the press in a sheltered place and bringing the plant specimens to the press. Or, the press can be left in the classroom and plants can be brought back from the field in plastic or paper bags. **Note:** It is very important that collection data be kept with each separate plant specimen. If the plant is not placed directly in the press at the collection site, care must be taken that the correct information is recorded and attached to the plant specimen (see

Activity #4).

MATERIALS FOR A PLANT PRESS

The top and bottom boards for a plant press should be precut from one-quarter inch plywood slightly larger than a folded section of a newspaper; cut 2 boards about 30.5 cm X 40.5 cm (12 X 16 inches) for each press. Cardboard and blotter paper should also be cut to the same size. **Note:** before cutting anything, measure the folded newspaper that will be used in the press. Newspapers vary in size, so measure first.

The press is then assembled by layering the newspapers, blotters, and cardboard. There is no rule for how many of each to use. Usually 5-10 pieces of cardboard and blotter paper are interspaced with three or four pieces of newspaper. Some plant collectors prefer to keep the newspapers separate until a piece is needed. When a specimen is collected it is placed in the folded newspaper and slipped between blotters into the press. The press is held together by two straps with friction buckles. The next page Student Activity Sheet 3a shows students how the plant press is assembled.

Lesson #2

Lesson #4

Expectation Code	Expectations
PSV.01	Demonstrate an understanding of the diversity of plants, and of their internal transport systems, reproduction, and growth;
PS1.03	describe in words and/or diagrams the life cycle of plants, and differentiate between such divisions of plants as ferns and horsetails;
PS3.04	evaluate the importance of plant diversity both in maintaining natural ecosystems and in providing sources of medicines

Bottom Line
Students will learn the life cycles of ferns and horsetails and they will identify an endangered plant and present a solution to save its habitat.

Teacher Materials	Student Materials
• Live or pictures of plant material (fern with sporangia, horsetail, pine cone with branch, kidney bean or plant seedling) • Plant life cycles overheads (Appendix 1A) • Overhead projector • Plant life cycles station activity (Appendix 1B) with live or pictures of plant material (fern with sporangia, horsetail, pine cone, kidney bean) • Poster paper • Computer and internet • 2-3 coloured pieces of paper for each student	• Plant life cycle worksheets #1 • Markers, pencil crayons, scissors, glue

Safety Concerns
Possible allergies to pollen and plants depending on season.

Lesson Sequence	Demo, Agriculture worksheet 1 Day Research and display (flow chart) 3 days

1. Students are arranged in cooperative groups of 4 to 5.
2. Teacher displays live or pictures of plant material and asks group to brainstorm and predict how each plant reproduces to complete its life cycle.
3. In groups students produce flow chart of each plants' life cycle.
4. Groups compare life cycles of the plants.
5. Using Plant Life Cycles overheads (Appendix 1A) and Plant life cycles worksheets (#1), teacher and students work through the worksheets completing the blanks.
6. Plant Life Cycles Station Activity (Appendix 1B): The teacher will place in various areas of the classroom one copy of a Station with the corresponding plant material. In cooperative groups of 4 to 5, students complete Plant Life Cycles Station Activity (Appendix 1B) using completed Plant life cycles worksheets (#1) for reference by moving from station to station answering the questions in their notebooks.
7. Teacher may correct Plant Life Cycles Station Activity in class, or collect for evaluation.
8. Teacher will direct the groups to draw the life cycles of the fern or horsetail on poster paper using the Internet as a resource. Teacher can then display the finished work on the walls of the classroom.
9. Plant diversity demonstration: Students are separated into two groups. Group 1 represents one type of tree (maples), and Group 2 represents a mixed forest of trees (including some maples). Each student will receive a paper describing what type of tree he or she is. The two forests will be infested with a hypothetical Beetle Blue. This beetle will only eat the tasty leaves of maple trees, and will deposit toxic slime on the branches and bark that will then kill the maples. All students that are maples will sit down, signifying death of the maple.
10. Teacher will ask students questions concerning the ecosystem of the forest. What will happen to the birds that nested in the maples? The squirrels? The chipmunks? The insects? Compare and contrast the two forests and the effect on the plant diversity present.
11. Teacher will assign Source for Medicine Presentation and Source for Medicine Rubric (Appendix 1C) .
12. Students present and teacher evaluates using Rubric.

Teaching and Learning Strategies
Cooperative groups, student centred learning, teacher directed learning

Assessment and Evaluation Tools

Students will be assessed on the completion and accuracy of the Plant Life Cycles Worksheets.

Students will be assessed on the completion and accuracy of the Plant Life Cycles Station

Activity.
Students will be assessed on the completion and accuracy of the fern or horsetail life cycle poster paper.
Students will be assessed on the Source for medicine presentation, by the Rubric for the Source for medicine presentation (Appendix 1C).

Background Information

Alternation of generations: the organism must complete a diploid and a haploid (sporophyte and gametophyte) generation to complete one life cycle
Angiosperm: plants with their seeds enclosed in a vessel (eg tomatoes, peas)
Antheridium: structure on the gametophyte where the male sperm is produced
Archegonium: structure on the gametophyte where the female egg is produced
Gametophyte: haploid plant that produces both sex gametes
Gymnosperms: plants with their seeds exposed to the environment (eg pines)
Sporangium: structure located on the sporophyte that produces spores
sporophyte: a diploid plant that produces spores

Plants such as ferns and horsetails undergo alternation of generations to complete one life cycle. Where angiosperms and gymnosperms do not. In ferns and horsetails, the gametophyte and the sporophyte are independent photosynthetic organisms.

In alternation of generations, the beginning of the sporophyte generation starts with the process of fertilization and the zygote. It will mature into a diploid sporophyte, and is easily recognizable as a fern or horsetail. Sporangium are located on the underside of fern leaves, are generally brown in colour and produce spores by meiosis.

The spores that are released, are haploid (N) and signals the start of the gametophyte generation. A spore will produce a small plant called a gametophyte, which is also haploid. This structure may be thin, green and heart shaped and is relatively small. It will produce root like rhizoids to access nutrients from the soil. This haploid plant will produce eggs in an archegonium, and sperm in an antheridium. Moist conditions are needed for the sperm to swim to the egg and fertilize it producing a zygote and signaling the start of the sporophyte generation. The young sporophyte will develop while attached to the gametophyte. As the sporophyte grows, the gametophyte withers away. The uncurled frond leaves of the fern are called fiddleheads, and some species are edible. It is worth noting that water is required for the sexual reproduction of the fern and horsetail.

Horsetails reproduce in a similar fashion to ferns, in that water is necessary for sexual reproduction to occur, and alternation of generations is a part of the life cycle. Horsetails house the sporangia on very distinctive conelike structures. The plant incorporates silica from the soil into the cell wall of the stem, giving the stem a rough texture- good for scouring pots and pans when you're camping.

Gymnosperms produce two sex cones that will give rise to gametophytes. Only the male gametophyte, the pollen grain is transported to the female gametophyte, the eggs. Pollination occurs when the pollen grain has reached the ovule, the pollen grain will develop a pollen tube (similar to that of angiosperms) that will carry the sperm to the egg. The fusion is when fertilization occurs, and in gymnosperms, it may occur some time after pollination. In angiosperms, pollination and fertilization generally occur within a reasonable amount of time.

Plant diversity is required for the survival of ecosystems because, among other things, they help to regulate conditions, and provide shelter and habitat to numerous organisms. Plants have genetically adapted to survive in the environment they populate. Some plants are more flexible than others, willow trees are found from Ontario to the arctic. It is difficult for a cactus from Mexico to survive in and Ontario garden. Many of the plants in the rainforest have become specialized for living in certain conditions, or to be pollinated by specific organisms. Since one fourth of today's medicine is derived from plants of the rainforest, loss of that environment would also mean loss of that plant, since it is specific to that area. Destruction of the rainforests, that hold a great amount of biodiversity, would definitely translate to the loss of discovering new cures for diseases.

