ANGIOSPERMS — MONOCOTS AND DICOTS

I. OBJECTIVE:

To study the differences and similarities between dicots and monocots within the Angiospermae.

II. BACKGROUND:

Like the gymnosperms, the angiosperms are adapted for life in a drier environment (although some are secondarily aquatic). Unlike gymnosperms, the seeds of the angiosperms form within an ovary on the adult plant: **fruit** is a ripened/mature ovary. As previously discussed, these seeds contain one cotyledon in the Monocotyledoneae (**mono** = one) and two cotyledons in the Dicotyledoneae (**di** = two). There are, however, other differences between monocots and dicots. In general, monocot leaves are parallel-veined while dicot leaves are net-veined. Monocots generally have flower parts in groups of three or multiples of three while dicots have flower parts in fours, fives, or occasionally twos (or multiples thereof). There are also differences between the two in the arrangement of the vascular bundles (xylem and phloem) in both the roots and stems. Xylem carries water up and phloem carries sugar, etc. around (down) the plant, In general, xylem is to the top and/or center of a leaf/stem with respect to the phloem.

III. MATERIALS NEEDED:

microscope
prepared slides of:

xs of *Triticum* (wheat) seed (monocot)	B726 or B726a
monocot vs. dicot roots	B518c
Medicago (alfalfa) stem (dicot)	B586
Triticum (wheat) stem (monocot)	B573
yucca leaf xs (monocot)	B666
pear leaf xs (dicot)	B669 or B669a
Lilium (lily) ovary xs. (monocot)	B680-685

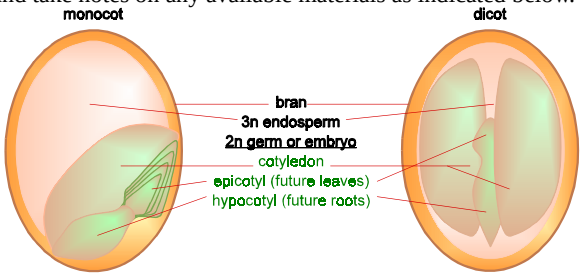
any available drawings/photos of the structures being discussed
any live and/or preserved material of the structures being discussed
giant models: roots, leaf, flower
sections of various woody stems and bamboo/palm stem
plastic mounts of sprouting corn and bean
dandelion flower head and flower from another plant family (take a short hike to obtain these)
dissection kit, dissecting microscope and lamp
fruits such as blueberries, cherries, strawberries, pineapple, coconut, green pepper, corn, squash, peanuts, etc. to examine and taste

IV. PROCEDURE AND DATA:

Examine, draw with labels, and take notes on any available materials as indicated below.

SEEDS

Examine the seeds of a dicot such as the plastic mount of a bean seed. Note the two **cotyledons** (**cotyl** = cup, socket, cavity) used to store food for the embryo plant, as well as the **hypocotyl** (**hypo** = under, beneath), terminating in the **radicle** (**radix** = root) which will become the roots. The mound of tissue between the cotyledons is called the **epicotyl** (**epi** = upon, over, beside) and will become the stem and leaves.



Examine a monocot seed such as the plastic mount of corn and the slide of a cross section of a *Triticum* (wheat) seed (wheat berry). A large part of these seeds is **endosperm** (**endo** = within, inner), which stores nutrients for the embryo. These seeds have only one **cotyledon** up against the endosperm with a **hypocotyl** ending in a **radicle** and a rather well-developed **epicotyl**.

The endosperm in angiosperm seeds is a result of a rather unusual fertilization. The egg produced by the female is 1n, but it is surrounded by some other tissue (also 1n). The pollen produces not one but two sperm nuclei. One of these fertilizes the egg, resulting in a 2n zygote. The other sperm nucleus unites with **two** nuclei from the tissue surrounding the egg to form a **3n** endosperm.

In some species of seeds, the endosperm is larger while the cotyledon(s) is/are smaller, but in other seeds, the reverse is true.

ROOTS

Examine the slide with cross sections of a dicot (*Ranunculus* – buttercup) root and a monocot (*Smilax* – greenbrier) root. In the dicot root, the **xylem** (**xylo** = wood) forms a cross or X in the center with the **phloem** (**phloeo** = the bark of a tree) in between its arms. This vascular bundle is surrounded by a layer of cells called the **endodermis** (**endo** = within, inner; **derm** = skin). The outermost layer of cells is the **epidermis**, and the region between the endodermis and epidermis is the **cortex** made of **parenchyma cells** (**paren** = parent, **chym** = juice, flavor) which are used to store food.

