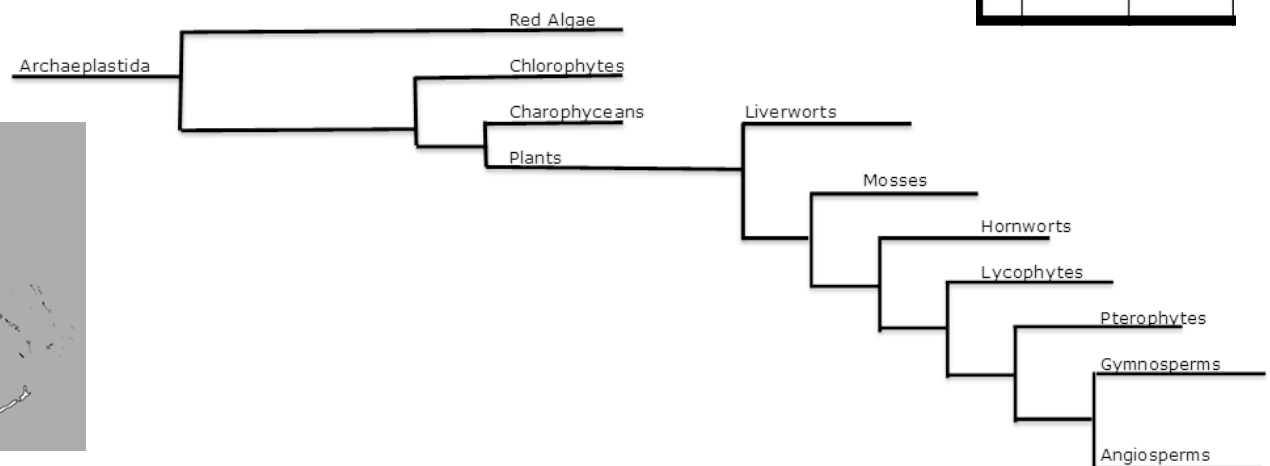


# Plant Classification (Nonvascular)

- General Characteristics and structures** – These organisms are **all multicellular eukaryotes that are autotrophs and acquire their nutrients by photosynthesis. They have plastids which contain chlorophyll A, Chlorophyll B, and carotenoids and the cells have walls consisting of Cellulose.**
- Natural History** – **Plantae** belong to the **Supergroup Archaeplastida** whose members engulfed a cyanobacteria. The first plants appear in the fossil record about **500 million years ago during the Precambrian.**
- Biogeography** – The distribution of plants is worldwide; as a group, are found in all but the harshest conditions. They accomplished this by producing a durable layer of a polymer called **sporopollenin** which prevents drying out. The nonvascular plants **lack conductive tissue** and are limited to a specific range of terrestrial habitats. These plants display two adaptations that first made the move onto land possible. They possess a **waxy cuticle** to reduce water loss and their gametes develop within **gametangia** for protection of the embryo.

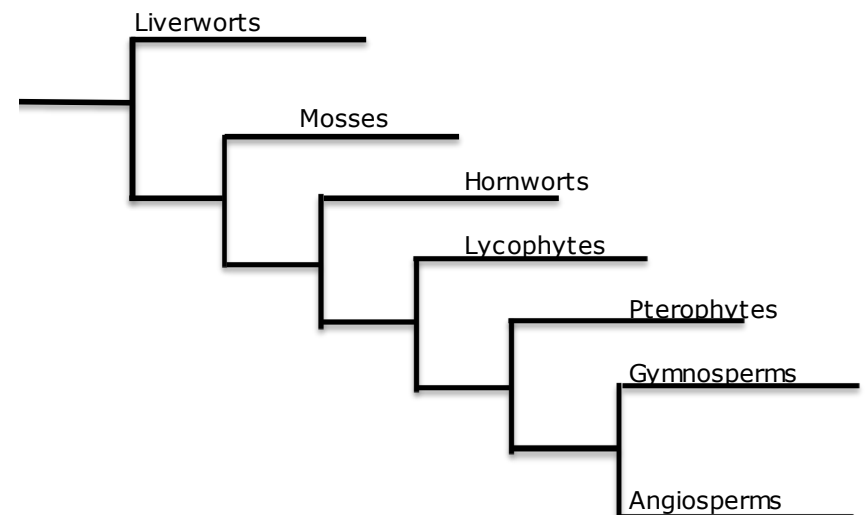
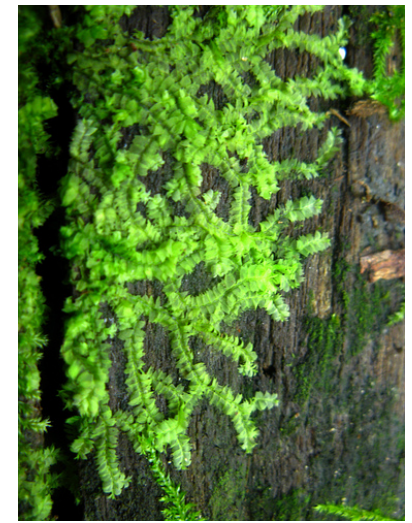
Era	System & Period	Series & Epoch
CENOZOIC	Quaternary	Recent
		Pleistocene
	Tertiary	Pliocene
		Miocene
		Oligocene
		Eocene
Paleocene		
MESOZOIC	Cretaceous	
	Jurassic	
	Triassic	
PALEOZOIC	Permian	
	Carboniferous	Pennsylvanian
		Mississippian
	Devonian	
	Silurian	
	Ordovician	
Cambrian		
	Precambrian	



