Lecture 7 Gymnosperms

Key Terms:
Ovule
Integuments
Gymnosperms
Angiosperms
Pollen grains
Pollination
Pollen tube
Cycads
Ginkgos
Gnetales
Conifers
Vessel elements
Cones
Strobili
Sporophylls
Sporocytes
Generative Cell
Tube cell
Woody plants
Resin
Monoecious
Diecious

Seed plants

Seed plants include the gymnosperms and the angiosperms. Their main way of reproduction is by seeds, which are made up of embryonic sporophyte, nutritive tissue and protective coat.

This replaces the spore reproduction method employed by the seedless plants but spores are still produced, just not shed.

Evolution towards seed plants

Based on the trend from non vascular non seed plants (mosses) to vascular non seed plants (ferns) we can see that the gametophyte generation is gradually reduced and replaced by the sporophyte as the dominate generation. In the vascular non seed plants, the gametophyte and sporophyte are independent of each other. In seed plants, we will see that the gametophytes have been reduced to such a degree that they are entirely dependent on the parent sporophyte.

In seed plants, the female gametophyte is developed from spores retained in the sporophyte. This allows the gametophyte to absorb nutrients from the parent sporophyte (matrotrophic) and protects it from the harsh environment conditions.

The gametophyte exists entirely within the spore and the spore is not released like in non seed plants. This requires the gametophyte to the extremely small, microscopic to our eyes. The female gametophyte will produce an egg in the archegonium to be fertilized.

The gametophyte is not completely eliminated since it is still required to nurture the embryo.

The female gametophyte, the megasporangium, and the a layer of sporophyte tissue that envelops the megasporangium (**integuments**) made up the **ovule.**

While all these are happening to the female gametophyte, the male gametophyte, also undergo several changes. Microspores are produced inside the microsporangium through the process of meiosis in the sporophyte. These microspores develop into **pollen grains** by the process of mitosis. Pollen grains are really male gametophytes with tough sporopollenin coats on the outside. These male gametophytes are unique in that they do not have the anteridium. (Famale gametophytes of seed plants still have the archegonium)

Pollen grains are carried by wind to ovules. (This means that in seed plants, the female gametophyte is the only one that are retained in the parent sporophyte) Once there, the pollen grains develop pollen tubes that eat their way to the female gametophyte's archegonium. Then sperm cells will be discharged into the egg and fertilize the egg to become a zygote.

Zygote will divide by mitosis to produce an embryo, a young sporophyte, that will be nurtured by the gametophyte to a cetain stage. The embryo and the ovule surrounds it will develop into a seed. The seed also contains the megagametophyte nutritive tissue, which will become the food for the embryo. These seeds will be carried by wind or animals to places where it will germinate once it finds a suitable place.

The seed can be thought of as a resting stage. In non seed plants, the embryo must develop into a mature sporophyte or die. Seeds give much better chance of the survival for the embryos since embryos can undergo reduced metabolism and survive for long periods of time.

It is important to know that all seeds plants are heterosporous. This means that there are female and male variety of the gametophyte. Without this feature, the whole pollen grain → egg → embryo → seed process cannot occur.

It is also important to note that no water is involved in any of the reproduction process. This is a key step in the evolution process that allows the gymnosperms to adapt themselves so well to the terrestrial environment. However, this does not mean that the sperm cells are not motile. In fact, some groups of gymnosperms have motile sperm cells that have hairlike flagella.

Seed
A seed is a complex and well protected package. It contains tissues from three generations. The 1st generation is the seed coat, which is formed from the diploid sporophyte parent's tissue. The 2nd generation is the nutritive tissue from the haploid female gametophyte, which provides the food source. The 3rd generation is the embryo, which is the new diploid sporophyte.

Groups within the Gymnosperm
There are four groups within the gymnosperm. They are:

Cycads
Cycads resemble palm tree of the tropics in possessing compound leaves Stout trunk like stems. They have motile sperms and seed/pollen cones.