In the monocot root notice the different arrangement of the vascular tissue within the endodermis. The xylem and phloem cells alternate around the edges of the central vascular area.

Also, view the giant root models.

STEMS

Stems of flowering plants can be herbaceous or woody. Vines, stolons (as in strawberries), and rhizomes (as in iris) are all types of stems. Examine cross sections of a dicot stem such as *Medicago* (alfalfa) and of a monocot such as *Triticum* (wheat). The center of the **dicot** stem should contain **pith** or **parenchyma cells**, around which are arranged bundles of **xylem** and **phloem**. The xylem is in the inner half of each bundle and the phloem is in the outer half. Outside of the phloem is a layer of **cortex cells** and beyond that the **epidermis**.

In the **monocot** stem, most of the space within the **epidermis** is filled with **parenchyma (pith) cells**. The **vascular bundles** are scattered throughout this area. Within a vascular bundle, note the larger **xylem** cells, the smaller **phloem** cells to the outside of the xylem and the large **intercellular passage** or **air space** to the inside. Because there are generally two larger xylem cells and one very large intercellular passage, the vascular bundles resemble "monkey faces."

Also study samples from woody stems to note how they grow each year. Notice the difference(s) between monocots and dicots.

LEAVES

Examine cross sections of leaves of monocots (yucca) and dicots (pear). Note that both have upper and lower **epidermis**, a spongy **mesophyll** (**meso** = middle, **phyll** = leaf) with a layer of **palisade cells** along the upper portion, **stomates** (**stoma** = mouth) which are found especially in the lower epidermis, and **vascular bundles**. In general, **xylem** is found in the "top and center" of vascular bundles. Note that both have a large vascular bundle in the **midrib** of the leaf. In the dicot leaf, you may see sections of other veins cut at an angle because the leaf is **net-veined**. In the monocot, notice that all the vascular bundles are visible in cross section because the leaf is **parallel-veined**. Also, examine the giant leaf model.

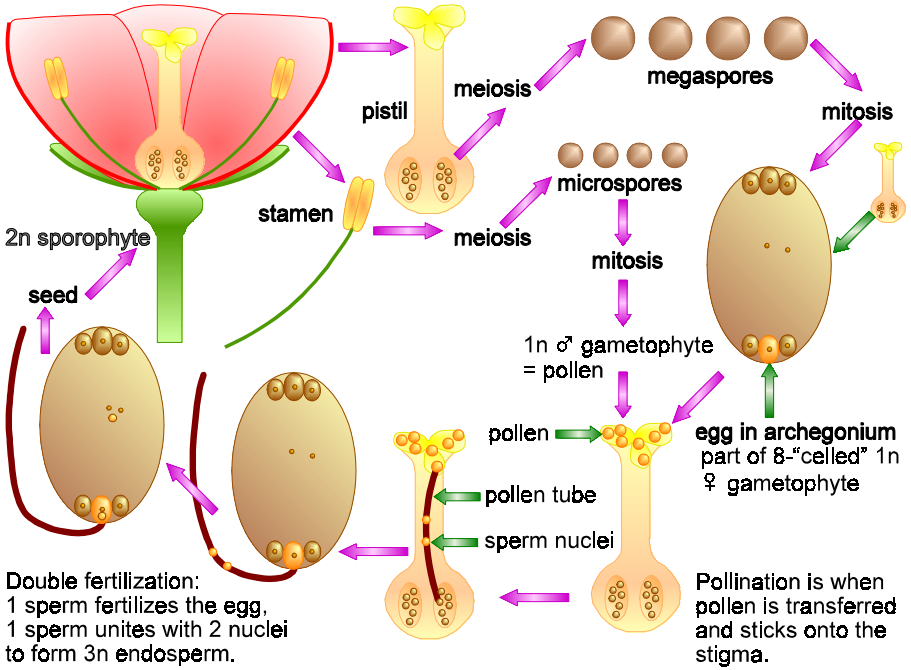
FLOWERS

In addition to materials available during this lab, we will also be examining flowers as we go on our hikes. Observe, as available, monocot and dicot flowers. Especially, examine a slide of lily ovaries and note that this monocot has flower parts in sets of three. Dicots, such as apple or starfruit, have flower parts in sets of four or five. Examine an apple and/or starfruit cut in half crosswise to observe the five chambers of the ovaries. Also, examine the giant flower model and locate the outer layer of **sepals**, the **petals** within them, then the **stamens**, and in the center, the **pistil(s)**.

