

Plant Diversity II. The Evolution of Seed Plants: Gymnosperms

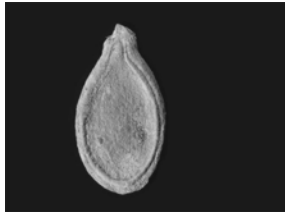


Figure 30.1. An ancient squash seed

The importance of seed plants

- Began to diversify ca. 360 MYA, today dominate terrestrial ecosystems.
- Basis of human civilization.
 - Nearly all crops are seed plants (mostly angiosperms).
 - Agriculture began ca. 13,000 YA.
 - Invention of agriculture transformed human society.

What is a seed?

The components of a seed include:

- An embryo (young sporophyte)
- Some energy-rich food reserves
- A protective seed coat

Evolutionary advantages of seeds

- Protective seed coat and energy reserves enable plants to resist harsh environments.
- Seeds can be widely dispersed by wind or animal vectors.
- Seed dormancy allows synchronization of plant life cycle with seasonality.

There are two main groups of seed plants

- Angiosperms, the flowering seed plants
 - ca. 250,000 species
 - Reproductive structures are flowers.
 - Seeds are enclosed in ovaries.
- Gymnosperms, the non-flowering seed plants
 - ca. 800 species, mostly conifers.
 - Reproductive structures are cones.
 - Seeds are “naked”, not enclosed in ovaries.

Pseudotsuga menziesii, Douglas Fir, a conifer



Douglas fir



Douglas fir – cones and needles



Juniperus virginiana, Eastern red cedar



Conifers are important sources of forest products



Ginkgo biloba



Ephedra viridis, Mormon tea



Zamia furfuracea, a Cycad



Seed plant life cycles: The main points

- Extreme reduction of gametophyte generation.
- Seed plants are heterosporous:
 - Megaspores produce female gametophytes.
 - Microspores produce male gametophytes.
- The *ovule* = a megasporangium + integuments
- The *pollen grain* = a male gametophyte enclosed in a microspore wall.

Homospory vs. Heterospory

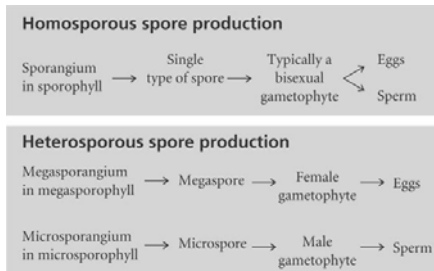


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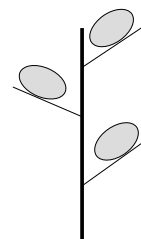
Homospory vs. heterospory: some terminological confusion

- A female gametophyte is sometimes called a *megagametophyte*.
- A male gametophyte is sometimes called a *microgametophyte*.
- In seed plants, *embryo sac* is another term for female gametophyte
- In seed plants a *pollen grain* is a male gametophyte

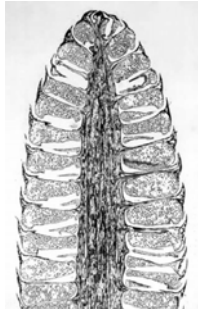
A strobilus or cone = a reproductive shoot consisting of an axis and sporophylls



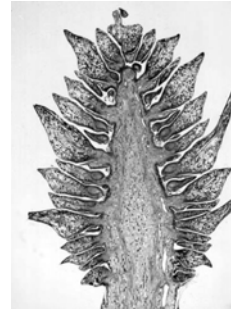
A strobilus = an axis, sporophylls, sporangia



Longitudinal section of male pine cone ("pollen cone")



Longitudinal section of a female pine cone ("ovulate cone")



Ovules and production of eggs (Overview of Pine life cycle)

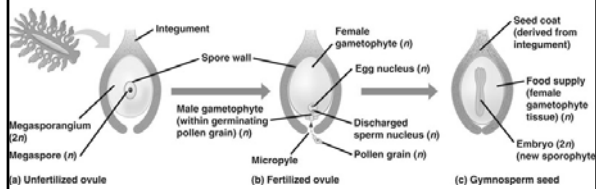


Figure 30.3

The Megagametophyte (female gametophyte)

- One cell in megasporangium – the megasporocyte – undergoes meiosis.
- Four megaspores result.
- One megaspore survives, three do not.
- Surviving megaspore undergoes mitosis to produce megagametophyte.
- Megagametophyte is multicellular, develops archegonia with eggs.
- All of this take place within the megasporangium surrounded by integuments (the ovule)

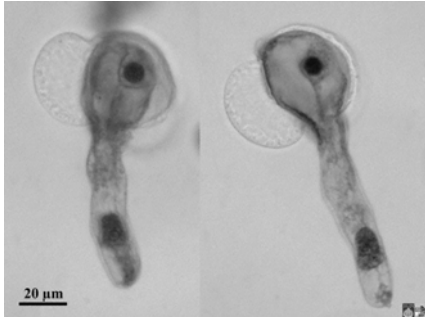
Pollen and production of sperm

- Remember, spores always develop into gametophytes!
- Microspores develop into microgametophytes (male gametophytes).
- A microgametophyte enclosed in a microspore wall = a *pollen grain*.

The pollen grain has only a few cells (four!)

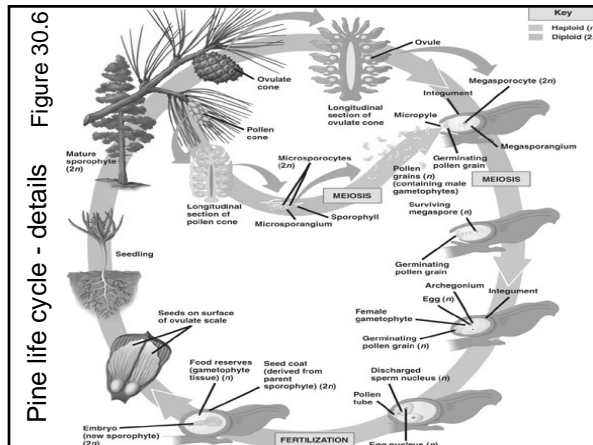


The pollen tube delivers two sperm nuclei to the female gametophyte



In gymnosperms, the gametophyte generation is extremely reduced

- Female gametophytes
 - multicellular, but tiny and enclosed in sporophyte tissue
 - archegonia present
- Male gametophytes (pollen grains)
 - reduced to four cells
 - no antheridia, obviously



Gymnosperm evolution

- First gymnosperms appear in fossil record ca. 360 MYA (> 200 MY before first angiosperm fossils)
- Carboniferous to Permian transition (ca. 290 MYA)– warmer and drier.
 - Gradual replacement of seedless vascular plants by gymnosperms.
 - Gymnosperm seeds, pollen grains and needles may have been advantageous in arid climates.
- Angiosperms began to replace gymnosperms ca. 100 MYA, but gymnosperms still dominate many ecosystems.