Biology II

Lecture Notes

Angiosperms

References (Textbook - pages 428 - 436, Lab manual - page 151 - 157)

- *Angio* is the Greek word for "vessel" - in angiosperms this refers to the ovary which develops into a fruit.
- This is a unique Angiosperm characteristic and does not occur in Gymnosperms
- *Sperma* is the Greek word for seed.

Major Characteristics (see Handout - Summary Comparison of Gymnosperms and Angiosperms)

1. **Angiosperms** are the *flowering plants*. We will dedicate an entire section on flowers.

2. There are over 240,000 known species of *angiosperms*. This is 6 times the number of species of *all other* plant groups combined.

3. *Angiosperms* live in a wide variety of *environments*, from *fresh water* to the *desert* and from the *very cold* arctic regions to *very* hot tropical regions.

4. Angiosperms range in size to the *very small*, almost microscopic *duckweed* to *Eucalyptus* trees over 300 feet tall.

5. The *dominant life stage* in alternation of generations is the *diploid sporophyte*

6. The *haploid gametophyte* is small, without chlorophyll, and dependent on the sporophyte

7. *Angiosperms* are *heterosporous* and produce *microspores* and *megaspores*.

8. *Angiosperms* produce seeds that are *covered* or *enclosed* within an *ovary*. When mature the ovary constitutes the *fruit*.

9. *Angiosperms* are *vascular plants* and possess *xylem* and *phloem*

10. *Angiosperms* possess *true leaves*, *true stems*, and *true roots*

   A. Leaves

   - *Leaves arise* from *terminal growing point* of the *stem*
• **Blade** of a leaf may be **attached directly** to the stem - called a **sessile leaf**  
  *(draw example on blackboard)*

• **Blade** of leaf often **attached** to leaf by a **stalk** called a **petiole** *(draw example on blackboard)*

• **Leaves** may be **simple** or **compound** *(draw example of each on blackboard)*

• **Leaves** usually possess **stomata** and **cuticle**

**B. Stems**

• In most plants, stems **form** the **main axis** of the plant **body**

• **Stems** normally **possess nodes** and **internodes** *(draw on blackboard)*

  (1) **node** - where **leaves** are **attached** to the **stem**  
  (2) **internode** - region **between nodes**

• **Stems** may be **herbaceous** or **woody**

• **Herbaceous stems** are:

  (1) **soft**  
  (2) usually **small** in **diameter**  
  (3) usually **green**  
  (4) possess **few hard tissues**  
  (5) are chiefly **annuals**.

• **Woody stems** are:

  (1) **tough** and **hard**  
  (2) **larger** in **diameter**  
  (3) are **not green**  
  (4) have well **developed hard tissues** (fibers)  
  (5) are chiefly **perennials**

• **stems** of **most gymnosperms** are **woody** as are the stems of many **angiosperm**  
  **tree species** like **oaks, elms, maples, hickories, poplars**, and others

• There are 3 principal **functions** of **stems**.

  (1) **production** and **support** of **leaves** and **flowers** (angiosperms) and  
      **cones** (gymnosperms)
(2) the conduction of substances (presence of xylem and phloem)

(3) storage of foods and water

- **stem** is a water reservoir in succulent plants

- **underground** horizontal stems may form tubers that store food

- (a tuber is a rounded storage organ that can be formed from a stem or a root - stem tubers can be differentiated from root tubers by the presence of remnants or vestiges of nodes and internodes on stem tubers)

- example is potato - evidence of nodes can be seen as eyes on potato

C. Roots

- There are 2 types of root systems in plants.

  (1) **taproot system** *(draw example on blackboard)*

  - there is a single, main primary root that is distinctly larger than the secondary roots

  - examples include radishes, carrots, beets, dandelions

  (2) **fibrous (diffuse) root system** *(draw example on blackboard)*

  - root system comprised of numerous slender roots, most of which are equal in size

  - there is no single main root larger than the others

  - examples include grasses and corn

- **Functions of roots** *(We discussed this already, but will quickly review)*

  (1) anchorage and support of the plant

  (2) absorption of water and dissolved minerals

  (3) conduction of substances through the roots

  (4) storage of foods

11. *Quickly review Handout - Summary Comparison of Gymnosperms and Angiosperms*
Importance of Angiosperms

*Angiosperms* are **critical** to the **survival** of **humans**. They provide food, drink, clothing, building materials, and medicines.