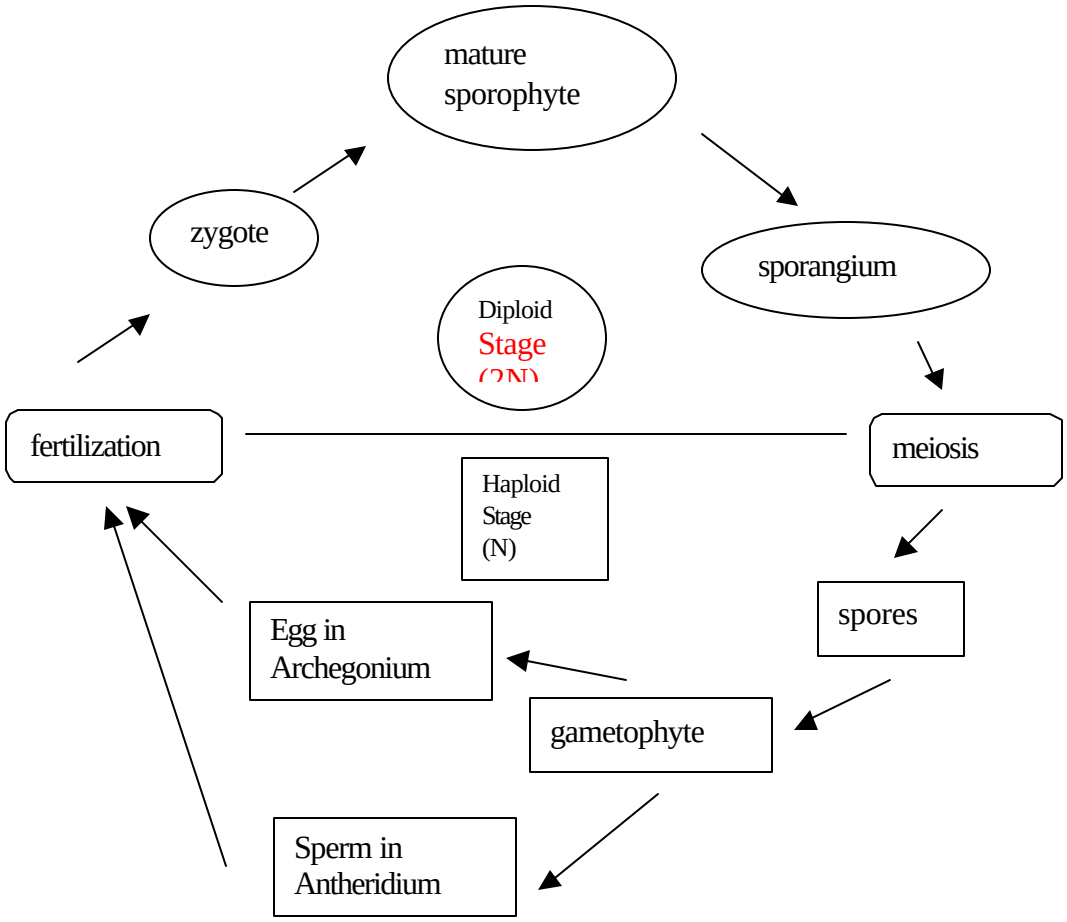
Helpful Hints
Using plant material from the surrounding area would be best. The web sites in the resources section include life cycle diagrams. These could be printed and the diagrams used for the Plant Life Cycle Activity.

Resources
• www.ultranet.com/~jkimball/BiologyPages/W/Welcome.html • web1.manhattan.edu/fcardill/plants/intro/plantmen.html • Understanding Biology. Don Galbraith. John Wiley & Sons. 1989. • Biology. Kenneth R. Miller & Joseph Levine. Prentice Hall. 1998.

Appendices

Appendix 1A

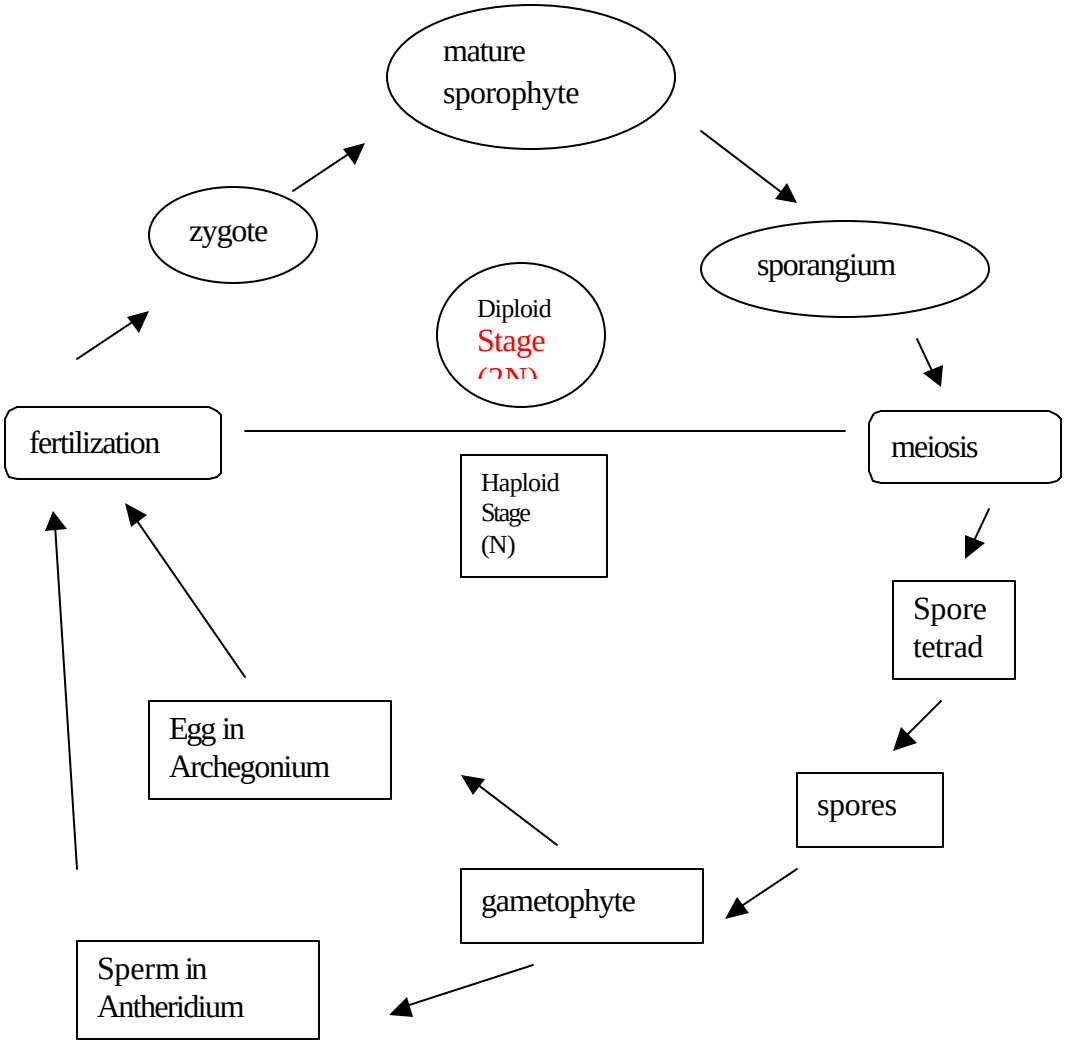
Life Cycle of Ferns



Life Cycle of Ferns

Fern plants that people recognize are the diploid sporophytes (a diploid plant that produces spores). They are the largest members of the spore bearing plants. While the majority of ferns grow in the rain forests because of the moist conditions, many species are also present in the forests of Ontario. The sporophyte plant will produce spores in the sporangium. The sporangium may be located under fern leaves, or on specialized leaves. When the sporangium matures, the spores will be released into the atmosphere. The spores are produced by meiosis. The spores will develop into a gametophyte (haploid plant that produces gametes) only if the right water, temperature, and light conditions are present. Fern gametophytes are typically heart shaped. The gametophyte will produce the gametes in two specialized structures in different locations on the plant. The egg (female gamete) is produced in the archegonium, near the top of the gametophyte. The sperm (male gamete) is produced in the anteridium, located near the bottom, close to the rhizoids. The sperm need some water in order to swim to the egg and fertilize it. The zygote will begin to develop in the archegonium, and the young sporophyte will begin to grow on the gametophyte, then develop into a mature plant. Fiddleheads are the young leaves of the sporophyte curled into a ball and some species many be eaten.

