### Kingdom Plantae

Seed plants with naked seeds

#### Gymnosperms

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Estimated Number of Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liverworts</td>
<td>9,000</td>
</tr>
<tr>
<td>Hornworts</td>
<td>100</td>
</tr>
<tr>
<td>Mosses</td>
<td>15,000</td>
</tr>
<tr>
<td>Lycophytes</td>
<td>1,200</td>
</tr>
<tr>
<td>Pterophytes</td>
<td>12,000</td>
</tr>
<tr>
<td>Ginkgo</td>
<td>1</td>
</tr>
<tr>
<td>Cycads</td>
<td>130</td>
</tr>
<tr>
<td>Gnetophytes</td>
<td>75</td>
</tr>
<tr>
<td>Conifers</td>
<td>600</td>
</tr>
<tr>
<td>Flowering plants</td>
<td>250,000</td>
</tr>
</tbody>
</table>
Seedplants have tiny gametophytes that are dependent on the sporophyte.
In seed plants, there are two kinds of spores produced in separate sporangia.

**Homosporous vs. Heterosporous**

- **Sporangium**
  - Spores
  - Gametophyte
    - Archegonium
    - Antheridium
    - Egg
    - Zygote
  - Sperm

- **Megasporangium**
  - Megaspores
  - Mega-gametophyte
    - Archegonium
    - Egg
    - Zygote
  - Antheridium
  - Sperm

- **Microsporangium**
  - Microspores
  - Micro-gametophyte
    - Archegonium
    - Egg
    - Zygote
  - Antheridium
  - Sperm
In seed plants, there are two different kinds of gametophytes that develop attached to the sporophyte.
<table>
<thead>
<tr>
<th>Gametophyte</th>
<th>Reduced (usually microscopic), dependent on surrounding sporophyte tissue for nutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sporophyte</td>
<td>Dominant</td>
</tr>
</tbody>
</table>

**Example**

**Gymnosperm**
- Microscopic female gametophytes \((n)\) inside ovulate cone
- Microscopic male gametophytes \((n)\) inside pollen cone

**Angiosperm**
- Microscopic female gametophytes \((n)\) inside these parts of flowers
- Microscopic male gametophytes \((n)\) inside these parts of flowers

Sporophyte \((2n)\)
Terrestrial adaptations of seed plants

- Microspores develop into male gametophyte, called a pollen grain
- Pollen grains contain sperm
- Pollen grains can travel by air

ADAPTATION: Sperm no longer needs _________
Terrestrial adaptations of seed plants

- Female gametophyte develops inside the ovule

Early ovule consists of: integument, megasporangium, megaspore

Megaspore develops into the female gametophyte, which will produce eggs

ADAPTATION: female gametophyte protected by sporophyte
Terrestrial adaptations of seed plants

- Ovules mature into seeds after fertilization
  - pollen grain travels to ovule (pollination)
  - pollen sends sperm into ovule and fertilizes the egg → zygote → embryo sporophyte

  Female gametophyte tissue → _____________ (in gymnosperms only)

  Integument → ________________

Seeds has three parts: embryo, food and seed coat

ADAPTATION: Seeds protect, and feed the embryo. Seeds can remain dormant
## Gymnosperms diversity

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Common Name</th>
<th>Estimated Number of Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nonvascular Plants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Bryophytes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylum Hepatophyta</td>
<td>Liverworts</td>
<td>9,000</td>
</tr>
<tr>
<td>Phylum Anthocerophyta</td>
<td>Hornworts</td>
<td>100</td>
</tr>
<tr>
<td>Phylum Bryophyta</td>
<td>Mosses</td>
<td>15,000</td>
</tr>
<tr>
<td><strong>Vascular Plants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seedless Vascular Plants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylum Lycophyta</td>
<td>Lycophytes</td>
<td>1,200</td>
</tr>
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<td><strong>Gymnosperms</strong></td>
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<td>Phylum Ginkgophyta</td>
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<td>Phylum Cycadophyta</td>
<td>Cycads</td>
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</tr>
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<tr>
<td>Phylum Coniferophyta</td>
<td>Conifers</td>
<td>600</td>
</tr>
<tr>
<td><strong>Angiosperms</strong></td>
<td></td>
<td></td>
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<td>Phylum Anthophyta</td>
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![Plant diversity diagram](chart.png)
Gymnosperms

- Gymnosperms develop their gametophytes within cones (pollen cone and seed cone)

- When the ovule becomes a seed and the seed cones release the seeds, seeds are “naked” not protected by fruit tissue
Phylum Cycadophyta (cycads)
They are the second largest group of gymnosperms after conifers

They have a fern like appearance

They have cones in the center of the plant

Cycads thrived during the dinosaur era, today restricted to tropical parts

Sperm is flagellated but confined to the pollen tube
Phylum Cycadophyta (cycads)

*Zamia pumila*  only native US cycad
Cycads are used in gardens
Phylum Ginkgophyta (Ginkgo)

*Ginkgo biloba* is the only surviving species

Fan-like leaves that turn gold in the fall.

Popular in cities because they tolerate air pollution well

Sperm are flagellated but confined to a pollen tube

Seeds are fleshy
Phylum Coniferopyta (conifers)

Largest group of gymnosperms

This group includes cypresses, pines, redwoods, firs and junipers

Conifer leaves are need or scale like, adapted to arid climates

Conifers are evergreens
Phylum Coniferopyta (conifers)

Bristlecone trees are some of the oldest Living organisms…. 5065 years old!

Torrey pines are the rarest pine species in the United States
Phylum Coniferopyta (conifers)

*Sequoias* are largest living things
They can weigh about 24 blue whales

Redwoods are the tallest living things
Phylum Coniferopyta (conifers)

Pine nuts are the edible seeds of pines, from 20 different species of pines.
Phylum Gnetophyta: *Ephedra* and *Welwitschia*

They have many similarities with angiosperms:

- Flower like strobili
- Double fertilization

*Welwitschia* live in SW Africa

*Ephedra* is found in the US
Trends in Seed plants

Which generation is the dominant one?

Which generation disperses the species?

What are the key differences between seedless vascular plants and the seed plants?
Which of the following is NOT a characteristic that distinguishes seed plants from other plants?

- Alternation of generations
- Ovules
- Integuments
- Dependent gametophytes

The male gametophyte in pine (a gymnosperm) is commonly known as _____.

- the ovule
- the seed
- wood
- pollen
- the fruit

In a pine (a gymnosperm), the seed develops from the _____.

- pollen grain
- male gametophyte
- ovule
- pollen cone