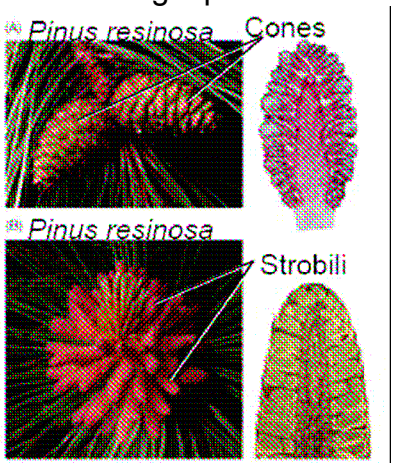
Ginkgos
There is only one species left in this group. They have x and y sex chromosomes, which is very rare in plants. They have motile sperms

Gnetales
Used to thought as the closest relatives to the angiosperms because they have **vessel elements,** which other than the gnetales only the angiosperms have. They do not have motile sperms.

Conifers
Cone bearing plants with non motile sperms. See below

Life cycle of a pine (conifer)
Lecture examined in detail the life cycle of a pine so we will do the same here. Lets define the conifers here.

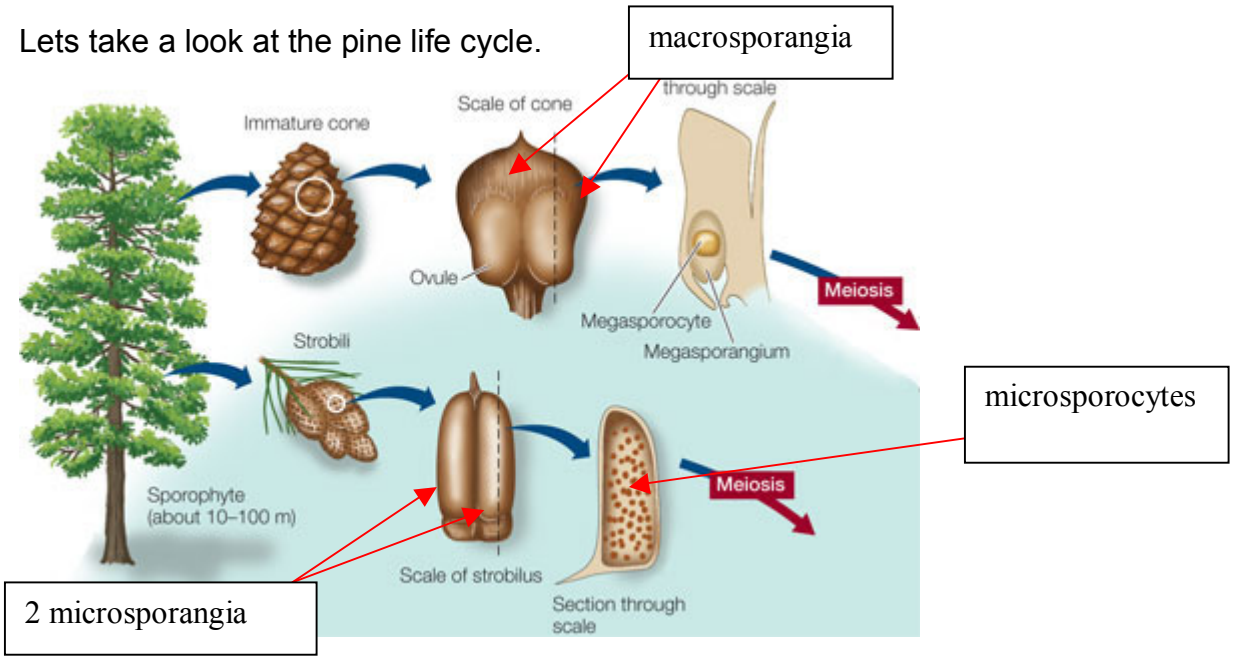
Conifers are called conifers because they are cone bearing plants. They have **cones**, modified branches specialized for reproduction and **strobilis**, modified leaves. Megaspores exist in cones, while microspores exist in the strobili.



All conifers are **woody.** This means that they have secondary growth that produce annual additions of secondary tissues (wood and bark) from tracheids.