1. **Food**

   A. The 5.6 billion humans that inhabit the earth derive most of their daily food needs from just 3 flowering plants

   B. You could call these the 3 most important food crops in the world. They include **wheat**, **corn**, and **rice**

   C. *All 3 are grains* and *all 3 are in the grass family*

2. **Wheat**

   - *Was first cultivated* in the **Near East** in the vicinity of **Iran** and **Iraq** about **8,000 BC**

   - *First* brought to the **U.S.** in **1520** by early **settlers**

   - **U.S.** is now one of **world's largest producers**

   - Most of **wheat** in **U.S.** is made into **flour** and **bread**

3. **Corn**

   - *Was first cultivated* in **Central America** (called maize) about **7,000 years ago** and **spread** throughout **North America** by **Indian cultures**.

4. **Rice**

   - *Originated* in **Southeast Asia** several thousand years ago.

   - *Was originally* grown in **swamps**

   - *Is currently* grown **throughout** the **world** in the **tropics** and **subtropics** where **water** is **abundant**.

   - **Rice** currently **feeds billions** around the **world**, but **especially** in **southeast Asia** and surrounding areas
2. Beverages

   A. Our most popular beverages come from flowering plants

   B. These include coffee, tea, cola, wine, beer, and other spirits

3. Sugar and Spices

   A. Sugar comes almost exclusively from 2 plants. These are sugarcane and sugar beets

   B. Sugarcane

   - Sugarcane is grown in South America, Africa, Asia, and the Caribbean

   - It is grown in Louisiana and Hawaii

   C. Sugar Beets

   - Sugar beets are grown in Europe and North America.

   - Sugar beets are an important crop in many northern states like Michigan and North Dakota.

   D. Most of the spices we use to flavor our foods come from flowering plants. A few of these include pepper, sage, garlic, dill, cloves, ginger, paprika, curry, and a host of others.

4. Building Materials

   A. Wood is made into lumber and used for structural portions of buildings, furniture, and other household items

5. Clothing

   A. Before the invention of synthetic fibers, cotton and other natural fibers were the only source of clothing

   B. The cotton fiber itself comes from filaments that grow on the seed.

6. Medicines

   A. Currently about 50% of all pharmaceutical drugs have their origins from plants.
B. Examples

- *Malaria* is treated by *quinine* which comes from the *bark* of the *cinchona tree*

- *Digitalin* is extracted from *foxglove flowers* and is used to *stabilize heartbeat* and *blood circulation*

- *Extracts* from *periwinkle leaf slow the growth* of some *cancer cells*

- the list of examples is *almost endless*

C. *Modern doctors* and medical *researchers* have *learned* much from the *tribal medicine man's* use of native plants.

Monocots and Dicots (see Handout - Comparison of Monocots and Dicots)

*Angiosperms* are divided into *2 classes*, the *Monocots* and *Dicots*

There are *6 characteristics* we will use to *compare Monocots* and *Dicots*. These 6 are *summarized* in the *handout*.

1. Cotyledons

   A. A *cotyledon* is *defined* as a *seed leaf* for the *embryo* of a *flowering plant*. It *provides nutrients* for the developing plant *embryo* before *photosynthesis* begins.

   B. *Monocots* have only 1 *cotyledon*. *Example* is *corn seed*.

   C. *Dicots* have 2 *cotyledons*. *Example* is *bean seed*.

   D. *Ask if anyone has ever helped shell beans and seen how the beans would divide into 2 halves*. *These are basically the 2 cotyledons*. *Note how you cannot do this with a corn kernel (seed) which has only 1 cotyledon*.