# Kingdom: Plantae

## Division: Hepaticophyta

- 1. General Characteristics and Structures** – These plants are **Nonvascular and Seedless**.
- 2. Biogeography** – They are found in moist areas.
- 3. Unique Characteristics -**  
Members of this division are small, **gametophytes** that are usually found in two different body types.
  - 1. Thallose:** flattened dorsoventrally
  - 2. Leafy:** resembling mosses



# Liverwort Thallus



The thallus is divided into an upper and lower section. The upper level contains **chlorophyll-bearing cells** and is used for photosynthesis. Along the upper surface, there are **pores** that open up to **air chambers** that surround the **chlorophyll-bearing cells** used for **gas exchange**. The lower surface is divided into larger **storage cells**. Attached to the lower surface are **rhizoids** (**single celled**) and **scales** (**multicellular**) used for attachment and **water absorption**.

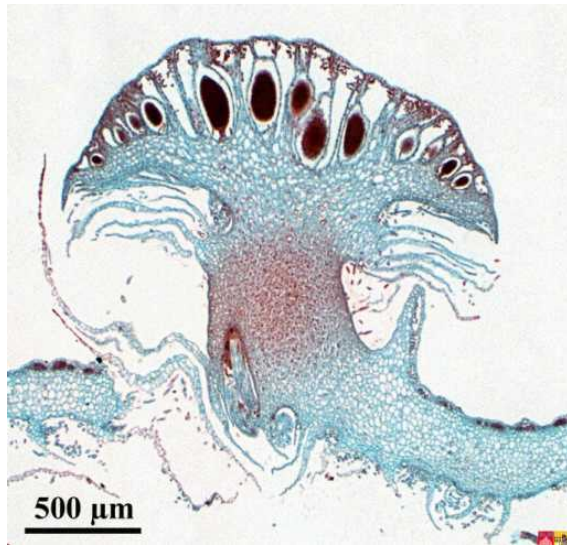
# Antheridial and Archegonial Receptacles



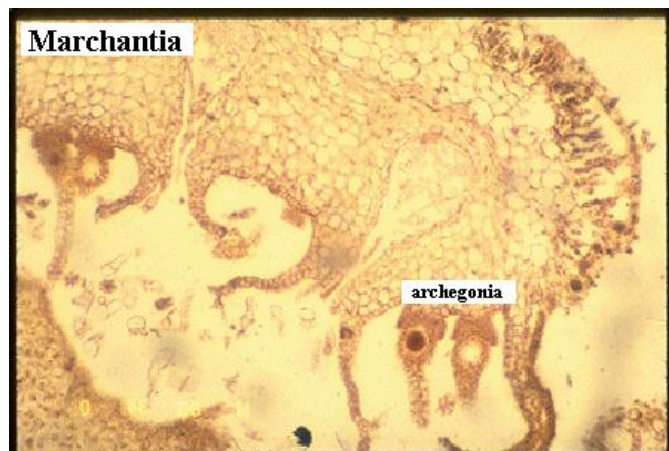
Liverworts produce gametangia on separate gametophytic plants. The male gametangia (**the antheridia**) resemble umbrellas and produce **sperm**. The female (**the archegonia**) resemble the spokes of a bicycle wheel and **produce eggs**.



