Introduction to Seed Plants

How seeds allowed the full colonization of land by plants

Wrap-up of cryptogams

- Free living gametophyte
  - Gametophytes independent of "parent" sporophytes
  - May be small & inconspicuous, but still free-living
- Have motile sperm AND require water for fertilization
  - Sperm swim through open environment to reach egg
- Therefore, not fully terrestrial
- Vestiges from aquatic heritage
- Only with development of seeds do plants become fully terrestrial

Advantages of Seeds

- Mechanism for fertilization without water
  - Sperm do not swim through open environment
  - Exploit new habitats (fertilization times, places, etc.)
- Provide new method for dispersal
  - Move into new areas
  - Open specialized dispersal mechanisms (wind, animals)
- Dormancy: wait for favorable conditions
  - Unlike (most) cryptogams
- Provide nutrition to developing sporophytes
  - Increase survivability; dormancy

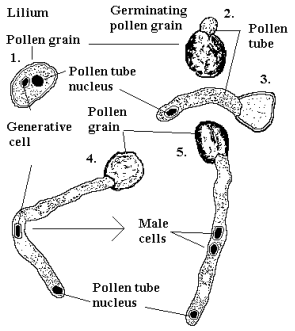
Advantages of Seeds

- For these reasons, seed plants are now dominant
- Replaced cryptogams in most areas
  - Often restricted to specialized habitats, now
- Other adaptations:
  - Axillary branching vs. uneven dichotomous branching
  - Secondary xylem & phloem production
  - Development of bifacial vascular cambium

What Makes Them Different?

- All are heterosporous
- Spore & gametophyte types modified
- "Pollen" not unlike microgametophyte of *Selaginella*
  - Sperm do not swim through open environment
  - Entire microgametophyte delivered to area of the egg
  - Sperm move through pollen tube to the egg
- Pollen = immature microgametophyte
- Pollen grain with pollen tube = mature microgametophyte

Microgametophyte Example



Megagametophyte

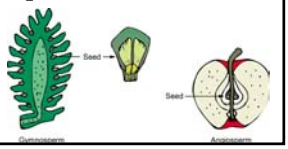
- A new outer, protective layer surrounds the megasporangium = integument
- OVULE = integumented megasporangium
- Megagametophyte is endosporic, but no longer free living
  - Nutritionally dependent on sporophyte, and not released from sporophyte tissue
- See "Seed Plants" handout

The Seed

- A SEED is an embryo (young sporophyte) encased in the megagametophyte (nutritive tissue), all enclosed by seed coat (remnants of nucellus & integument of old sporophyte generation)
- Contains 3 generations in one:
  - Integument(s) = seed coat - remnants of megasporangium (2*n*) [grandmother]
  - Megagametophyte = nutritional source for developing embryo (1*n*) [mother]
  - Embryo = young sporophyte (2*n*) [daughter]

Major Seed Plant Lineages

- **Gymnosperms** – "naked seeds" [Greek, *gymnos* = naked]
  - Borne in exposed position, e.g., sporophylls, scales, etc
- **Angiosperms** – "seeds" inside "vessels" [Greek, *angios* = vessel]
  - Enclosed in a carpel