   E. *Draw* on blackboard *example* of *seedling* with 2 *cotyledons* (bean) - *see Figure 28.11, page 504 of Textbook*.
F. *Draw* on blackboard *example* of seedling with 1 cotyledon (corn) - *see Figure 28.12, page 505 of Textbook.*

2. **Flower Parts**

   A. *Monocots* have *flower parts* that are in 3's or *multiple of 3's* - *draw example on blackboard*

   B. *Dicots* have *flower parts* that occur in 4's or 5's or in *multiples* of 4's or 5's - *draw example on blackboard*

3. **Type of Stem**

   A. *Monocots* usually have *herbaceous stems.*

   B. *Dicots* may have either *herbaceous* or *woody stems*

4. **Venation in Leaves**

   A. *Monocots* usually have *leaves* with *parallel venation* - *draw example on blackboard*
5. Arrangement and Structure of Vascular Tissue

A. *Monocots* usually possess *vascular tissue* in *scattered bundles* in *stem* - *draw cross section of stem showing example on blackboard*

B. *Dicots* usually possess *vascular tissue* that occurs in *bundles* in a *ring* or *star formation* in *stem* - *draw cross section of stem showing example on blackboard*

6. Type of Root System

A. *Monocots* usually possess a *fibrous root system* - *draw example on blackboard*

B. *Dicots* usually possess a *taproot system* - *draw example on blackboard*
Examples of Monocots - most grasses, corn, sorghum, wheat, cattail, lily, and orchid

Examples of Dicots - pokeweed, beans, strawberries, potatoes, hickory trees, and oak trees,

The Flower (see Handout - Basic Anatomy of Flower)

A. Basic Anatomy - major flower parts are as follows.

1. Peduncle - the stalk or stem that bears the flower

2. Receptacle - the expanded tip or end of the peduncle that bears the 4 major flower parts (sepals, petals, stamens, pistil)
   • These 4 major parts are attached to the receptacle in whorls (or circles)

3. Sepals
   • Are the outermost flower parts
   • Are commonly leaf-like and green, but may be colored like the petals in some flowers
   • The entire whorl of sepals is called the calyx
   • Sepals surround and protect the flower bud before it opens
   • Sepals may drop off and not persist for the entire life of the flower

4. Petals
   • Normally occur between sepals and stamens
   • Are normally larger than the sepals and colored
   • Are typically delicate in texture
   • The entire whorl of petals is called the corolla
1. **Petals**, like sepals, **may be shed** soon **after** the **flower opens**

2. The **color** and **fragrance** of **petals** serves to **attract** insect **pollinators**

3. Some **wind pollinated flowers** have **no petals** at all

5. **Stamens**
   - Represent the **male reproductive parts** of the **flower**
   - Usually occupy a **position** near the **center** of the **flower**
   - **Vary** widely in **size, color, and shape**
   - **Stamens** consist of **2 parts**
     1. **Anther** - **sac-like organ** that **produces** and **contains** the **pollen**
     2. **Filament** - the **stalk** that **connects** the **anther** to the **flower**

6. **Pistil** (called Carpel in our textbook)
   - Represent the **female reproductive parts** of the **flower**
   - Usually **occupy** a **central position** on the **flower**
   - **Some** flowers have only a **single pistil** (like the Lily), while **other** flowers may have **several** or **many pistils** (like the Buttercup)
   - Each **pistil** consists of **3 parts**.

   1. **Stigma**
      - A **pollen receptive area** at the **summit** of the **pistil** (at the **top end** of the **style**)
      - May be **swollen** and **sticky**
      - The **stigma** may be **single, lobed, or even branched**
(2) **Style**

- The *stalk-like part* of the *pistil* that *elevates* the *stigma* *above* the *ovary* and *other* flower *parts*.
- *(ask why this is a good strategy)*

(3) **Ovary**

- The *enlarged portion* near the *base* of the *pistil*
- A *single ovary* may contain 1 to over a *hundred ovules*
- *Remember* that an *ovule* is merely an *immature seed*.

7. **Note** - *that not all flowers possess all these 4 major parts.*

B. **Types of Flowers**

1. **Complete vs Incomplete Flowers**

   - *Complete flowers* - all 4 parts present (sepals, petals, stamens, and pistils)

   - *Incomplete flowers* - *lack one or more* of the 4 basic flower *parts*

2. **Bisexual vs Unisexual Flowers**

   - *Bisexual flowers* - *flowers* have *both stamens* and *pistils*

   - *Unisexual flowers* - *flowers* have *either stamens* or *pistils*, but *not both*

   (1) *Flowers* with *just stamens* are called *male flowers* or *staminate flowers*

   (2) *Flowers* with *just pistils* are called *female flowers* or *pistillate flowers*
(3) If *staminate* and *pistillate flowers* are found on the *same plant*, the plant is said to be *monoecious* (*Oaks and Birches* are examples of *monoecious plants*).