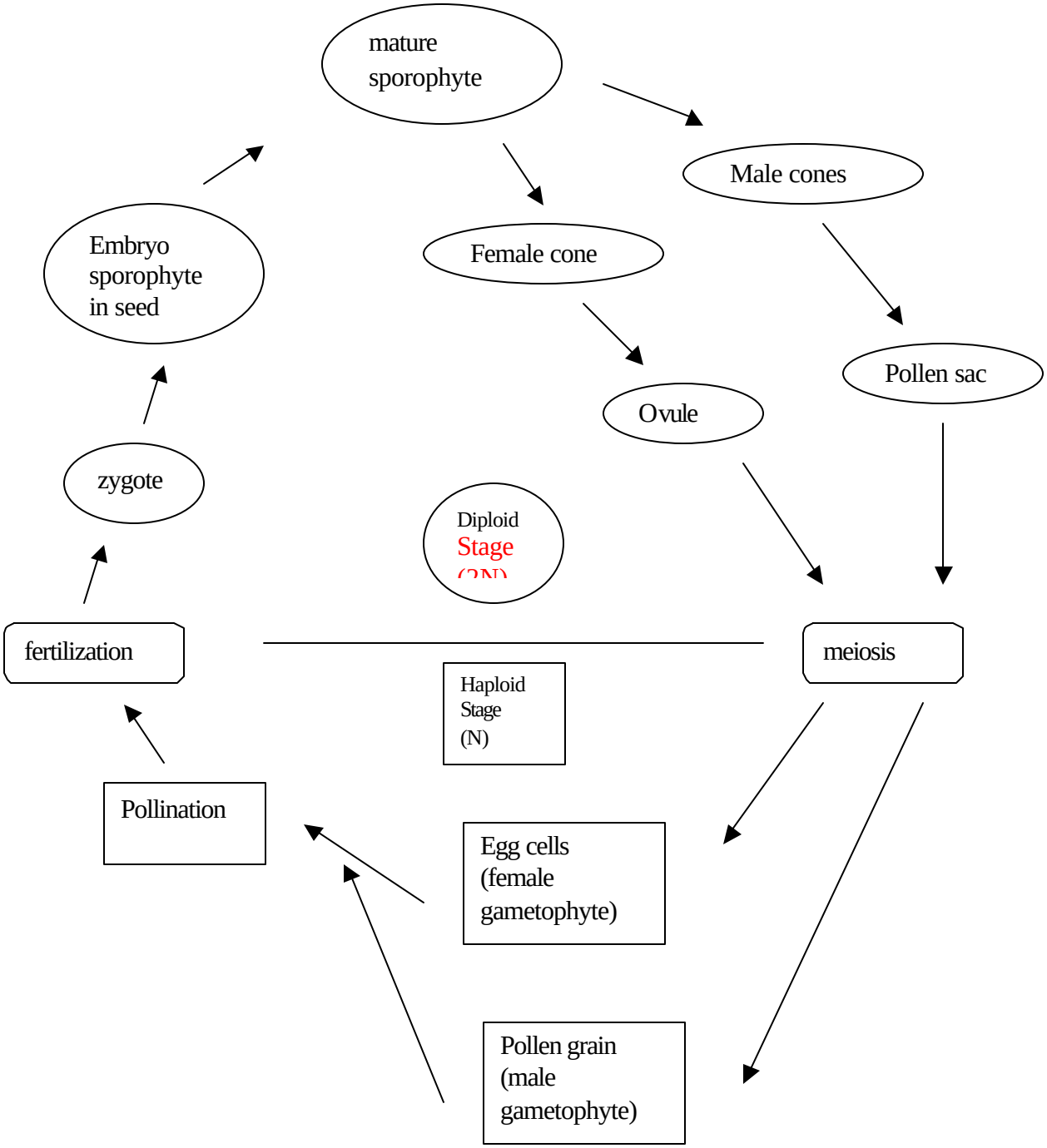
Life Cycle of Horsetails



Life Cycle of Horsetails

Only one genus of horsetails, *Equisetum*, with about 50 species are present today. The common name for horsetails is the "scouring rushes" because their rough surfaces contain bumps of silica that are useful to scrub pots and pans. The horsetail sporophyte is a slender stem with many branches. The sporangium can be located on the tip of a specialized stem in a cone- like structure. At maturity, the spore tetrad will be released from the sporangium. Under the right light, water and temperature conditions, the spore will develop into a gametophyte. The gametophyte will produce the gametes in two specialized structures in different locations on the plant. The egg (female gamete) is produced in the archegonium, at one pole of the gametophyte. The sperm (male gamete) is produced in the anteridium, located near the other pole. The sperm need some water in order to swim to the egg and fertilize it. The zygote will begin to develop in the archegonium, and the young sporophyte will begin to grow on the gametophyte, then develop into a mature horsetail sporophyte.

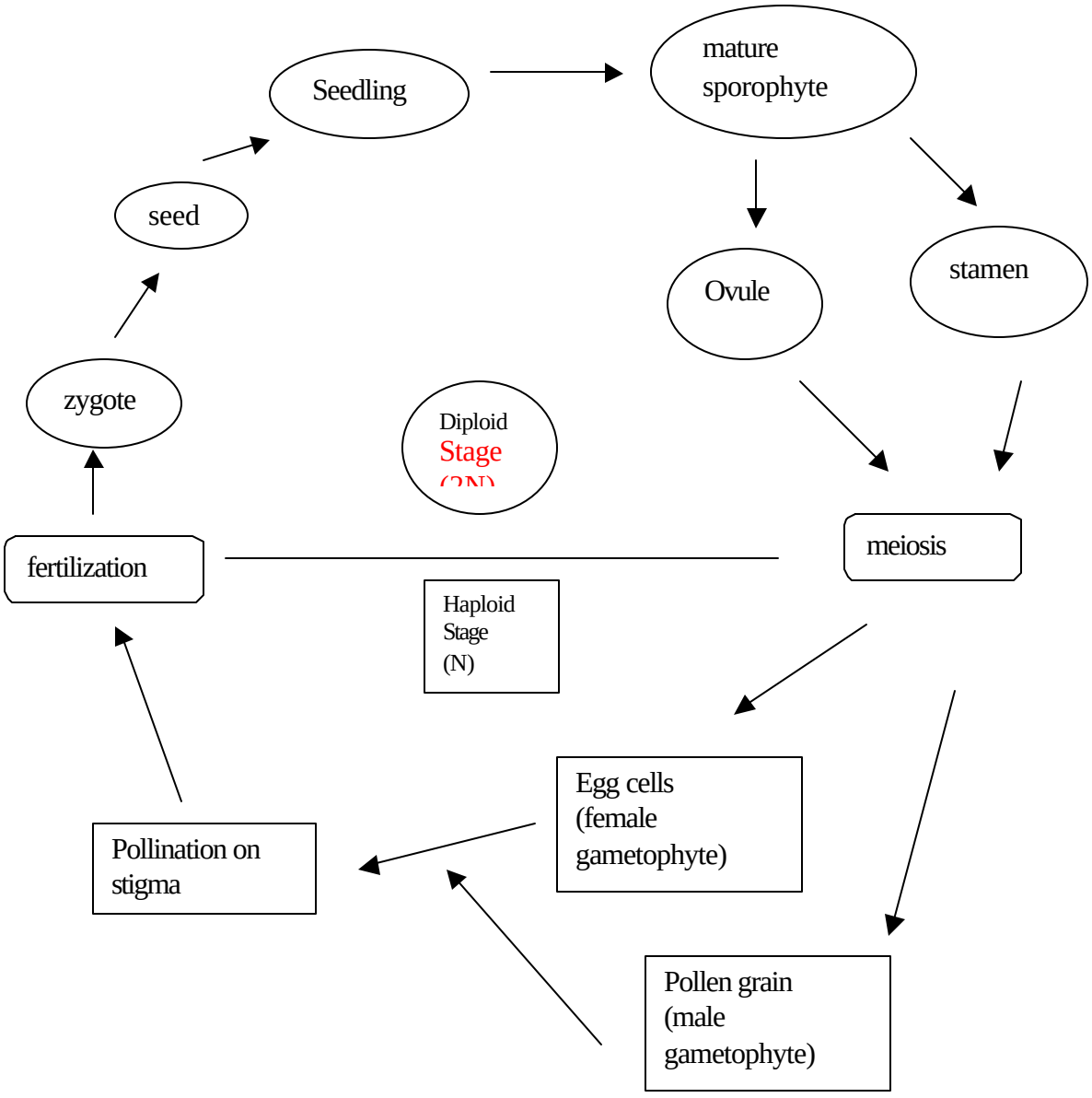
Life Cycle of Gymnosperms



Life Cycle of Gymnosperms

Trees that are members of the gymnosperms include pines, firs,spruces, ginkgos, cycads, junipers and redwoods. Gymnosperm means “naked seed” because the seeds are open to the environment at pollination. The trees we recognize are the mature sporophyte. Trees produce two separate sex cones in early spring. The cones are where the sporangia are located. In the male cone, the pollen sacs in the sporangia, undergo meiosis to produce pollen grains. Male pollen grains (haploid male gametophytes) are released into the air in early spring. The female cones contain ovules. Inside the ovules, the sporangia are located. The ovule undergoes meiosis to produce the eggs (haploid female gametophyte). Pollination is when the wind transports the pollen grains to the female cone. When the nucleus of the pollen grain (sperm) joins the nucleus of the female egg fertilization has occurred and a zygote is formed. Sometimes, fertilization will occur some time after pollination. The zygote will develop into a sporophyte embryo packed into a seed. The seed will then germinate and develop into a sporophyte, a tree.