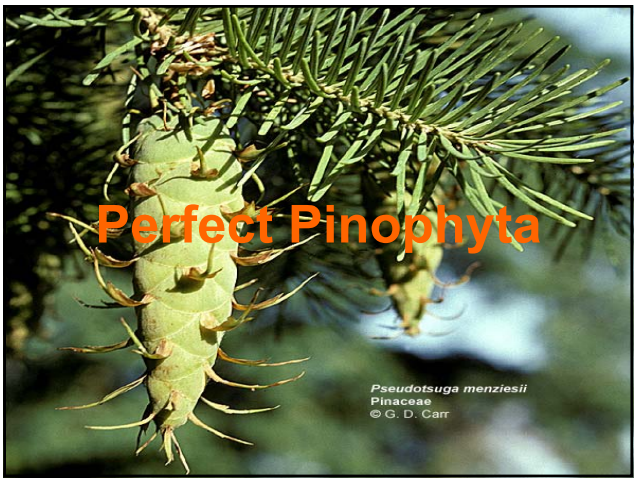


Seed Plant Lineages

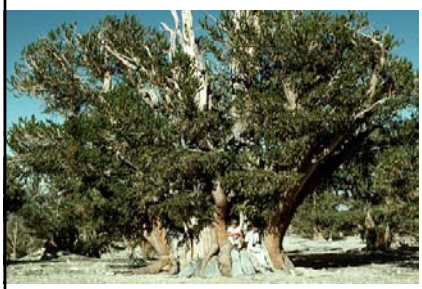
- Gymnosperms
  - Pinophyta
  - Gnetophyta
  - Ginkgophyta
  - Cycadophyta
- Angiosperms
  - Magnoliophyta





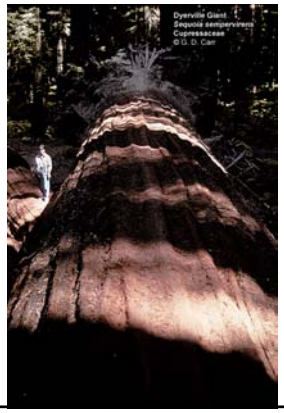


Oldest, Single, Living Organism




Pinus longaeva
(bristle-cone pine)

Tallest Living Organism



Cupressaceae
Sequoia semperivirens
(coastal redwood)

Eucalyptus regnans

- **Tallest recorded tree**
  - **Chopped down**
- **~ 135 m high [443 ft.]**

Pinophyta

- **Largest division of extant gymnosperms**
  - **600 living spp. [spp. = species, plural]**
- **Secondary growth common**
  - **Wood**
- **Greatest distribution among extant gymnosperms**
  - **Especially in N. boreal regions**
  - **Coniferous forests for a nearly continuous ring around the N. Hemisphere (= boreal coniferous forest**

Pinophyta

- **Also found in more temperate areas, e.g., "pyro-phytic" pinelands of SE U.S.**
  - **Fire-maintained ecosystems**
  - **Where fire is eliminated, replaced by angiosperms**
- **Mostly monoecious (some dioecious)**
- **Pollen grains have a pair of sac-like appendages (lost in some lineages)**

Pinophyta Economics

- Timber
  - *Pinus*, *Pseudotsuga*, *Picea*, *Tsuga*, *Larix*, *Abies*
- Pulp (for paper)
- Chemicals
  - Resins, turpentine, oils; "pitch" from pines used to coat naval ships
  - Important draw for England to SE Va. – Capt. John Smith
- Ornamentals
- Pine nuts
  - *Pinus edulis* seeds (NOT nuts!)

Pinophyta Taxonomy

- Taxopsida
  - Taxaceae
- Pinopsida
  - Pinaceae
  - Cupressaceae
  - Podocarpaceae
  - Araucariaceae *
  - Phyllocladaceae *
  - Cephalotaxaceae *

Pinaceae (10 gen., 220 spp.)

• *Pinus* (pines)	100 spp.
• *Abies* (firs)	40 spp.
• *Picea* (spruces)	40 spp.
• *Tsuga* (hemlocks)	10 spp.
• *Pseudotsuga* (Douglas fir)	5 spp.
• *Larix* (larches)	10 spp.
• *Cedrus* (true cedars)	4 spp.

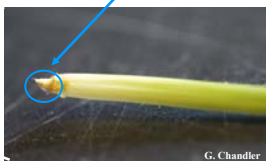
Vegetative Morphology: *Pinus*

- *Pinus* (& some others) have 2 types of shoots: long & short
- Resin canals
- 3 types of leaves
  - Scale (cover long shoots)
  - Sheath (cover short shoots)
  - Needle (photosynthetic)
- Evergreen
  - Leaves not shed all at once