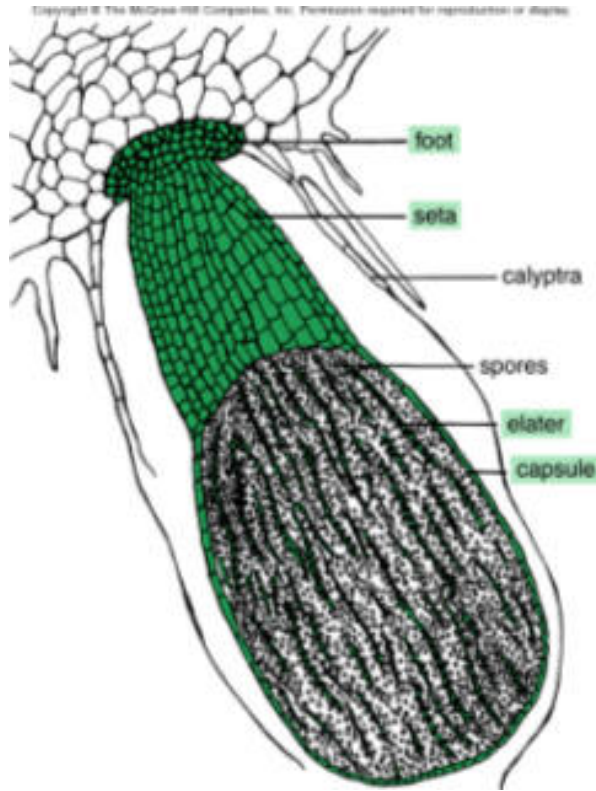
# Antheridial and Archegonial Receptacles



The **antheridium** of a male liverwort contains sperm mother cells that produce sperm. The **archegonium** of a female liverwort contains a swollen area (**venter**) which holds the egg. The archegonium proceeds down into a **neck** with a canal that allows the sperm to get at the egg.



# Liverwort Sporophyte



The **sporophyte** generation is **diploid (2n)** and is dependent on the **gametophyte** generation. It is attached to the female gametophyte by a **foot** and a small stalk called a **seta**. The capsule contains **spores** and **elaters**. The elaters are used for dispersal. They change with a change in humidity and fling the spores away from the parent plant.

# Asexual Reproduction



Asexual reproduction occurs when the thallus produces **gemmae cups** that contain **gemmae**. The **gemmae** are dispersed when **it rains and water splashes the gemmae out of the cup**. This insures that the conditions are right for the **gemmae** to germinate and produce new plants.

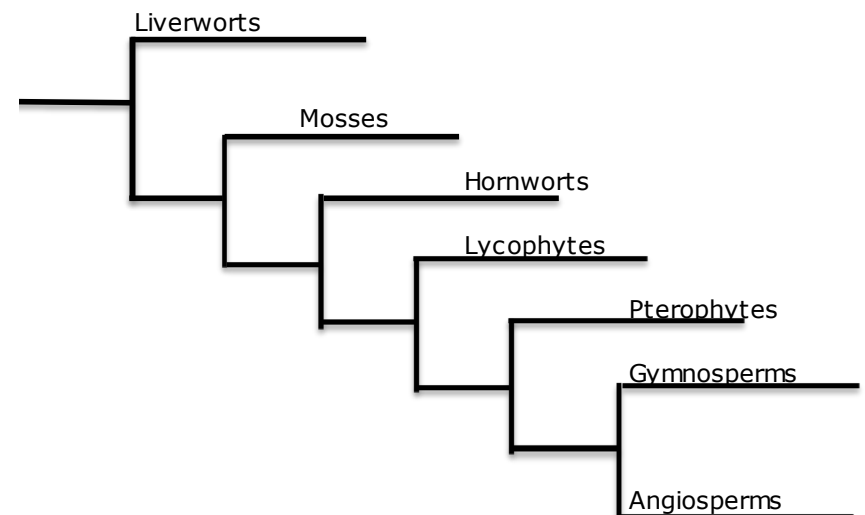
# Kingdom: Plantae

## Division: Bryophyta

- 1. General Characteristics and Structures** – Mosses are **nonvascular and Seedless plants**.
- 2. Biogeography** - Members of this division are small, **gametophytes** that usually grow upright. In moist places, they may form a large mat of vegetation.
- 3. Unique Characteristics** - Individual plants consist of a stem-like stalk with attached **leaf-like structures that lack veins**. Root-like rhizoids anchor the plant and absorb materials.