In pine trees, the male strobilius are smaller than the female cones. Female cones exist on top of the male strobilius because it is hard for winds to carry the pollen grain upwards. Therefore, this allows pines to produce with cones/strobilius on other trees rather than on itself.

Lets take a look at the pine life cycle.



Conifers, as we have dicussed, have strobili and cones. We will take a look at each one individually.

Step 1)
Strobili:
Male cones composed of sporophylls. (“Cone scales”)
There are 2 microsporangia per sporophylls.
Each microsporangia contain numberous microsporocytes. (microspore mother cells)

Cones
Female cones are composed of cone scales.
Each scale has 2 megasporangia.
Each megasporangium has a megasporocyte (macrospore mother cell)

Step 2)
They all undergo meiosis, each micro/mega sporocyte producing 4 haploid spores.

Step 3)

Strobili:
4 haploid microspores make up a pollen grain but 2 dies.
2 left becomes a generative cell and a tube cell.

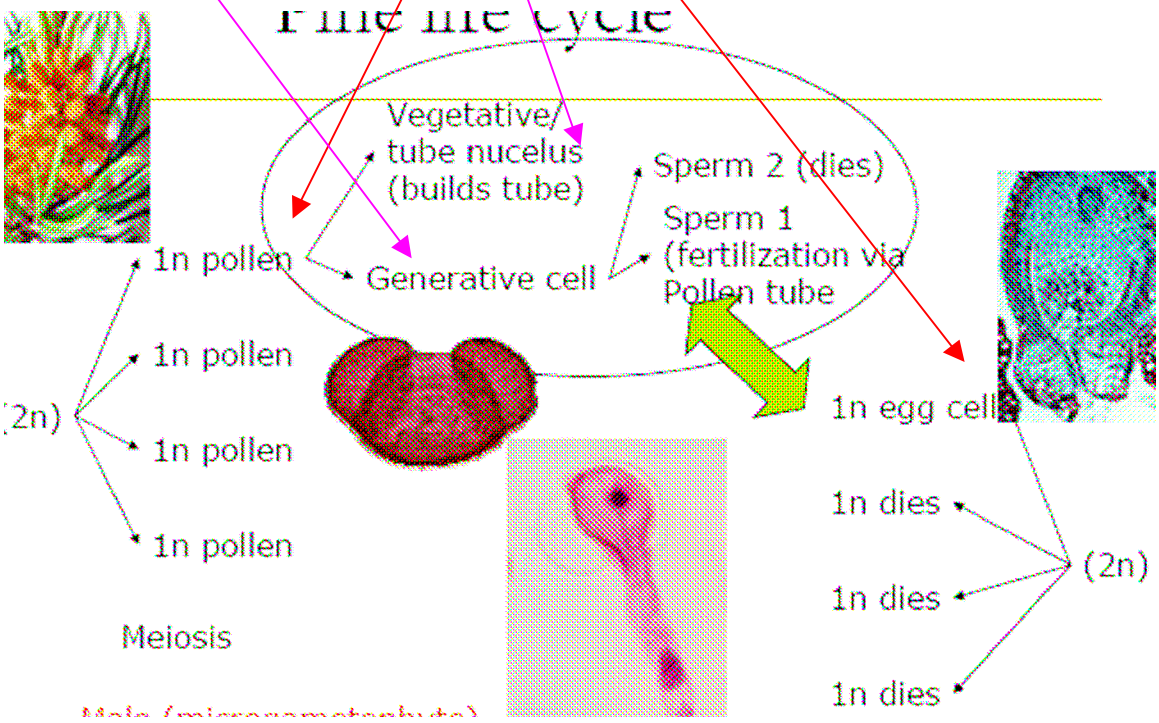
Cone:
3 dies
1 left divide by mitosis to produce a female gametophyte, which in turn produce an egg shell

Step 4)
Pollination occurs, pollen cones (used up strobili) wither and drop off the ground

