Seed and Flowering Plants

Possessing a seed represents a shared derived character in gymnosperms (pines and relatives) and angiosperms (flowering plants). In seed plants, the gametophyte is reduced to a small, multicellular structure that is never released from the sporophyte. Whereas in bryophytes, the sporophyte was dependent on the gametophyte, in seed plants fertilization occurs on the female sporophyte and the new sporophyte grows out of egg cells found on the female sporophyte. Thus, seed plants evolved increased investment of parental resources in each offspring. Retaining the gametophyte on the sporophyte makes it difficult for sperm cells to reach egg cells. Recall that in mosses and ferns, sperm swim in water to the egg in the archegonium. Seed plants release the male gametophyte (pollen), which travels through air (by wind or some carrier) to the female gametophyte. Once it is there, a pollen tube grows to the egg and delivers sperm for syngamy. Thus, seed plants no longer rely on water for reproduction.

There are four phyla that are called gymnosperms with pines representing one.

- Coniferophyta - pines and other cone-bearing gymnosperms
- Cycadophyta - cycads
- Ginkgophyta – ginkgo
- Gnetophyta - the gnetophytes, a small group

There is only one phylum of flowering plants.

- Anthophyta
  - Class Monocotyledones - monocots: lily flowers
  - Class Dicotyledones - dicots: *Medicago, Tilia*

Exercise 1- Gymnosperm life cycle

1. Follow the pine life cycle in Fig. 30.4 in your textbook during this exercise. Examine the branch of a pine tree on demonstration. Look for small, papery cones among the pine needles (leaves). These cones contain microsporangia where meiosis occurs to produce the male gametophyte. Female cones are larger and tough. They contain megasporangia where meiosis occurs to produce the female gametophyte, which will eventually be fertilized by pollen. Using this information, and the figure, fill in the table below.

Cone type	Sporangium	Sex	Size of gametophyte	Name of gametophyte

2. Return to your lab bench and examine the slide 'Pine Staminate Cone' under 4X power. Identify a microsporangium with male gametophytes. Draw it and label the sporophyll and pollen grains.

2. Obtain the slide 'Pine Germinated Pollen' or 'Pinus pollen tubes' and examine under 10X power. Pine pollen consists of a cell and two air bladders for wind dispersal. Pine pollen can travel great distances on wind. Look for germinated pollen with a pollen tube that has grown out of the pollen grain. You can make out the pollen tube nucleus inside the pollen tube. The generative nucleus is found in its own cell in the pollen grain. Once the pollen tube reaches the archegonium, the pollen tube nucleus will divide into two sperm cells. Draw a germinated pollen and label air bladders, pollen tube, pollen tube nucleus, and generative nucleus.

3. Obtain the slide labeled 'Pine Pollinated Cone c.s. and l.s.' and examine under your dissecting microscope, with light shining from below (Ask for instructions if you are unsure how to do this). Draw and label the ovule resting on the sporophyll on the longitudinal section (l.s.) below, left. Then draw the two paired ovules on the cross section (c.s.) below, right.

4. Obtain the slide labeled 'Pine Mature Embryo' and examine under the dissecting scope. The pine embryo is enclosed in the ovule. The embryo & ovule combination is now called a seed. The seed protects, nourishes and provides a means of dispersal for the embryo. Once the embryo is mature, the female cone now opens and drops seeds, which often glide away from the parent. Draw and label the seed, embryo, and megagametophyte.

5. Now that you are familiar with the pine life cycle, indicate whether each structure given below is haploid (n) or diploid (2n).

Pine tree	_____	Pollen	_____	Food reserves	_____
Microsporangium	_____	Pollen generative nucleus	_____	Megagametophyte	_____
Pollen cones	_____	Pollen tube	_____	Ovuliferous scale	_____

Exercise 2- Angiosperm life cycle and diversity

Gymnosperms produce seeds in an open structure. Thus "gymnosperm" means "naked seeded." Flowering plants produce ovules inside a structure called a carpel, which is not open until seed dispersal. Thus "angiosperm" means "hidden seeded". Another angiosperm innovation involves embryo nourishment. While gymnosperm embryos nourish themselves with megagametophyte tissue, angiosperms provide a new tissue called endosperm.

1. Working with a partner, obtain a flower and identify structures in Fig. 30.13 in the textbook. The outermost appendages, _____ protect the flower in the bud. The next appendages are brightly colored _____, which are used to attract animals to move pollen, or pollinate the flower. There will be several _____ in the flower, each comprised of a long stalk (filament) and an anther (or microsporangium). Finally, the innermost part is the female reproductive structure, the_____(s), which consist of an apical cap or stigma, on top of a long style, and a basal _____, in which ovules are located. Pollen is caught on the stigma, and the pollen tube grows through the style to the ovary to the egg. Once the egg and sperm unite, fertilization is complete. Cut open the ovary to find the small ovules and examine under the dissecting scope. Draw the flower and label sepals, petals, stamens, anther, filament, carpel, stigma, style, ovary.

