### Biology II Lecture Outline

**Gymnosperms**

**References** (Textbook - pages 424 - 427, Lab manual - page 145 - 150)

- The term *gymnosperm* means "naked seed" (*Greek* - *gymnos* - naked) (*Greek* - *sperma* - seed)

#### Major Characteristics

1. *Gymnosperms* are *vascular plants*

2. *Gymnosperms* produce *seeds*
   - A *seed* is composed of **three parts**. These are
     - *Sporophyte embryo*
     - *Stored food*
     - *Protective seed coat*
   - *Stored food* and *protective seed coat* allow embryo to *survive* harsh conditions during long *periods* of *dormancy*, maybe even for **hundreds** of *years*.
   - When a *seed* *germinates* the *stored food* is a *source of nutrients* for the growing *seedling*
   - The *survival value* of seeds are the *reason* that *plants* that *produce seeds* are the *most plentiful* plants *on earth*.
   - In gymnosperms the *seed* is *naked* in that it is *totally exposed* or *borne* on the *scales* of *cones* and is *not enclosed* in an *ovary*.

3. The *sporophyte* is the **dominant life stage** of a *life cycle* that exhibits **alternation of generations**.

4. *Gymnosperms* are *heterosporous*. There are **two types** of *spores* that produce *male* and *female gametophytes*. Two types of spores are:
   - **Microspores**
     - *Microspores* are *small* and produce multicellular *pollen grains* which are the *male gametophyte*
     - *Pollen grains* are *drought resistant*
• no external water is required for fertilization (note difference with Bryophyta and seedless Tracheophytes where external water is required for fertilization.)

• also note that in gymnosperms the entire male gametophyte moves to the female gametophyte, rather than just the sperm as in seedless plants

B. Megaspores

• Megaspores develop within an ovule

• Megaspores grow into the female gametophyte which may develop several archegonia

• After fertilization, the female gametophyte develops within the ovule to eventually form a seed.

• As already mentioned - in Gymnosperms the ovules are not completely enclosed by sporophyte tissue (ovary in angiosperms) at the time of pollination and are thus called naked.

5. Gymnosperms include about 750 species of perennial trees and shrubs

• Perennial plants are those that have vegetative structures that live more than one growing season

6. Most are evergreen and shed their leaves gradually and replace their leaves gradually

• Evergreen means they retain their leaves year round - deciduous trees loose their leaves in the fall

7. Gymnosperms are usually woody and they are often called the softwoods because their wood is soft as compared to the hardwood of species like oaks.

8. The gymnosperms were very prominent during the Mesozoic Age of geologic time. The Mesozoic has been called the Age of Gymnosperms.

4 Major Groups of Gymnosperms

1. Conifers

   A. The term conifer means cone-bearing

   B. Includes approximately 575 species that are especially common in Canada, Northern Europe, and Siberia.
C. Includes pines, spruces, firs, cedars, hemlocks, redwoods, cypresses, larches, and others

D. Most conifers are monoecious and have separate male and female reproductive organs on the same plant. There are commonly called pollen cones and seed cones.

E. Leaves are tough, needle like and resistant to water loss because of a thick cuticle and recessed stomata.

F. Conifers are mostly softwoods and have evergreen foliage.

G. Uses of conifers.
   
   - Wood of pines used in construction.
     
     (the wood of pines is made mostly of xylem and lacks some of the more rigid cell types found in flowering-trees (angiosperms) like oaks. Therefore, pine is considered a softwood rather than a hardwood like oak.)
   
   - Resin made by pines to repel insects and fungus is harvested and used to make turpentine.
   
   - Several species of conifers are sold and used extensively as Christmas trees.

H. Two interesting conifers
   
   - The tallest living vascular plants are the coastal redwoods in northwestern California and southwestern Oregon. Some of these trees may attain up to 330 feet in height.
   
   - The oldest living tree has been identified as a bristlecone pine in California that is estimated to be 4,900 years old (based on tree ring analysis).

I. We will study the life cycle of pine in detail - later.

2. Cycads

   A. There are about 100 species of cycads that grow mostly in subtropical and tropical forests.

   B. They are widely used for home and garden landscaping.
C. Most have leaves clumped near the top of a stem and appear palm-like in appearance.

D. Cycads are dioecious and pollen (male) and seed (female) cones are on separate plants. (remember they are on the same plant in most conifers - monoecious)

E. Cycads have a life cycle similar to pines except they are pollinated by insects rather than by the wind.

F. Also, the sperm in cycads are similar to the sperm of seedless Tracheophytes in that it is flagellated and still swims to reach an egg.