Life Cycle of Angiosperms



Life Cycle of Angiosperms

Plants that have flowers are in the group of angiosperms, and these include trees such as apples, peaches, cherries, and plants such as lilies, roses, periwinkle. Angiosperm means seeds enclosed in a vessel or case, they are not open to the environment. The flower we see is the mature sporophyte. Male and female structures are located on the same sporophyte. The stamen is where the male gametophyte, the pollen grain, is produced. Meiosis produces the haploid male gametophyte. Transporting the pollen grain to the tip of the sticky stigma, also known as pollination, can occur in many ways, by insects, birds, or wind. In the ovule, meiosis occurs to produce the haploid female gametophytes, the eggs. When the nucleus of the pollen grain joins the nucleus of the egg, fertilization has occurred, and a diploid zygote is produced. The zygote will develop into an embryo inside the seed. Under the right conditions, the seed will germinate and grow into a seedling, then a mature sporophyte, or flower.

Appendix 1B

Plant Life Cycles Station Activity

Station 1 (Fern)

On a separate piece of paper answer the following questions about the plant in front of you. Not all of the questions can be answered.

Is the plant in front of you is a spore bearing plant or a seed bearing plant?
Is it diploid or haploid?
Is it a gametophyte or a sporophyte?
Where would I find the sporangium on this plant? Locate the sporangium if you can.
Draw the plant indicating where the sporangium should be.
What generation is this plant in?
Draw the next stage in this plant's life cycle.
Give a location where this plant would be found (tundra in the Yukon, grassland of Manitoba, temperate forest of Ontario)?

Station 2 (Fern gametophyte picture)

On a separate piece of paper answer the following questions about the plant in front of you. Not all of the questions can be answered.

Is the plant in front of you is a spore bearing plant or a seed bearing plant?
Is it diploid or haploid?
Is it a gametophyte or a sporophyte?
Where would I find the sporangium on this plant? Locate the sporangium if you can.
Draw the plant indicating where the sporangium should be.
What generation is this plant in?
Draw the next stage in this plant's life cycle.
Give a location where this plant would be found (tundra in the Yukon, grassland of Manitoba, temperate forest of Ontario)?

Station 3 (Pine cone)

On a separate piece of paper answer the following questions about the plant in front of you. Not all of the questions can be answered.

Is the plant in front of you is a spore bearing plant or a seed bearing plant?
Is it diploid or haploid?
Is it a gametophyte or a sporophyte?
Where would I find the sporangium on this plant? Locate the sporangium if you can.
Draw the plant indicating where the sporangium should be.
What generation is this plant in?

Draw the next stage in this plant's life cycle.
Give a location where this plant would be found (tundra in the Yukon, grassland of Manitoba, temperate forest of Ontario)?

Stage 4 (Horsetail picture)

On a separate piece of paper answer the following questions about the plant in front of you. Not all of the questions can be answered.

Is the plant in front of you is a spore bearing plant or a seed bearing plant?
Is it diploid or haploid?
Is it a gametophyte or a sporophyte?
Where would I find the sporangium on this plant? Locate the sporangium if you can.
Draw the plant indicating where the sporangium should be.
What generation is this plant in?
Draw the next stage in this plant's life cycle.
Give a location where this plant would be found (tundra in the Yukon, grassland of Manitoba, temperate forest of Ontario)?

Stage 5 (Kidney bean)

On a separate piece of paper answer the following questions about the plant in front of you. Not all of the questions can be answered.

Is the plant in front of you is a spore bearing plant or a seed bearing plant?
Is it diploid or haploid?
Is it a gametophyte or a sporophyte?
Where would I find the sporangium on this plant? Locate the sporangium if you can.
Draw the plant indicating where the sporangium should be.
What generation is this plant in?
Draw the next stage in this plant's life cycle.
Give a location where this plant would be found (tundra in the Yukon, grassland of Manitoba, temperate forest of Ontario)?

Station 6 (Horsetail gametophyte picture)

On a separate piece of paper answer the following questions about the plant in front of you. Not all of the questions can be answered.

Is the plant in front of you is a spore bearing plant or a seed bearing plant?
Is it diploid or haploid?
Is it a gametophyte or a sporophyte?
Where would I find the sporangium on this plant? Locate the sporangium if you can.

Draw the plant indicating where the sporangium should be.
What generation is this plant in?
Draw the next stage in this plant's life cycle.
Give a location where this plant would be found (tundra in the Yukon, grassland of Manitoba, temperate forest of Ontario)?

Appendix 1C: Source for medicine presentation

Source for medicine presentation

A rare species of plant in the rainforest is losing its habitat. This plant may have the chemical to cure a disease. It is your job as an environmental scientist to fight for the survival of this plant!

But before you begin, you must be able to answer all of these elements:

- Identify the plant with a name and picture (hand drawn or computer generated)
- Draw a map, showing where its habitat is located.
- Explain what is causing the plant to lose its habitat?
- What can be done to save the plant and its habitat?

Your information can be displayed in any manner you wish (the more creative the better). Presentation of your group's research and answering questions from the class will be assessed.

Rubric for Source for Medicine Presentation

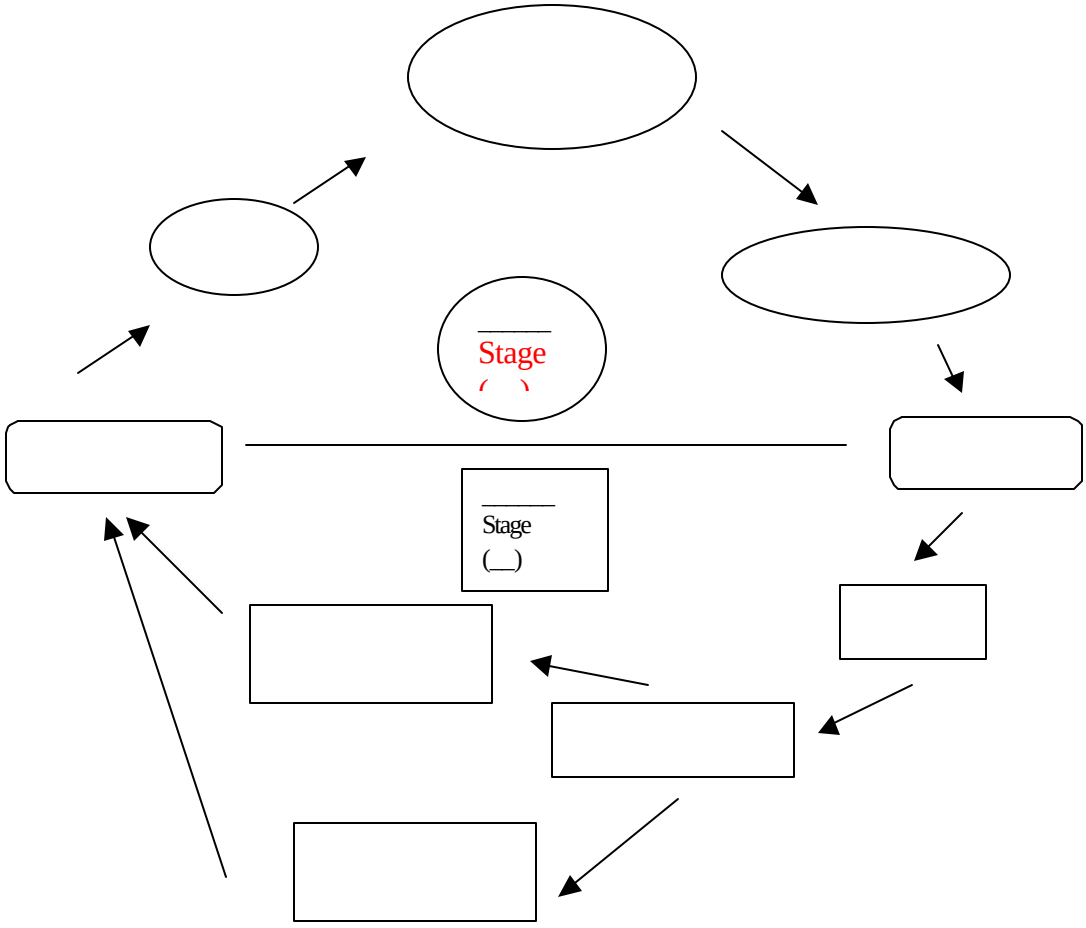
Criteria	1	2	3	4
Presentation skills: voice, body language	Monotone, lack of enthusiasm, minimal eye contact, fumbles over words, low volume, reads verbatim	Some expression and eye contact, limited enthusiasm, little audience involvement, not rehearsed	Expressive and strong voice, shows enthusiasm, involves audience, smooth and well rehearsed	High level of enthusiasm, constant involvement from the audience, highly polished presentation skills
Creativity	Limited use of visuals or of skit	Some use of visuals, brief skit	Use of well developed visuals, coherent and well developed skit	Effective use of visuals, dynamic and highly developed skit
Required elements	Contained 2 or fewer of the required elements of information	Contained 3 of the required elements of information	Contained all 4 required elements of information	Contained more than the required elements of information
Quality of information/ ideas	Shows little understanding of the topic, answers questions in a limited manner	Shows some understanding of the topic, answers direct questions only	Thorough and broad understanding of the topic, answers almost all questions effectively	Thorough, broad, insightful understanding of the topic, answers questions thoroughly and