2. Examine Fig. 30.17. Inside ovaries, ovules develop after meiosis occurs. Only one of four cells resulting from meiosis (megaspore) will survive. After a few mitotic divisions of the haploid nucleus, an _____ sac develops, which will eventually possess _____ nuclei. This sac encloses the highly reduced _____ gametophyte.

3. Obtain the slide 'Lillium: female migrating nuclei' and place under 4X power under your compound microscope. There are six ovaries on the slide, and some of these possess clear embryo sacs with multiple nuclei. When you find one, switch to 10X power and show it to your instructor. Draw and label the embryo sac and its nuclei.

4. When a pollen tube reaches the female gametophyte, one of the male nuclei fuse with the egg cell, resulting in a __ploid (2N) zygote that will become the embryo. The other male nucleus fuses with two nuclei in the middle of the embryo sac, resulting in ___ ploid (3N) _____ tissue, which nourishes the embryo.

5. After fertilization, the zygote divides, forming the embryo, and endosperm cells divide. Together, these make a mature seed. The ovary (or carpel) also becomes larger, preparing seeds for dispersal. The mature carpel and associated structures produce a fruit. Examine the ear of corn on display and note how seeds are enclosed. Then obtain the slide 'Corn grain' and place it under the dissecting scope with the label facing down. On your upper left, large blue green cells make up endosperm. On the lower right, purple cells make up the embryo. A cone shaped structure facing upwards represents embryonic leaves and the cone shaped structure pointing downwards represents the embryonic root. Draw the corn grain and label endosperm, leaf, stem, and root.

6. Name and describe three fruits (dry or fleshy) displayed in the laboratory.

7. Flowering plants are very diverse. Two large groups may be recognized, the monocots and eudicots. These two groups are based on the number of embryonic leaves produced (cotyledons) with monocots producing one and the eudicots two. However, it is usually not easy to see cotyledons. Other features may be used to quickly tell which group a plant belongs to. Below is a chart of characteristics.

	Monocots	**Eudicots**
Roots	fibrous (all of same size)	tap root (main root and lateral roots)
Veins in leaves	parallel (no major vein)	net (main vein and branches)
Flower parts	3 or multiples	4 or 5 or multiples
Produce wood	no	yes, but not all species

Identify five plants on display as being monocot or dicot.

Exercise 3- Comparing bodies of different vascular plants

Vascular plants (ferns and their relatives from last week's laboratory; seed plants in this laboratory) possess features in their external form that represent adaptations to life on land.

1. Examine living plants on display and identify basic parts of the plant body. _____ are usually underground structures that anchor the plant, absorb water and nutrients from the soil,

and may store nutrients. Look at exposed roots and find the fine structures that occur near their tips. These _____ _____ absorb water and nutrients (Fig 35.14, 36.7, 37.6).

2. Leaves (and other structures) are borne on stems. Identify stems of available plants. In herbaceous plants (non-woody) the stem is green, meaning that some cells produce food photosynthesis. Stems may be used for storage as well.

Which plants have obvious storage stems, and what do you think is being stored in the stem?

Exercise 4- Stem anatomy

1. Obtain the slide labeled 'Sunflower Young Stem' c.s. and examine under 4X and 10X on the compound microscope. Refer to Fig 35.18a while locating the following structures:
   - **Pith**- Inner most, thin-walled cells, which store nutrients and provide support.
   - **Xylem**- Red stained, thick-walled cells that surround pith and make up water conducting vascular tissue. Cells called can be seen as large and small 'holes.' These cells are stacked end on end as tubes up the stem. In a living plant, vessels are filled with water. Water is kept inside the xylem by lignin (stained red) in cell walls.
   - **Phloem**- Several rows of tightly packed, small, green-stained cells outside xylem. Phloem cells transport solutes such as sugar throughout the plant.
   - **Cortex**- Several layers of thin-walled cells outside the phloem. Provide support.
   - **Epidermis**- One outer layer of cells.

Which tissue, shown in the text, is missing from your slide, and why do you believe this is the case?

What other differences do you see between your slide and the figure in the text?

2. Obtain the slide labeled 'Tilia Stem Combination' and examine under the 4X objective. This is a series of stem sections taken from stems of different age. Examine the smallest stem closely. Instead of forming separate bundles, the vascular tissues now form rings around the pith in the inside of the stem. Using Fig 35.18 as an approximate guide, draw this stem and label each tissue listed above.

3. Now examine the older stems and note the increasing number of rings of _____ tissue. Each ring consists of large vessels, which result from rapid growth in the spring, and fewer and smaller vessels during summer growth. This represents lateral growth in a plant. At the end of a growing season, no vessels are added. Determine the age of the three older stems

4. Examine woody stems in the lab. What tissue does the wood consist of, and what do the rings evident in the wood section represent?

Exercise 5- Campus field trip

1. Join your lab instructor on a walk around campus. Describe the growth form of four different plants you see and indicate whether they are gymnosperms, or monocot or eudicot angiosperms.