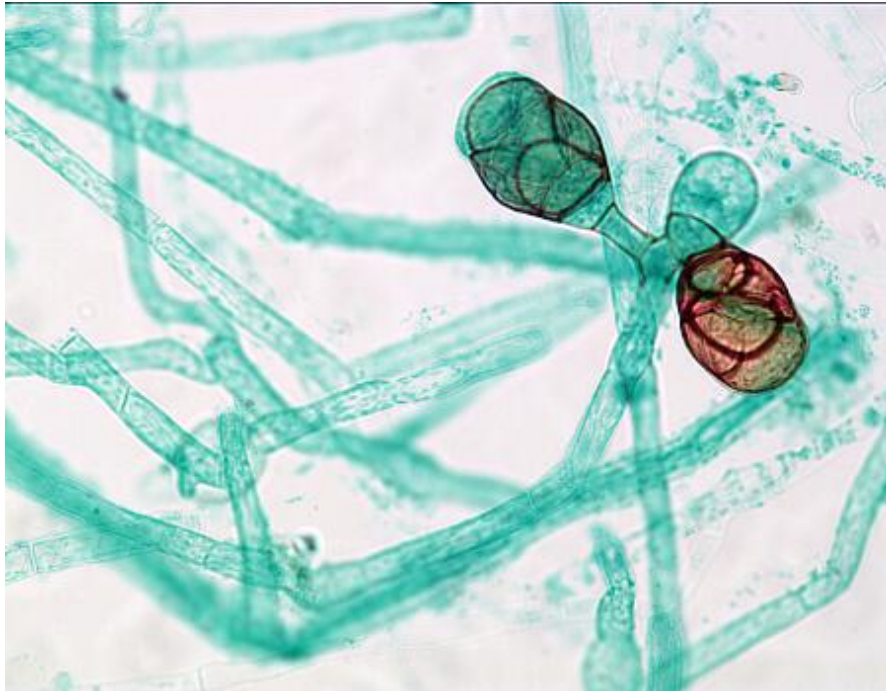


Mosses





# Protonema (Germinating Spores)



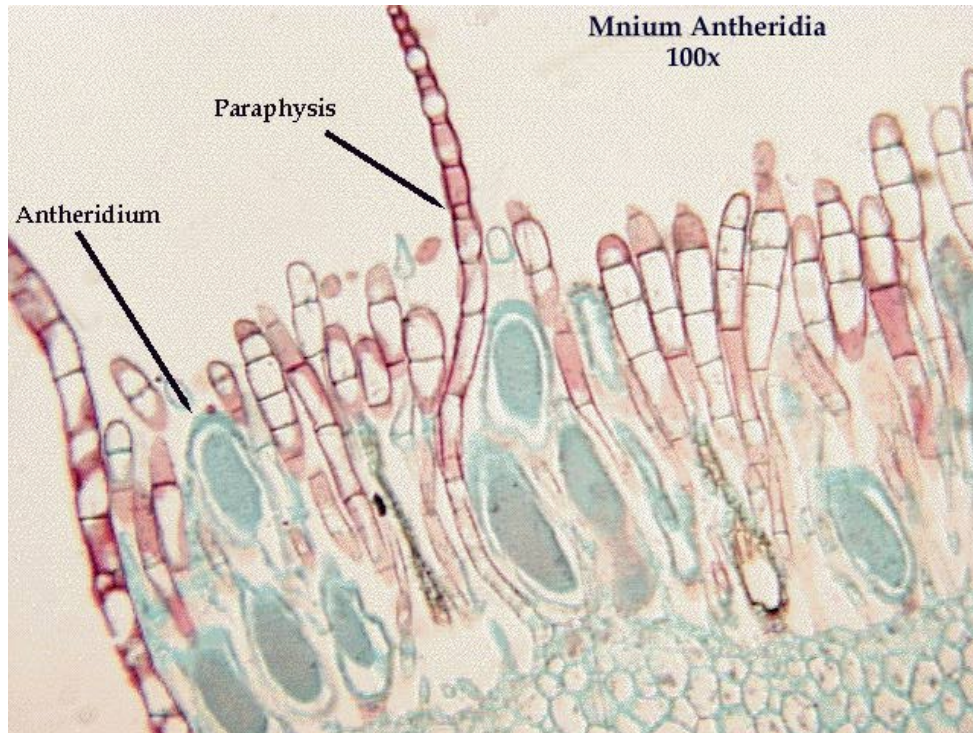
The germinating structure is called a **protonema**. This structure is very similar to some filamentous green algae and is one piece of evidence that mosses might have evolved from some form of green algae. Be able to recognize this slide.