				effectively

Section 4: Student Worksheets

Plant Life Cycles Worksheets #1

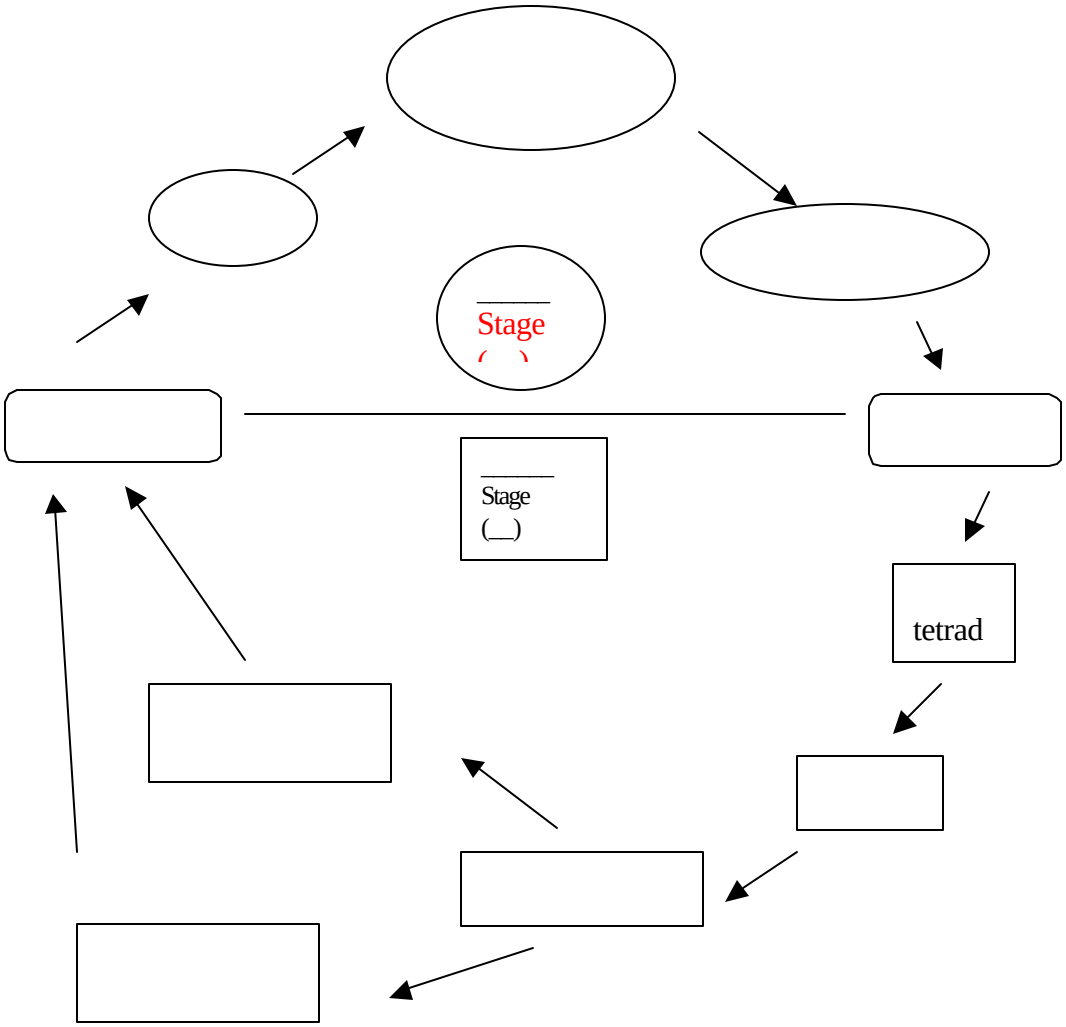
Life Cycle of Ferns Worksheet



Life Cycle of Ferns Worksheet 2

Fern plants that people recognize are the diploid sporophytes (_____). They are the largest members of the spore bearing plants. While the majority of ferns grow in the _____ because of the _____, many species are also present in the _____ of Ontario. The _____plant will produce _____ in the sporangium. The sporangium may be located _____, or on _____ leaves. When the _____ matures, the _____ will be _____ into the atmosphere. The spores are produced by _____. The spores will develop into a gametophyte (_____ _____) only if the right _____, _____, and _____ conditions are present. _____ gametophytes are typically _____ shaped. The _____ will produce the gametes in two specialized structures in different _____ on the plant. The ____ (female gamete) is produced in the _____, near the top of the _____. The _____ (male gamete) is produced in the _____, located near the _____, close to the rhizoids. The sperm need _____ in order to swim to the egg and _____. The _____ will begin to develop in the _____, and the _____ will begin to grow _____, then develop into a mature plant. _____ are the young leaves of the _____ curled into a ball and some species many be _____.

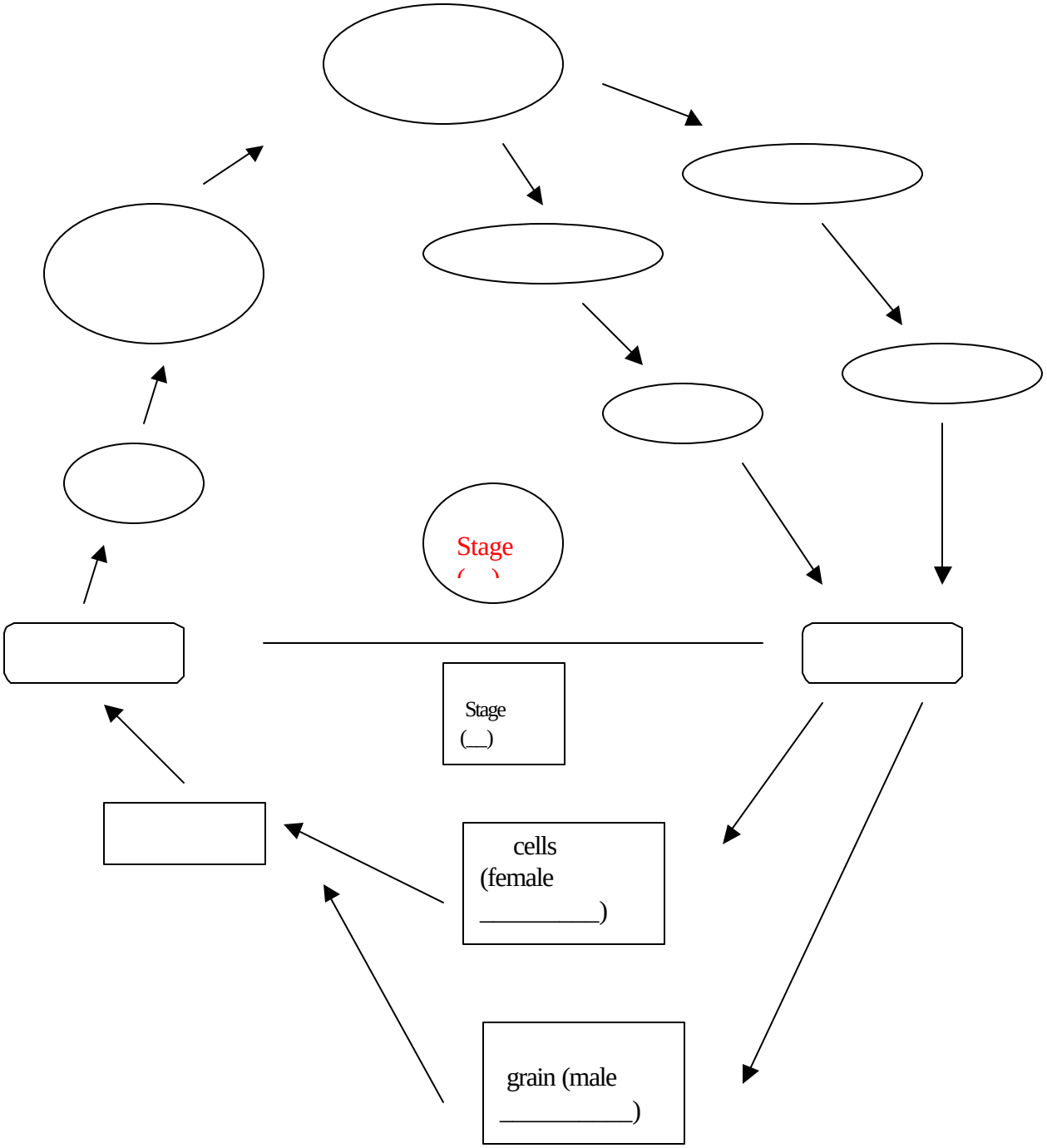
Life Cycle of Horsetails Worksheet



Life Cycle of Horsetails Worksheet 2

Only one genus of horsetails, *Equisetum*, with about _____ are present today. The common name for horsetails is the "_____" because their _____ contain bumps of silica that are useful to scrub pots and pans. The horsetail _____ is a slender stem with many branches. The _____ can be located on the tip of a specialized stem in a _____ structure. At maturity, the _____ will be released from the _____. Under the right _____, _____ and _____ conditions, the spore will develop into a _____. The gametophyte will produce the _____ in two specialized structures in _____ on the plant. The ____ (female gamete) is produced in the _____, at one pole of the _____. The sperm (_____) is produced in the _____, located near the _____. The sperm need _____ in order to swim to the egg and _____. The _____ will begin to develop in the _____, and the young _____ will begin to grow on the gametophyte, then develop into a _____.