(4) If *staminate and pistillate flowers* are on *separate plants*, the plant is said to be *dioecious* (*Willows and Poplars* are examples. *Another example* include *Holly trees* and *if you want red berries you had better get a female plant - one that has pistillate flowers and a male plant - one with staminate flowers*) *WHY DO YOU NEED BOTH???*

3. **Inflorescence**

- The term inflorescence simply means a cluster of flowers.

- Inflorescences can be classified and named based on the arrangement of clusters of flowers on a plant. *Draw the following examples on the blackboard- these are just a few examples of many types*

<table>
<thead>
<tr>
<th>Solitary</th>
<th>Spike</th>
<th>Raceme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panicle</td>
<td>Umbel</td>
<td>Catkin (<em>unisexual</em>)</td>
</tr>
</tbody>
</table>
4. Composite flowers (see Handout - Sunflower flower)

- **Composite flowers** are flowers that appear to be a single flower but actually consist of a group of many tiny flowers.

- There is an entire plant family that has composite flowers and it is called the Compositae or Asteraceae.

- These include many of the common weeds we see blooming on roadsides and pastures in summer and early fall.

- Good example is the sunflower (see Handout - Sunflower flower).

- There are 2 types of flowers on the head.

  (1) Ray flowers

  - Look like the petals of a typical flower
  - Stamens and pistils may be poorly developed or absent
  - Ray flowers may be sterile

  (2) Tube flowers

  - Occur in the center of the head
  - Usually fertile and possess both stamens and pistils

Life Cycle of Angiosperms (see Handout - Figure 24.26. Flowering Plant Life Cycle from page 430 and 431 of textbook)

Our discussion will follow the outline and numbering system of this Figure.

**Development of Female Gametophyte**

1. **Ovary** occurs at base of pistil (carpel in textbook) and contains one or more ovules

   A. **Ovule** consists of

   - Megasporangium
   - Megasporocyte
   - Integument (2 layers)
2. *Megasporocyte* undergoes *meiosis* to produce 4 haploid *megaspores*

3. 3 *megaspores degenerate* leaving only 1 *functional* megaspore

   A. *Functional megaspore* divides and *develops by mitosis*

4. *Embryo sac* or mature *female gametophyte* is formed.

   A. A *mature female gametophyte* consists of 7 *cells* that include

   - 1 egg cell
   - 2 synergid cells
   - 1 central cell, with 2polar nuclei
   - 3 antipodal cells

*Development of Male Gametophyte*

1. *Anthers* possess *pollen sacs* that contain *microsporocytes*

2. Each *microsporocyte* undergoes *meiosis* to produce 4 *haploid microspores*

   A. each *microspore* develops to form a *immature pollen grain* that is also called *immature male gametophyte*

   B. *Immature pollen grain* consists of

   - larger *tube cell* - will later produce *pollen tube*
   - smaller *generative cell* - will later produce 2 *sperm cells*.

3. *Step 3 is pollination*. This occurs when *immature pollen grains* are *released* from *anther* and are *windblown* or *carried by insects* to the *stigma* of the *pistil* of a flower of *same species* of plant.

4. *Pollen grain* now becomes *mature* by:

   A. *Tube cell generates a long pollen tube* that grows *down* the *style* until it *reaches* an *ovule* in the *ovary*

   B. *Generative cell divides* to form 2 *sperm cells*. *(Note sperm cells do not have flagella - WHY??)*

*In summary - The mature male gametophyte consists of the pollen grain with its pollen tube and 2 sperm.*
Double Fertilization

5. Pollen tube discharges sperm into ovule and double fertilization occurs
   A. 1 sperm unites with the egg and forms a (2N) diploid zygote
   B. 1 sperm unites with the 2 polar nuclei of central cell to produce a triploid (3N) endosperm cell
      • endosperm cell divides and matures to form the endosperm - the food source for the embryo and future seedling

Development of Seed

6. Ovule develops into a seed that is composed of 3 parts
   A. seed coat - for protection
   B. endosperm - food for embryo and future seedling
   C. embryo - the immature sporophyte plant

Fruits

1. In Angiosperms, the ovary or ovaries and sometimes adjacent parts of the flower will develop into a fruit that surrounds the seed.