Long & Short Shoots

Long shoot

Short shoot



Pinus Leaf Types

Needle leaves

Sheath leaves

Scale leaves

Pinus Leaf Types

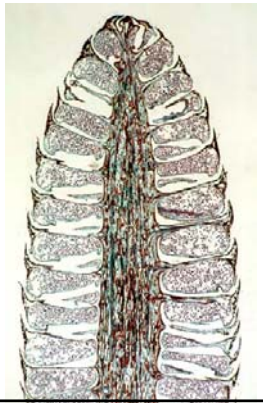
Sheath leaves Needle leaves Scale leaves

Pine Needle Leaves

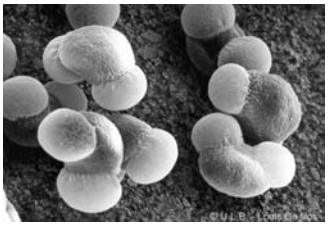
Reproduction in Pinaceae

- Monoecious (male & female on same plant)
- Microstrobilus = pollen cone
- Megastrobilus = pine cone

Microstrobilus

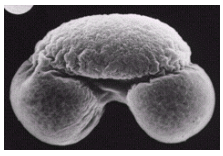


- "Simple" strobilus
- 1 axis with sporophylls
- Pollen with bladders
  - Immature microgametophyte

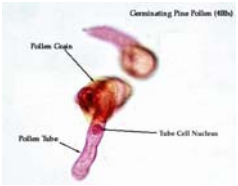


Microgametophyte

- Shed at 4 nucleate stage (immature)
- Fully mature when pollen tube grows
  - 6 nuclei (including 2 sperm nuclei/cells)



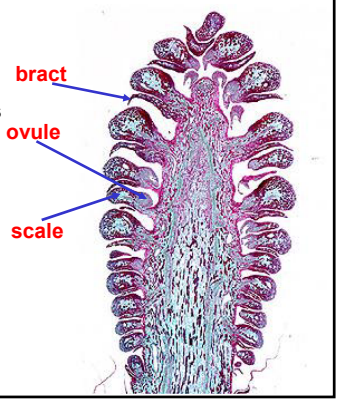
Immature



Mature

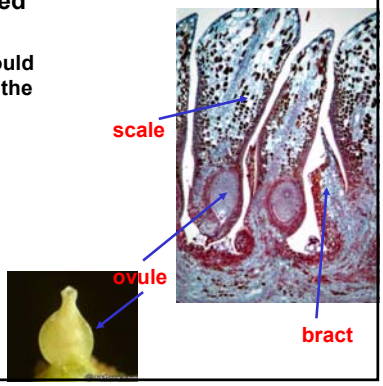
Megstrobilus

- "Compound" cone
  - 2 axes
  - Main axis
  - Lateral axes = branches not leaves (scales)
  - Bracts represent leaves
- See handout on *Pinus* gametogenesis



Young Ovule

- Wing of seed derived from cone scale
  - In angiosperms, would be an outgrowth of the fruit
- Some keep scales
  - E.g., *Pinus*, *Picea*
- Some cone scales deciduous
  - E.g., *Cedrus*, *Abies*



Pinaceae Examples

Pseudotsuga
Douglas Fir

Picea
Spruce

Cedrus
True Cedars

Tsuga
Hemlock

Abies
Firs

Deciduous Leaves

Larix
Larch

Pinopsida: Cupressaceae




Cupressaceae

- Important woods!
  - Many are rot- and termite-resistant
- *Cupressus* (true cedars)
- *Juniperus* (junipers, E red cedar)
- *Thuja* (arbor vitae, W red cedar, white cedar)
- *Chamaecyparis* (white cedar)
- *Taxodium* (bald cypress)
- *Sequoia* (coastal redwood)
- Sequoiadendron (mountain redwood)

Taxodium



Pinopsida: Podocarpaceae

- Seeds borne on swollen *tip* of branch: the aril
- Dispersal of seed by animals
- NOT the same as a fruit!
  - Seed still naked

Taxopsida: Taxaceae

- Only family in class
- Also has aril!
- Convergence
- Aril *surrounds* seed

Torreya californica

- ***Taxus*** **(yews)**
- ***Torreya*** **(stinking cedar; California nutmeg)**