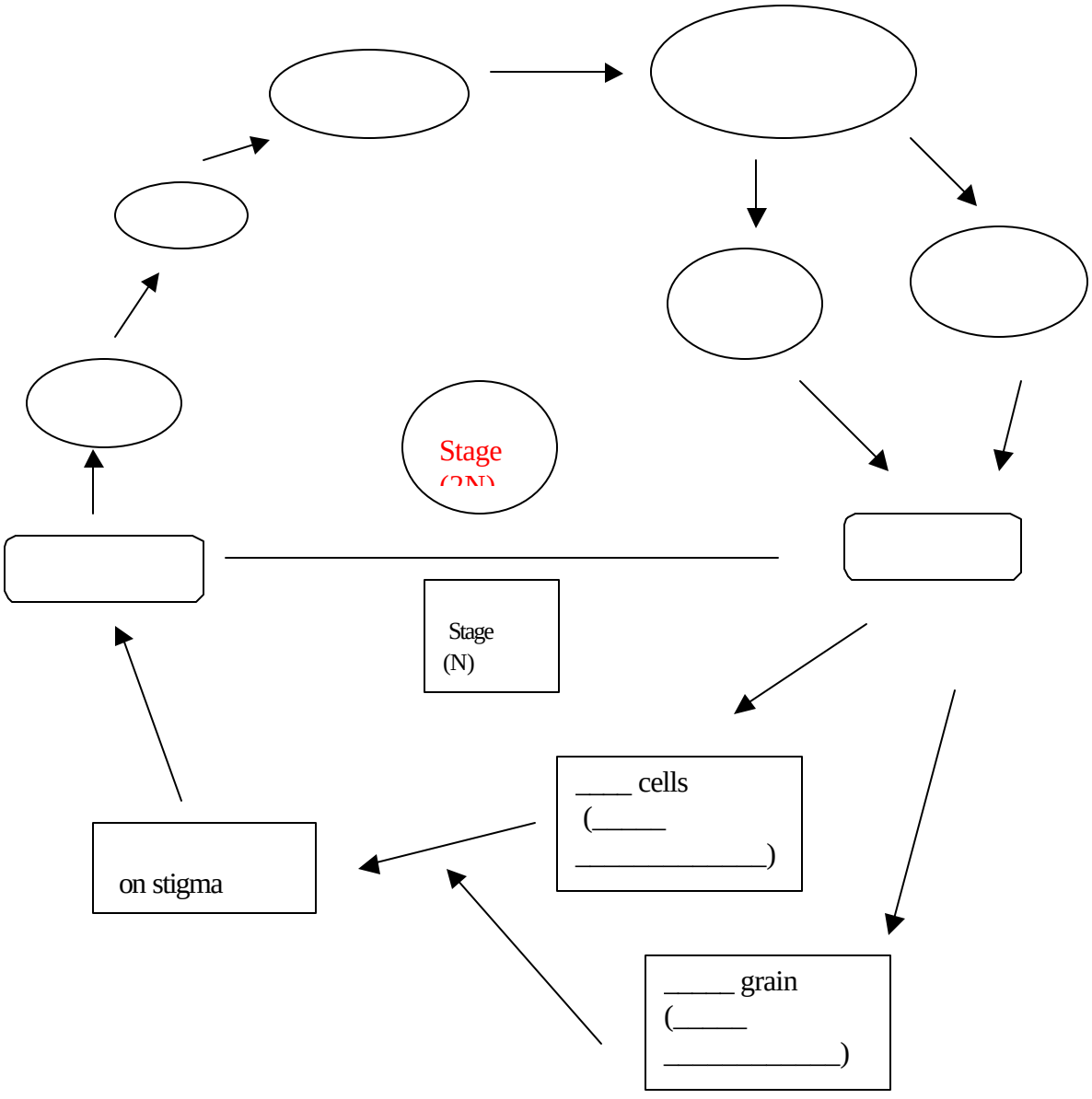
Life Cycle of Gymnosperms Worksheet



Life Cycle of Gymnosperms Worksheet

Trees that are members of the gymnosperms include ____, ___,_____, _____, _____, junipers and redwoods. _____ means “naked seed” because the seeds are open to the environment at _____. The trees we recognize are the mature _____. Trees produce two separate _____ in early spring. The cones are where the _____ are located. In the male cone, the _____ in the sporangia, undergo _____ to produce _____. Male pollen grains (_____) are released into the ___ in early spring. The female cones contain _____. Inside the ovules, the _____ are located. The _____ undergoes meiosis to produce the eggs (_____). _____ is when the wind ____ the pollen _____ to the female ____. When the _____ of the _____ (_____) joins the _____ of the female egg _____ has occurred and a _____ is formed. Sometimes, _____ will occur some time after _____. The zygote will develop into a _____ packed into a _____. The seed will then _____ and develop into a _____, _____.

Life Cycle of Angiosperms Worksheet



Life Cycle of Angiosperms Worksheet

Plants that have flowers are in the group of _____, and these include trees such as _____, _____, _____, and plants such as _____, _____, _____. Angiosperm means _____, they are not open to the environment. The flower we see is the _____. Male and female structures are located on the _____ _____. The _____ is where the _____, the _____ grain, is produced. _____ produces the _____ male gametophyte. Transporting the _____ to the tip of the sticky _____, also known as _____, can occur in many ways, by _____, birds, or _____. In the _____, meiosis occurs to produce the _____, the _____. When the nucleus of the _____ joins the nucleus of the_____, _____ has occurred, and a_____ is produced. The zygote will develop into an_____ inside the seed. Under the right _____, the seed will _____ and grow into a seedling, then a mature _____, or flower.

Lesson #3

Lesson #3

Expectation Code	Expectations
PS2.04	analyse the chemical and physical elements that contribute to plant production in the agriculture and forestry industries
PS3.02	outline the use of plants in the food, textile, pharmaceutical, and fresh produce industries;

Bottom Line
Students will learn the importance of growth regulators in agriculture, and will present one plant used in an industry.

Teacher Materials	Student Materials
• Pieces of unripe fruit (tomato, green banana) • 1 ripe banana, sliced apple • 2 paper bags • Chemicals in agriculture production #1 note • Plants in Industry Display	• Chemicals in agriculture production worksheet

Safety Concerns
Students with potential allergies to fruit.

Lesson Sequence	Before and after demo	1 day
	Design and conduct experiment	3 – 4 days

1. Teacher has ripe and unripe fruit (bananas, tomato) and asks the class which fruit would be the choice fruit to eat. Teacher asks the students how to ripen the immature fruit. Teacher will test students' ideas to ripen the fruit and compare to paper bag demonstration (with a comparable piece of unripe fruit, the teacher will place it and a ripe yellow banana in a paper bag). Compare the two pieces of fruit next day to determine which method of ripening fruit was most effective.
2. Chemicals in agriculture production #1 note (Appendix 2A) and chemicals in agriculture production worksheet #1.
3. Ask students to explain why the fruit in the paper bag with the ripe banana should have matured first.
4. Demonstration: place 2 pieces of unripe fruit in 2 paper bags. Place a ripe banana in

one bag, and a slice of apple in the other bag. Have students predict which fruit will mature first and give reasons for their prediction. Have students draw diagrams of the paper bags and the fruit contents with the ethylene gas present.

5. The class will be divided into four groups to complete the Plants in Industry Display assignment (Appendix 2B). Each group will choose the plant they wish to research, the teacher will assign the industry.
6. Students present their display and teacher evaluates using the Plants in industry display rubric.

Teaching and Learning Strategies
Constructivism, cooperative learning, student directed learning, teacher- directed learning

Assessment and Evaluation Tools
Completion and accuracy of Chemicals in agriculture production worksheet
Students will be assessed on the Plants in industry display, by the rubric for the Plants in industry display (Appendix 2B).