Dissect and illustrate a dandelion and some other wildflower as follows. First, make sure you know how to use the dissecting scope and dissecting kit.

1. Take a short field hike to pick two wildflowers. This must be on a sunny day so the flowers are open.
   a. a fresh dandelion and
   b. some other wildflower, not a composite (Purple Dead-nettle, Yellow Rocket, violet, etc).
2. Answer these questions for each of the two flowers before dissection:
   a. What is its scientific name?
   b. To what family does it belong (give characteristics of this family)?
   c. Briefly summarize the habitat where you found it.
3. Dissect out a complete floret from the dandelion, illustrate as large as you can in a single field under the dissection scope to show and label:
   a. ovary
   b. corolla, petals if distinguishable
   c. style
   d. stigma
   e. fused anthers
   f. calyx (sepals)

4. State which features of the flower structure indicate relative evolutionary advancement over early primitive flower structures.
5. Dissect and illustrate your second flower, providing the same information for it.



REPRODUCTION

The pistil is the "female" reproductive structure (the megasporophyll), and the ovary within it is actually the megasporangium. Megaspores are produced by meiosis, and then form 1n female gametophytes that contain eight nuclei. Six of these nuclei are in smaller cells at the ends of the gametophyte, one of which is the actual egg, and two are in a larger cell in the center.

The stamen is the "male" reproductive structure (the microsporophyll), and the anther at its tip is the microsporangium. Microspores are produced and grow into 1n male gametophytes (= pollen) within the anther. Mature gametophytes are released and transferred to the stigma of the pistil by some **pollinator** (wind, insects, birds, etc.), and this process is referred to as **pollination**. Each pollen grain grows a pollen tube down into the ovary and its two sperm nuclei travel down to a female gametophyte.

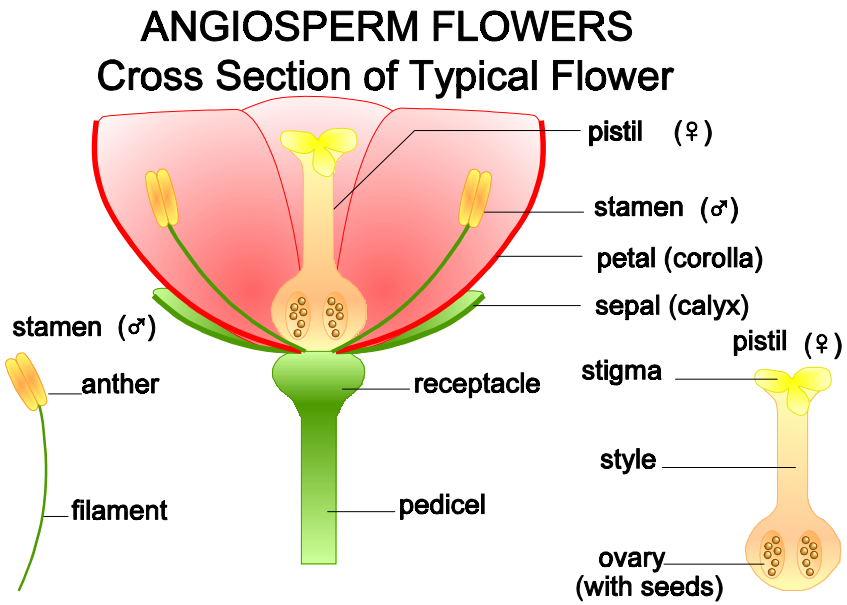
Angiosperms have a somewhat unusual mode of fertilization. As might be expected, one of the two sperm nuclei fertilizes the egg, forming a 2n zygote which is the start of the new 2n sporophyte generation. Interestingly, however, the second sperm nucleus unites with the two nuclei in the "center" of the female gametophyte to form 3n **endosperm** tissue. In many seeds, this 3n endosperm serves as a nutrient storage area.