3. Ginkgoes

A. Ginkgos are common in the fossil record.

B. Only one tree species, Ginkgo biloba, is living today.

C. The tree resistant to pollution and is used as a landscaping plant along city streets and in city parks.

D. Ginkgo trees are dioecious.

E. When fleshy seeds ripen in the fall, the female tree gives off a foul odor and male trees are usually preferred for landscape plantings.

F. Like cycads, sperm is flagellated and swims to the female gametophyte.

4. Gnetophytes

A. There are 3 living genera of gnetophytes that include approximately 70 species.

B. The 3 living genera are:

   (1) Gnetum
   - Occurs in the tropics
   - Are trees or climbing vines

   (2) Ephedra
   - Occurs only in southwestern North America and southeast Asia
   - A shrub with small scale-like leaves
   - Source of the drug ephedrine
(3) *Welwitschia*

- Lives in the *deserts* of *southwestern Africa*
- Has only *two* large *strap-like leaves*

C. All *gnetophytes* lack an *archegonia.*

(Note that all plants we have studied so far possess an archegonia and this is the first group to lack an archegonium. The lack of an archegonia is also a characteristics of the angiosperms, a group we will study later.)

D. *Insects* are responsible for *pollination* of *gnetophytes*

**Life Cycle of Pine** *(see handout of Figure 24.18 from page 425 of textbook)*
*(see handout of Figure 13.5 from page 150 of lab manual)*

- Life stage descriptions below - follow the numbering system from figure 24.18 on page 425 in the textbook

1. *Sporophyte* is *dominant life stage.*

   A. *Sporophyte* is *monoecious*

   B. *Sporangia* are borne in *pollen* (male) *cones* and *seed* (female) *cones*

   C. *Pollen cones* are also called *microstrobili* or *staminate cones*

   D. *Seed cones* are also called *megastrobili* or *ovulate cones*

**Development of Male Gametophyte** *(see handout of Male Reproductive Structures - Pine)*

2. *Pollen cones* are *small* and develop near *tips* of *lower branches*

   A. each *pollen cone* is made up of a number of *pollen cone scales* called *microsporophylls*

   B. *microsporophylls* bear the *microsporangia* (male sporangia)

3. Within *each microsporangium* are *microsporocytes* (or *microspore mother cells*)

   A. *microsporocytes* (microspore mother cells) undergo *meiosis* to produce *4 microspores.*
4. Each microspore develops into a pollen grain

   A. Pollen grain is the male gametophyte in the pine life cycle.

   B. Each pollen grain has two wings and is carried by the wind to the seed cone where pollination occurs.

Development of Female Gametophyte

2. Seed cones are larger than pollen cones and located near tips of branches of higher branches

   A. Each seed cone is made up of many seed cone scales called megasporophylls

   B. On the upper surface of the each megasporophyll lie two ovules

   C. Each ovule is surrounded by a thick, layered integument with an opening at one end

3. Within each ovule is a megasporangium

4. Inside the megasporangium, a megasporocyte (megaspore mother cell) undergoes meiosis to form 4 megaspores

5. Only 1 of these megaspores develops into the female gametophyte

   A. Female gametophyte will have 2 to 6 archegonia

   B. Each archegonia will contain a single large egg lying near the ovule opening.

Development of Seed

6. Pollination and fertilization

   A. Pollination occurs when pollen becomes enclosed in seed cone, and enters the ovule through the opening in the integument.

   B. Once enclosed, pollen grain develops a pollen tube that digests its way toward a female gametophyte.

       • This process takes a full year before the pollen tube reaches a mature egg in the archegonium.
C. *Fertilization* occurs when the *pollen tube releases 2 non-flagellated sperm* into the *archegonium*

*(note - water is not needed for successful fertilization as with Bryophytes and seedless Tracheophytes)*

- *One sperm fertilizes* an *egg* and the *other* sperm *degenerates*

D. *Fertilization* is an entirely *separate event* from *pollination* and *occurs one year after pollination.*

7. *After fertilization, ovule matures* into *seed*

   A. *Seed* is composed of *3 parts*

      - *Embryo*
      - *Reserve food*
      - *Seed coat*

   B. In *fall* of *second season* (after pollination)

      - *seed cone* becomes *hard* and *woody*
      - seed cone *opens* and *releases winged seeds*
      - because *gymnosperm (pine)* seeds are *not enclosed by fruit*, like *angiosperms*, they are called *naked seeds*

   C. seeds fall on fertile soil and germinate into a new pine tree
Draw the following illustration on the blackboard and encourage students to be able to assign the life stages discussed above to their appropriate places on the illustration. *Note how this is similar to the exercise of constructing sentence diagrams in English grammar classes*