# The Gametophyte Generation of a Moss



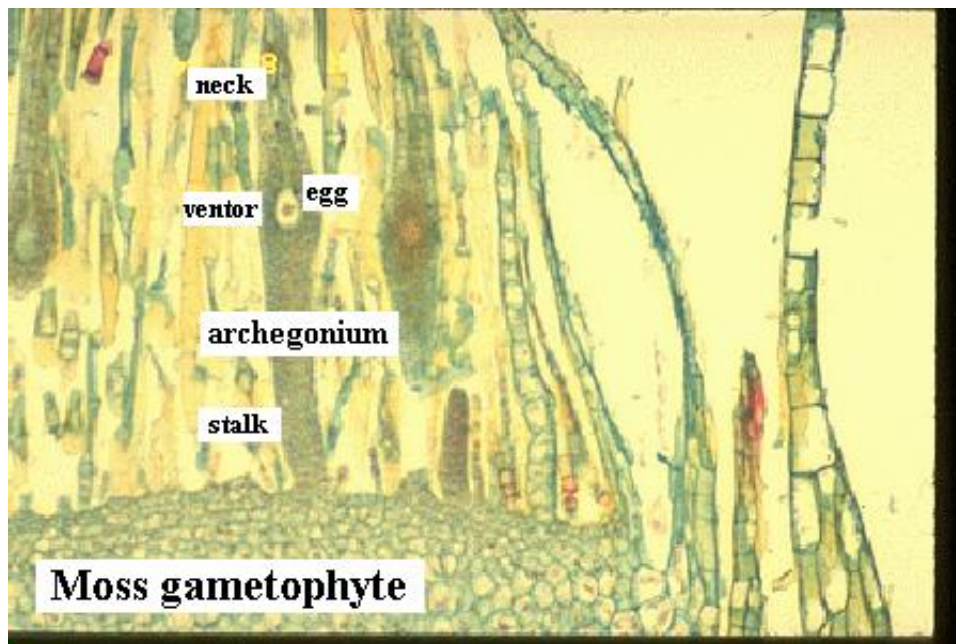
The **protonema** have **buds** that develop into the “leafy” moss. Examine the moss plants provided for you. **Male plants can be identified by the flower-like cluster of “leaves” at the tip of the gametophyte.** In the female plants, the “leaves” closely surround the tip of the gametophyte. **Be able to recognize the difference between male and female plants.**

# The Antheridium



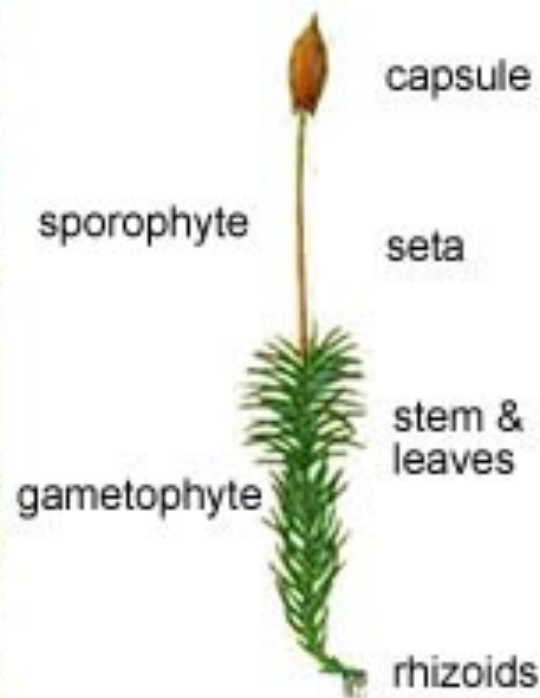
Examine the prepared slide of a longitudinal cross section of a male gametophyte tip. The **antheridia** contain **sperm** that are surrounded by **sterile jacket cells**. The **antheridia** are found in between **paraphyses** which are believed to protect the **antheridia**.