2. Fruit development occurs after fertilization. Do not get endosperm mixed up with fruit. Endosperm is a constituent part of the seed and seeds are part of or enclosed within the fruit

3. Definition of a fruit - is one or more matured ovaries, together with their contents, which may or may not be united with other closely related structures.

4. Some fruits provide a fleshy covering for the seeds (example - apple)

5. Other fruits provide a dry covering for seeds (example pods of peas)
6. *Functions of fruits*

   A. *Protect seeds*

   B. Aid in *dispersal of seeds* (example - birds eat berries and deposit seeds elsewhere)

7. *2 kinds of fruits* are: *(See handout of Table 28.1 from page 503 of Textbook)*

   A. *Simple Fruits* - develop from a *flower* with a *single ovary*

   B. *Compound Fruits* - develop from a *group* of *individual ovaries*

   *(Discuss types of fruits, their descriptions and examples from Table 28.1.)*
1. pollen grain  
2. pollen tube  
3. sperm nuclei  
4. tube nucleus  
5. anther  
6. filament  
7. stamen  
8. petal  
9. sepal  
10. receptacle  
11. peduncle  
12. stigma  
13. style  
14. ovule  
15. ovary  
16. nucellus  
17. inner integument  
18. outer integument  
19. funiculus  
20. embryo sac  
21. synergid  
22. egg  
23. polar nuclei  
24. antipodals  
25. pistil  

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GENERALIZED DICOT FLOWER AND MALE GAMETOPHYTE

p. 155 of manual
Fruits and Seeds

The stimuli of pollination and fertilization initiate changes in the ovary of a flower which result in the formation of the fruit. A fruit may be defined as the ripened ovary (or ovaries), with contents, of a flower, often including closely associated parts. There are numerous kinds of fruits, ranging from small, dry seedlike fruits to the larger, fleshy types. The correct botanical classification of fruits may at first be disturbing, for instance, the fact that a tomato is really a berry. There can be no argument about what is a fruit and what is a vegetable; if it is derived from the ovary of a flower it is a fruit.

Parts entering into fruit are ripened ovary wall or pericarp (which may be differentiated into outer exocarp, inner endocarp and intermediate mesocarp), seeds, placental tissues; partitions; receptacle, axis of stem. 

1. Simple fruits, each derived from a single ovary.
   a. Fleshy fruits (pericarp fleshy): berry, drupe, pome, pepo
   b. Dry fruits (pericarp dry): 1. Dehiscent (splitting open when ripe): legume, follicle, capsule, siliqua 2. Indehiscent (not splitting open when ripe): akene, carpospyrum (grain), nut

2. Aggregate fruits, derived from a number of ovaries belonging to a single flower, massed on or scattered over a single receptacle, later uniting into a single fruit: strawberry, raspberry, blackberry.

3. Multiple fruits, derived from the ovaries of several flowers, more or less united into one mass: mulberry, pineapple, fig. The drawings of fruit types referred to by figure number in this exercise are to be found on pages 155 and 157.

Legume. Examine the pod of a pea (Figure 110) or a bean. Along how many sides does this fruit split? Identify the floral structures which are here represented. The pod is composed of one carpel. The fact that this carpel may represent a modified leaf is more apparent in the pea than in many fruits since the venation is not obscured.

Remove one of the peas and examine the hilum, or scar of the seed stalk and close by it the micropyle, a tiny opening through which the pollen tube entered the ovule and which admits water as a preliminary to germination. Remove the seed coat, noting the relative position of the micropyle and the radicle of the embryo. This relation is true for all seeds. Is there an endosperm? The fleshy halves of the cotyledons are attached by slender connectives to the axis of the embryo. The primordial root is known as a radicle and the embryonic bud as the plumule. What is the character of the hypocotyl, the epicotyl?

Follicle. A follicle (Figure 111), differs from a legume in splitting along one side only. Examine follicles of milkweed, of peony. In the milkweed each seed has a large tuft of hairs by which it may be carried by air currents. From what ovule structure are these hairs derived?

Capsule. Examine capsules of mullein, castor bean, Ludwigia or Iris (Figures 112, 113). How do these differ from follicles and legumes? How many carpels are there in the Iris capsule?