Background Information
Plant growth regulators help the plant to grow at a faster rate. Gibberellins promote cell division and elongation. If this hormone is sprayed on stems, they will elongate. If sprayed on seeds, they may germinate. This helps the agriculture industry to produce more yield at a faster rate. Ethylene has a role in fruit ripening. Fruits produce ethylene as they ripen. Unripened fruit sold commercially, is stored under conditions where ethylene concentrations and temperatures are low. To ripen, the fruit is treated with ethylene gas. Bananas and apples produce ethylene gas. Photoperiodism is the response of a plant to varying lengths of day. Plants that bloom in late summer, such as chrysanthemums and poinsettas, will only flower when the length of daylight is relatively shorter than a critical period. Plants that bloom in early summer, such as spinach or lettuce, require more daylight hours than a critical minimum period to produce crops. Greenhouses artificially reproduce the appropriate conditions (number of daylight hours, temperatures) in order to produce crops of vegetables or flowers indoors. Plants are an integral part of our daily lives, from the food we eat, to the natural fibres we wear, to medicine that we take. Biotechnology is used to modify plants in order to suit our needs.

Resources
http://es.epa.gov/oeca/ag/forestry.html#Facts and Figures http://www.canadian-forests.com/inform.html#TOP http://www.for.gov.bc.ca/hfp/pubs/interest/pi/pitext.htm#pi004 www.ultranet.com/~jkimball/BiologyPages/W/Welcome.html Understanding Biology. Don Galbraith. John Wiley & Sons. 1989. Biology. Kenneth R. Miller & Joseph Levine. Prentice Hall. 1998.

Appendices

Appendix 2A

Chemicals In Agriculture Production

Plants produce chemicals that help them grow or help their fruit mature. Different chemicals serve different purposes.

Ethylene is a gas produced by fruits when they are ripe. Fruits that are not ripe do not produce this gas. If immature fruit is treated with ethylene gas, the fruit will soon ripen. Commercial growers pick many fruits before they are ripe, and store them in cold temperatures. Before sending them to the markets, they will place the fruit in warmer temperatures, and treat them with ethylene gas to ripen the fruit faster.

Gibberellin is a chemical that is produced by plants to speed up cell division. Plants that have short and small stems, can have long and tall stems after treatment with gibberellin gas. Some dwarf plants can become "taller" because the cells are dividing at a faster than normal rate. Gibberellin can also be used on seeds to speed up germination.
How can commercial growers use gibberellin?
To speed up germination and to check which seeds will not germinate.

Not only do chemicals help producers, but light helps as well.
Photoperiodism is a plant's response to varying daylight hours. Greenhouse growers use the plant's minimum hours of light requirement to grow roses for Valentine's Day and chrysanthemums for Mother's Day. Chrysanthemums are an autumn flower, requiring short daylight hours and long night hours. The greenhouse producers will give the plants the minimum amount of light they need to bloom at any time of the year.

Appendix 2B

Plants in Industry Display

Choose a plant that is used in the industry assigned to your group.
The following information is required to explain how the plant is used in the industry.
Additional information that is relevant would be beneficial.
Be creative in your display- but remember to include all the information below.
You will present your findings to the class, be creative in your presentation!

Identify the plant used.
Using a flow chart, explain how the plant is used in your industry (follow the plant as it moves through the stages of processing).
How many products are produced? Show these products in your flow chart.
How long does it take the plant to move through the process?
Where does the plant come from?
Where do the products go? (identify countries or provinces)
How is the product used?
Who uses the product? (give age groups, gender)

Rubric for Plants in Industry Display

Criteria	1	2	3	4
Presentation of Display	Poorly written, difficult to understand flow chart and information, many spelling / grammatical errors	Legible, with minimum requirement for flow chart and information, some spelling/ grammatical errors	Coherent and well developed flow chart and information with few spelling / grammatical errors	Very well written and developed, no spelling / grammatical errors
Required elements	Contains few of the required elements	Contains some of the required elements	Contains all of the required elements	Contains all of the required elements , well organized
Quality of information/ ideas	Shows little understanding of the topic, provides information in rote manner	Shows some understanding of the topic, provides some information in interesting manner	Thorough and broad understanding of the topic, provides information in clear thoughtful manner	Thorough, broad, insightful understanding of the topic, provides information in thought provoking manner
Creativity	Limited use of	Some use of	Use of well	Effective use of

	visuals	visuals	developed visuals	visuals

Section B

#1

Chemicals In Agriculture Production Worksheet

Plants produce _____ that help them grow or help their fruit mature. Different chemicals serve different purposes.

_____ is a gas produced by fruits when _____. Fruits that are not ripe do not _____. If immature fruit is treated with _____, the fruit will soon _____. Commercial growers pick many fruits _____, and store them in ____ _____. Before sending them to the markets, they will place the fruit in warmer temperatures, and treat them with _____ to _____.

_____ is a chemical that is produced by plants to speed up _____. Plants that have short and small stems, can have _____ after treatment with _____. Some dwarf plants can become _____ because the cells _____ at a faster ____ _____. Gibberellin can also be used on seeds to speed_____.
How can commercial growers use gibberellin?

Not only do _____ help producers, but _____ as well.
_____ is a plant's response to _____. Greenhouse growers use the plant's _____ to grow roses for Valentines Day and chrysanthemums for Mother's Day. Chrysanthemums are an _____ flower, requiring _____ and _____. The greenhouse producers will give the plants the minimum _____ it needs to bloom at any time of the year.

Lesson #3

Lesson #3

Expectation Code	Expectations
PS1.05	explain the role of tropisms in plants (e.g., describe the reaction of a plant to light, to gravity, or to humidity).
PS2.05	investigate tropisms by growing plants from seeds

Bottom Line
Students will learn phototropism or gravitropism in self directed investigations.

Teacher Materials	Student Materials
• Plant (pothos, spider plant) • Oblong balloon • Scotch tape and marker • Tropism #1 note • Kidney beans • Record player • Aluminum foil • Paper towel • Clear plastic cups • Scotch tape • Tropism Lab: Getting plants to move	Tropism Worksheet

Lesson Sequence		
	Worksheets	1 day
	Stations, drawings	2 days
	Demo	--
	Research and presentation (orals)	3 – 4 days

1. Teacher will ask students if the plant in the room can move.
2. Place a plant (pothos, spiderplant, fern) in a sunny window, place masking tape on the side of the pot that is exposed to the sun. Students will sketch a "before" plant. After one or two days, the plant will exhibit signs of phototropism in the leaves.
3. Teacher will ask students if the plant has moved and what their evidence is. Students will sketch an "after" plant
4. Using an oblong ballon that has been sectioned into rectangles to represent cells, the teacher will inflate the ballon, students will note the shape and size of the cells. Slightly deflate the ballon, place some scotch tape on the middle third of one side of the balloon. Inflate the balloon, and it will bend as the plant in response to phototrophism. Have the students note the difference in cell shape.

5. Overhead of Trophism #1 (Appendix 3A) note and student worksheet Trophism Worksheet .
6. Place 2-4 bean seeds in damp paper towel, then wrap in aluminum foil. Outline the seed on a paper glued to one side of the packet. Secure the packet onto a turntable. Have the students predict how the roots will respond to gravitropism, and draw "before" diagram. Run the turntable for 4 consecutive days at 75 rpm. Have the students draw "after" diagrams.
7. Lab: In groups students will design and conduct an experiment using kidney bean seed to demonstrate phototrophism or gravitrophism, Tropism Lab: Getting plants to move and Rubric (Appendix 3B).

Teaching and Learning Strategies
Constructivism, cooperative learning groups, teacher- directed learning

Assessment and Evaluation Tools

Student responses to plant and balloon demonstration can be used as an evaluation tool.
Trophism Worksheet can be evaluated for completeness and accuracy.
Student labs will be assessed on procedure, data collecting and analyzing. Rubric for Trophism Lab (Appendix 3B)

Background Information
Trophisms Trophism: response of an organism to an environmental stimulus A plant growing towards a stimulus has a positive tropism, plants growing away from a stimulus has a negative tropism. Stimuli include light, gravity, touch and humidity. A plant's response to light is phototropism, to gravity is gravitropism. When a seed germinates, the root experiences negative phototropism (grows away from the light stimulus) and positive gravitropism (grows toward the stimulus, gravity). These responses to stimuli that direct the plant's growth are controlled by hormones. The hormone auxin stimulates cells to elongate. If the light stimulus is directly overhead, the stem is growing vertically, the concentration of auxin will be the same on all sides of the stem. If the light is to one side of the stem, the auxin will move toward the shaded cell region, increasing the hormone concentration, causing the cells on that side of the stem to elongate, and the stem to bend. Auxin produced in the roots function in much the same fashion, except the effect is negative phototropism and positive gravitropism with high hormone concentrations. Root exposed to the light will accumulate auxin in the cells on the shaded region. The accumulation of auxin will inhibit cell elongation, and the cells on the exposed region will grow. An obstruction in the soil functions in the same manner, the concentration of auxin will be greatest in the cells that first come into contact with the object. The auxin will inhibit the cell elongation, and the other cells will continue to grow, causing the root to bend downward.