# The Archegonium



Examine the prepared slide of a longitudinal cross section of a female gametophyte tip. The **archegonia** has a swollen area called a **venter** which contains the **egg**. Above the **venter** is the **neck** of the **archegonium**. The **archegonia** are surrounded by **paraphyses**.

# The Sporophyte Generation



The **sporophyte generation** of a moss develops in the archegonium of a female gametophyte. A **capsule** develops on a long stalk called a **seta**. The capsule contains spores held inside by a hard covering called the **operculum**. A soft covering called a **calyptra** is part of the gametophyte generation and is created when the sporophyte grows out of the top of the female gametophyte.

# The Sporophyte Capsule



The **sporophyte generation** has photosynthetic tissue but is attached to the female gametophyte. It develops a **capsule** which is covered by a hard covering called an **operculum**. In the middle of the capsule is a structure called a **columella** that gives the capsule shape. Inside the capsule, **spores** are produced.

# Plant Classification

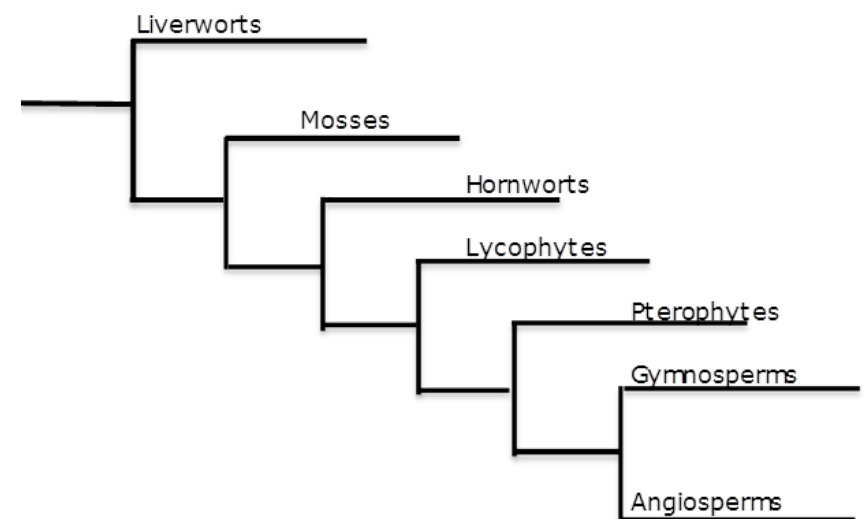
- General Characteristics and structures** – These organisms are **all multicellular eukaryotes that are autotrophs and acquire their nutrients by photosynthesis. They have plastids which contain chlorophyll A, Chlorophyll B, and carotenoids and the cells have walls consisting of Cellulose. Vascular plants first developed vascular tissue called xylem (for moving water) and phloem (for moving food).**
- Natural History** – **Vascular Plants** first appear in the fossil record about **385 million years ago during the Devonian.**
- Biogeography** – The distribution of plants is worldwide; as a group, are found in all but the harshest conditions. They accomplished this by producing a durable layer of a polymer called **sporopollenin** which prevents drying out. The nonvascular plants **lack conductive tissue** and are limited to a specific range of terrestrial habitats. These plants display two adaptations that first made the move onto land possible. They possess a **waxy cuticle** to reduce water loss and their gametes develop within **gametangia** for protection of the embryo.



Era	System & Period	Series & Epoch
<b>CENOZOIC</b>	Quaternary	Recent
		Pleistocene
	Tertiary	Pliocene
		Miocene
		Oligocene
<b>MESOZOIC</b>	Cretaceous	Eocene
		Oligocene
		Paleocene
<b>MESOZOIC</b>	Cretaceous	
		Jurassic
		Triassic
<b>PALEOZOIC</b>	Carboniferous	Pennsylvanian
		Mississippian
	Devonian	
		Silurian
		Ordovician
		Cambrian
<b>PALEOZOIC</b>	Precambrian	