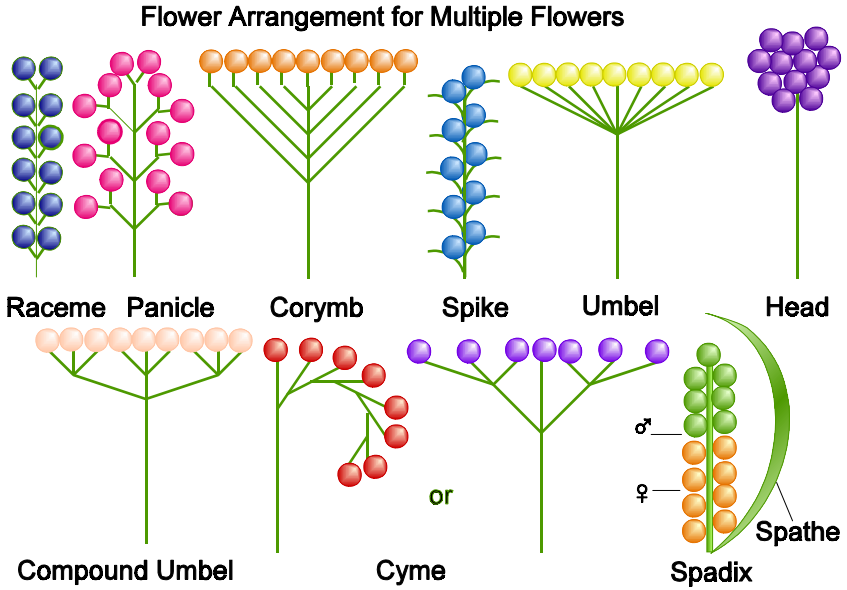
Angiosperm seeds, then, are composed of the new 2n sporophyte (epicotyl, cotyledon(s), and hypocotyl) surrounded by or next to 3n endosperm, and covered by some kind of seed coat made from the old 1n female gametophyte. The ovary, itself, typically grows into some kind of structure that aids in dispersal of the seeds. A ripened or mature ovary is called **fruit**, and can be anything from the apples and oranges that we think of as "fruit" to squash to peanut shells to maple "helicopters" to dandelion "fluff."

Simple fruits, such as cherries, peas, squash, and coconut, originate from one ovary within one flower, **aggregate** fruits, such as strawberries and raspberries, originate from multiple ovaries within one flower, and **multiple** fruits, such as mulberries and pineapple, originate from many, tightly-clustered flowers whose ovaries/fruit fuse together. As time, interest, and samples allow, examine and draw the structure of and/or taste various types of fruits.

V. DISCUSSION:

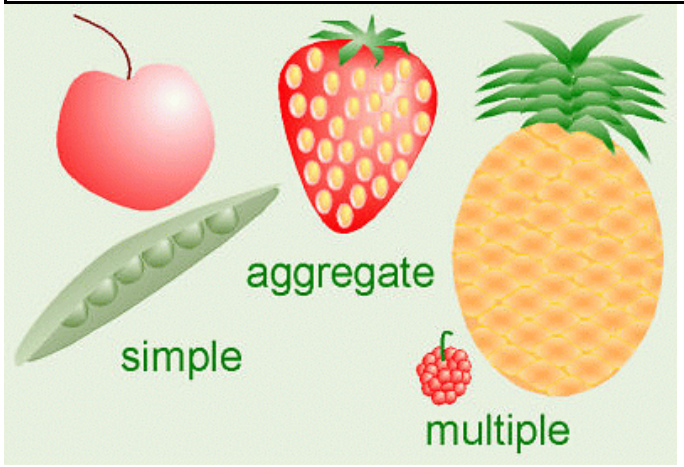
As part of your discussion, summarize the differences between monocots and dicots in a chart.





PLANT FAMILIES

PLANT FAMILY example	Tree or Herb?	Type of Leaves	Type of Flowers	Fruit and/or Seeds	Other
Pinaceae Genus *Pinus* pines	tree	needles*		pine cone*	gymnosperm
Gramineae grasses	herb	blades w/ parallel veins		seeds like wheat or corn	monocot
Ranunculaceae buttercups	herb		5 petals* many stamens ovary above		dicot
Rosaceae rose, cherry, bramble, apple	both	alternate simple or compound	5 petals* many stamens ovary under	rose hips raspberry strawberry	
Cruciferae mustard, etc.	herb		4 petals* 6 stamens		olive fam. has 4 pet. & 2 stamens
Aceraceae Genus *Acer* maple, (boxelder)	tree	most simple opposite*		seed with a wing	
Leguminosae pea, bean, locust tree	both	compound alternate	petals joined so pea flower	peapod shaped fruit*	
Fagaceae Genus *Quercus* oaks	tree	simple alternate		acorn*	
Umbelliferae carrot, dill, Queen Anne's lace	herb		many flowers arranged in an umbel*	seeds like dill or caraway	
Compositae daisy, goldenrod, dandelion	herb		many flowers arranged in one head*		
Labiatae mints	herb	simple opposite	some petals joined so irregular		stems are square*



Examples of some types of fruit