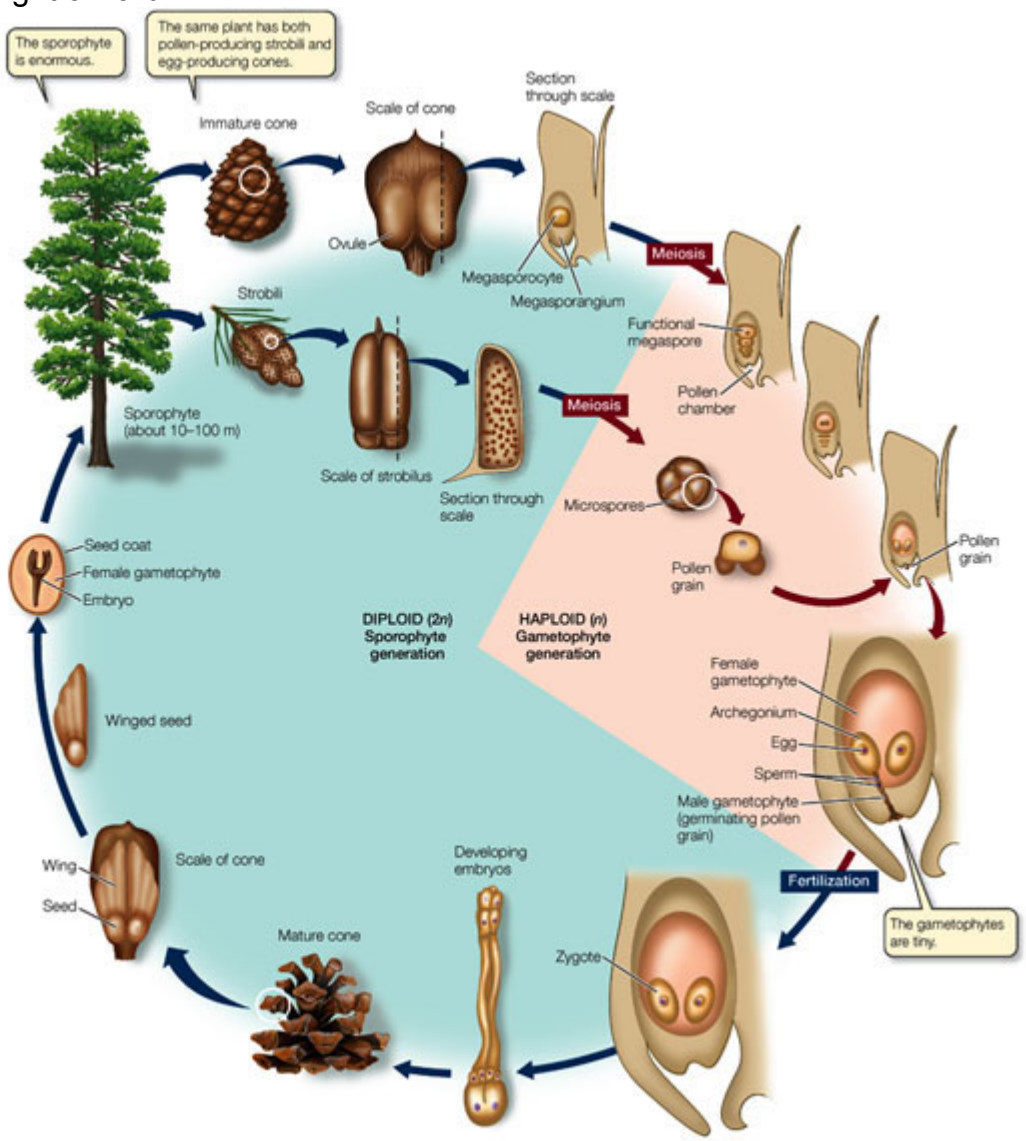
Step 5)
Pollen grain:
Tube cell develops a pollen tube that eats its way to the female gametophyte. (pollen grain itself is an immature male gametophyte but the one with a pollen tube is a mature gametophyte)

Generative cell enters tube , divide to form 2 non motile sperms (actually, it divides to form a body cell and a stalk cell, then the body cell divides to form 2 sperms).

One sperm fuses with the egg, the other dies.



The rest is pretty straightforward.



***LIFE 8e*, Figure 29.8**