Helpful Hints
When germinating the bean seeds, the paper towel should be moist at all times. Avoid submerging the bean in water. Have the students place 2-3 beans in the cup, in the event their bean doesn't germinate. The record player demonstration is really amazing for the students to see.

Resources
• biocomp.arc.nasa.gov/plants • http://www.woodrow.org/teachers/bi/1998/presentations/holley/ • www.ultranet.com/~jkimball/BiologyPages/W/Welcome.html • Understanding Biology. Don Galbraith. John Wiley & Sons. 1989. • Biology. Kenneth R. Miller & Joseph Levine. Prentice Hall. 1998.

Appendices

Appendix 3A

Tropism

Plants will react to conditions in the environment. If a plant doesn't receive enough sunlight, what will happen?

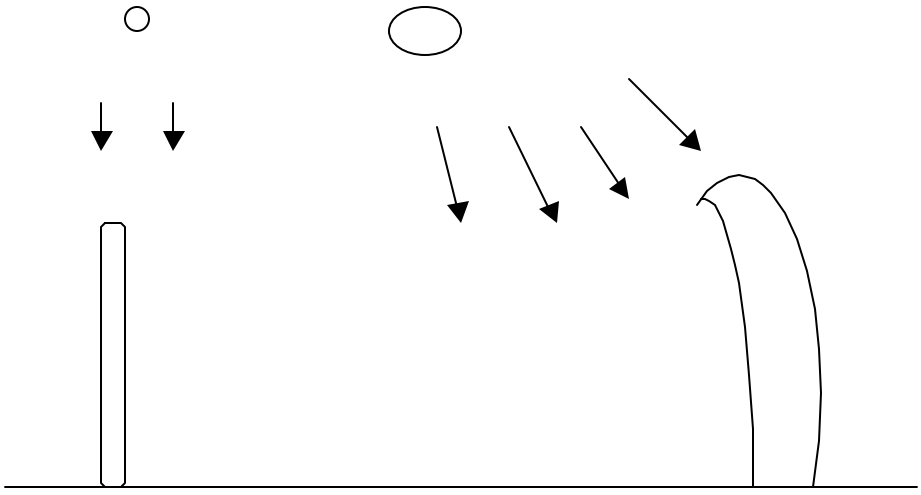
The plant can't function properly and may wither and die.

How do plants cope when there isn't enough light?

They will bend their stems so the leaves will face the light.

The plant responded to a change in the environment. Light is the stimulus, and it grew toward the stimulus.
Phototropism is a plant's response to light.
Trophism is a plant's response to a stimulus.

How does a plant show phototropism? What is happening in the cells?



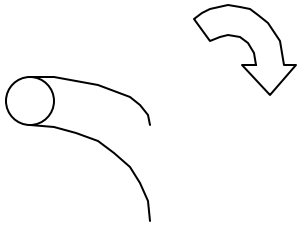
When the sun is overhead the plant receives sun on all sides equally, there is no shading on the shoot. When the shoot is at an angle to the sun, the shoot will bend.
This is because the cells on the right side of the stem, in the diagram above, receives some shade. A hormone called auxin will move to the shaded cells, and this will cause the cells to grow faster and longer. The cells on the left sunny side will not grow as fast because they do not contain auxin. The more auxin in the cell, the faster the cell will grow longer.

Why do roots grow down?
The roots are growing in the same direction as gravity. The tips of the roots have the auxin hormone, causing the cells to elongate.
This is gravitropism, the plant's response to the gravity stimulus.
Roots will grow in the direction of gravity (away from the light); shoots grow in the direction opposite to gravity. The roots show positive gravitropism (toward the stimulus, gravity), and the shoots show negative gravitropism (away from the stimulus of gravity).

This is a diagram of a seedling, with roots showing positive gravitropism. If the seedling was tilted on its side, how would the roots grow? Draw arrows to show the direction of the root growth.

Seedling with roots down

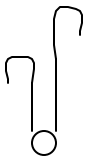
Seedling with roots tilted on side



Draw a diagram of a seedling with roots, pointed up. How should the roots respond to gravitropism?

Seedling with roots down

Seedling with roots pointing straight up



Do roots grow toward or away from the light? Do roots show positive or negative phototropism?
Do shoots grow toward or away from the light? Do shoots show positive or negative phototropism?

Appendix 3B
Tropism Lab: Getting plants to move

Using standard lab report write up (Title Page, Title, Purpose, Hypothesis, Materials, Procedure, Diagram, Observations, Results, Conclusion) design an experiment to grow a bean seedling. Show the effect of phototropism or gravitropism. If showing phototropism, be sure to control the amount of light the plant will receive.
Use the materials provided to germinate the bean seedling in the clear plastic cups wrapped in damp paper towel. One the bean has a shoot of 2 to 3 cm, begin your experiment.

Rubric for Tropism Lab

Criteria	1	2	3	4
Presentation of Report	Poorly written, disjointed, many spelling / grammatical errors	Legible, with minimum information, some spelling/ grammatical errors	Coherent and well developed with few spelling / grammatical errors	Very well written and developed, no spelling / grammatical errors
Lab Report Format	Contains few of the required elements	Contains some of the required elements	Contains all required elements	Contains all elements, thoroughly developed
Quality of information/ ideas	Shows little understanding of the topic, provides information in rote manner	Shows some understanding of the topic, provides some information	Thorough and broad understanding of the topic, provides information in clear thoughtful manner	Thorough, broad, insightful understanding of the topic, provides information in thought provoking manner

Part B:

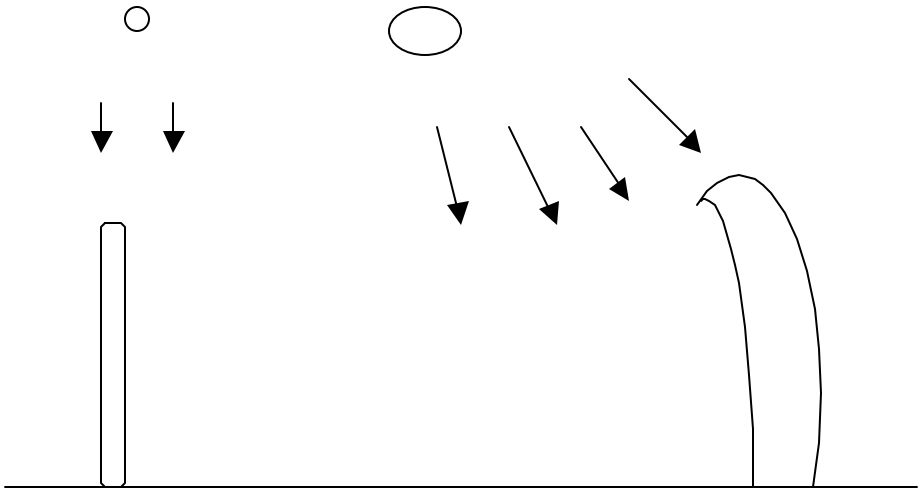
Tropism Worksheet

Plants will react to conditions in the environment. If a plant doesn't receive enough sunlight, what will happen?

How do plants cope when there isn't enough light?

The plant responded to a change in the environment. Light is the_____, and it grew toward the stimulus.
_____is a plant's_____.
_____is a plant's_____.

How does a plant show phototropism? What is happening in the cells?



When the sun is overhead the plant receives sun on all sides equally, there is no shading on the shoot. When the shoot is at an angle to the sun, the shoot will _____
This is because the_____, in the diagram above, receives some shade. A hormone called_____, will move to the shaded cells, and this will cause the cells to_____. The cells on the left sunny side, will not grow as fast because they do not contain____. The more _____in the cell, the _____.

Why do roots grow down?
The roots are growing in the ____direction as _____. The tips of the roots have the _____, causing the cells to elongate.

This is _____, the plant's response to the _____.

Roots will grow in _____, shoots grow in the _____ direction of gravity. The roots show _____ (_____), and the shoots show _____ (_____).

This is a diagram of a seedling, with roots showing positive _____. If the seedling was tilted on its side and allowed to grow, how would the roots grow? Draw arrows to show the direction of the root growth.

Seedling with roots down

Seedling with roots tilted on side

Draw a diagram of a seedling with roots, pointed up. How should the roots respond to gravitropism when it is allowed to grow?

Seedling with roots down

Seedling with roots pointing straight up

Do roots grow toward or away from the light? Do roots show positive or negative phototropism?
Do shoots grow toward or away from the light? Do shoots show positive or negative phototropism?