Akene. Examine akenes of buckwheat or sunflower (Figures 114-115). Crack the outer coat and remove the seed. Are the seed coats attached to any part of the pericarp? Peel off seed coats and dissect out the embryo. Are these plants monocotyledons or dicotyledons? Explain.

Winged akenes are found in many plants, such as dandelions (Figure 116), lettuce, and Clematis.
From what flower structure is the parachute of the dandelion fruits derived?

Samara. The broad-winged fruits of ash and maple (Figure 117) are known as samaras or key fruits. From what flower structure are the wings derived? Drop one of these fruits from the height of six feet. Explain how the behavior of this fruit as it falls might benefit the plant.

6. Nuts. Acorns (Figure 118) filberts and hazelnuts are examples of true nuts and not be confused with such commercial "nuts" as almonds, walnuts and hickory nuts which are really the stones of drupes, or with pine nuts and Brazil nuts which are hard-walled seeds. The pericarp is stony in a true nut. Examine an acorn, note the involucr (cup) at the base. Open the shell and dissect out the seed, noting the abortive ovule. Is this the seed of a dicotyledon or a monocotyledon?

7. Caryopsis. The caryopsis (Figures 119, 120), is the typical fruit of the grasses. Examine a grain of corn (one of the largest grasses) and find the embryo or germ. Section the grain longitudinally, perpendicular to the flat sides. Identify the pericarp, the large endosperm (divided into horny and starchy portions) and the embryo. The latter is composed of a single cotyledon (scutellum), which is the structure in contact with the endosperm. Note the plumule, radicle, and hypocotyl. What is the coleoptile, the colorhiza? How does this fruit differ from an akene?

7. Berry. Examine the fruit of cranberry, grape or tomato (Figures 121-122). Cut sections and determine the number of carpels and the arrangement of seeds. Such a fruit is a true berry.

The hesperidium is a type of berry with a leathery rind: orange (Figures 123-124), and lemon. From what is the pulp derived?

F. E. Study cucumber, squash, pumpkin, melon or gourd. Cut sections and observe the arrangement of the seeds. A fruit of this type is developed from a flower with an inferior ovary, so the fruit wall and rind are composed in part of tissues from the receptacle. The flesh is mostly mesocarp and endocarp, but the placental tissues may also be

well developed (especially in watermelon) to form much of the pulp. This fruit, peculiar to the melon family, is a modified berry.

8. Drupe. Cut longitudinally through a cherry, peach, plum, or olive (Figures 125-128). Remove the flesh from one side, leaving the stone in place. Identify the exocarp or skin, the fleshy mesocarp, and the bony endocarp. Remove and crack the stone, exposing the seed. Vestiges of an abortive ovule may be present, or rarely, two seeds.

9. Pome. Examine an apple (Figures 127-128) cut longitudinally and another cut transversely. Identify sepal, ripened ovary, receptacle tissues, vestiges of stamens. How many carpels are there? Was the ovary inferior or superior? Pears and quinces have similar structural features. Haws are similar but differ in having bony ovary walls instead of papery ones as in a pome.

10. Note the fruits (drupelets) of basswood (Figure 129) attached to a leaf-like bract. Drop one of these fruits from a height of six feet. What happens? Would this behavior serve any useful purpose to the plant?

11. The strawberry (Figure 130-131) is an aggregate fruit in which the fleshy part consists of the enlarged receptacle. The small, seed-like structures (fruitlets) scattered over the surface of the receptacle are small akenes.

References are at end of Exercise 28.

QUESTIONS

1. What is a fruit?
2. Distinguish between a caryopsis and an akene.
3. Why is the tomato fruit a berry?
4. What are the three layers of the pericarp?
5. What part of the pericarp is eaten when you eat: olives, cucumbers, oranges, tomatoes, plums, bananas?
6. What is the fleshy part of the apple, the strawberry?
7. What is the stone in a drupe?
8. What is the commercial importance of the caryopsis type of fruit?
9. List ways in which fruits and seeds may be naturally disseminated.
10. Comment on the value of fruits in the life of a plant.

FRUIT — One or more matured ovaries, together with the contents, which may or may not be united to other closely related structure.