# Division: Lycophyta (Club Mosses)

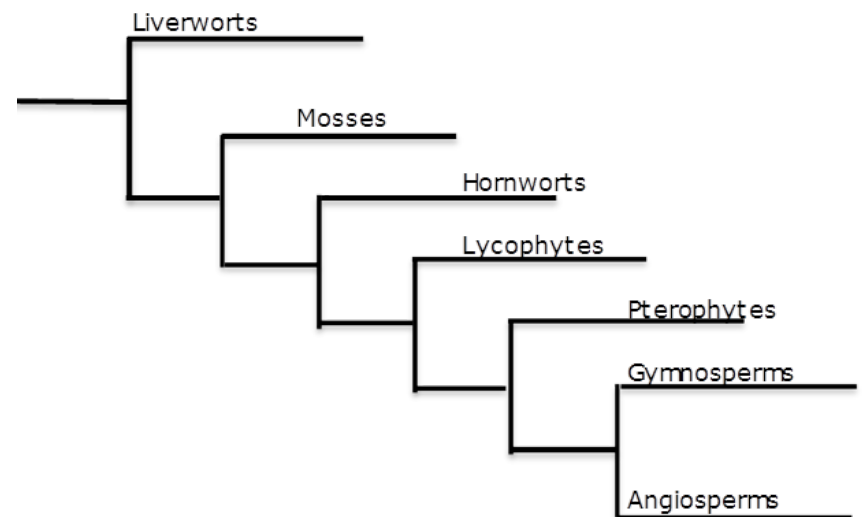
1. **General Characteristics and Structures** - These **sporophytes** have **true stems, roots, and leaves**.
2. **Biogeography** – Many grow on tropical trees or on the floor of temperate forests.
3. **Unique Characteristics** - The stems are covered with small leaves with one vein called **microphylls**. They have modified leaves called **sporophylls** that bear sporangia.





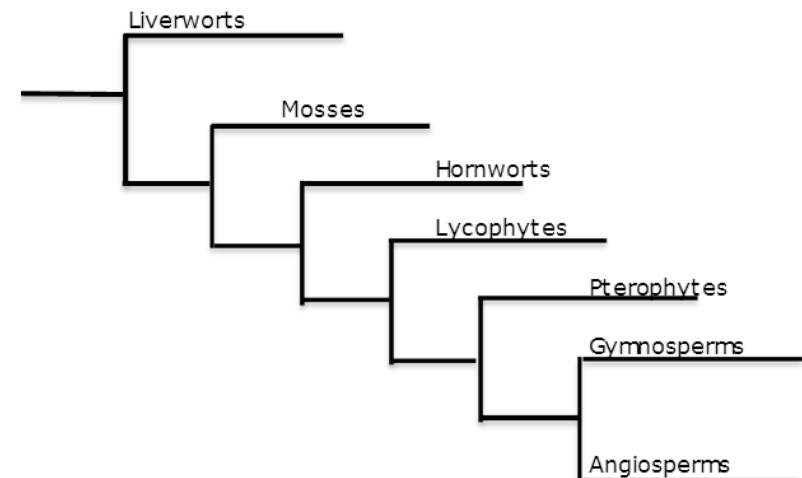
# Division: Pterophyta (Psilophyta) Whisk Ferns

1. **General Characteristics and Structures** - These sporophytes are unique among vascular plants because they do not have true roots or leaves. They only have true stems.
2. **Biogeography** – They are found in the New World, Asia and the Pacific.
3. **Unique Characteristics** - The stems usually demonstrate dichotomous branching.



# Division: Pterophyta (Sphenophyta) Horsetails

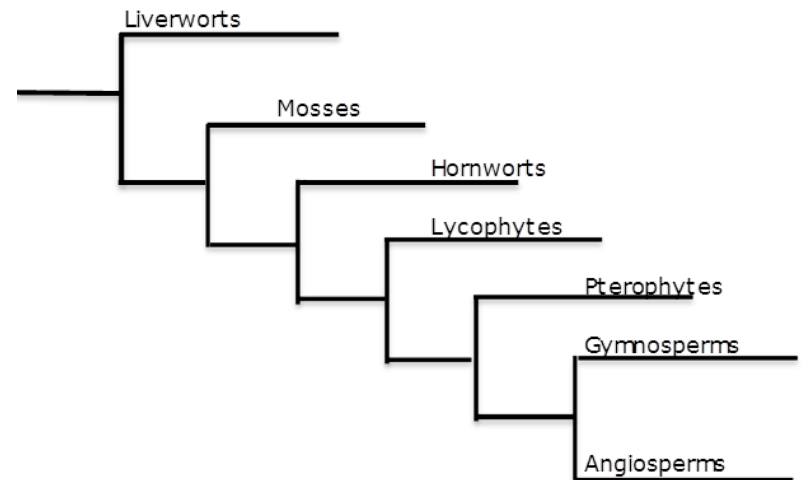
1. **General Characteristics and Structures** – These **sporophytes** are vascular plants that have **true roots, stems and leaves**.
2. **Biogeography** – They are found everywhere except Antarctica.
3. **Unique Characteristics** – **The leaves are microphylls (one vein) and lack chlorophyll at maturity. The stems have silica in their cell walls. Some stems have a specialized cone-like structure called a strobili.**



# Division: Pterophyta

## Ferns

- 1. General Characteristics and Structures** – These **sporophytes** are vascular plants that have **true roots, stems and leaves**.
- 2. Biogeography** – The majority of ferns inhabit warm, damp areas of the Earth. Growing profusely in tropical areas, ferns diminish in number with increasingly higher latitudes and decreasing supplies of moisture. Few are found in dry, cold places.
- 3. Unique Characteristics** - The large leaves are called **megaphylls or fronds**. The fronds first appear tightly coiled and are called **fiddleheads**. This process is called **circinate vernation**. The specialized leaves with spores are called **sporophylls**.



## Characteristics of a Fern Frond

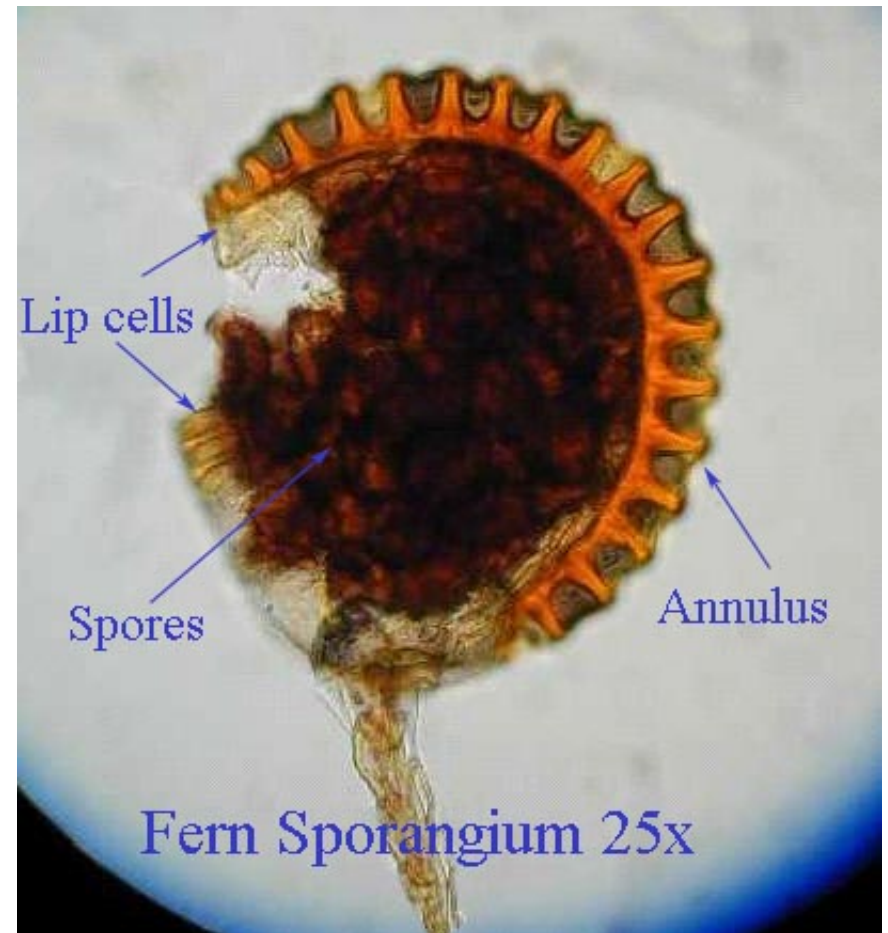
Ferns reproduce by producing spores. The **fronds** have small brown patches called sori. The sori are made up of clusters of **sporangia** which produce the spores. Many species have a protective covering called an **indusium**.

## Fern Frond



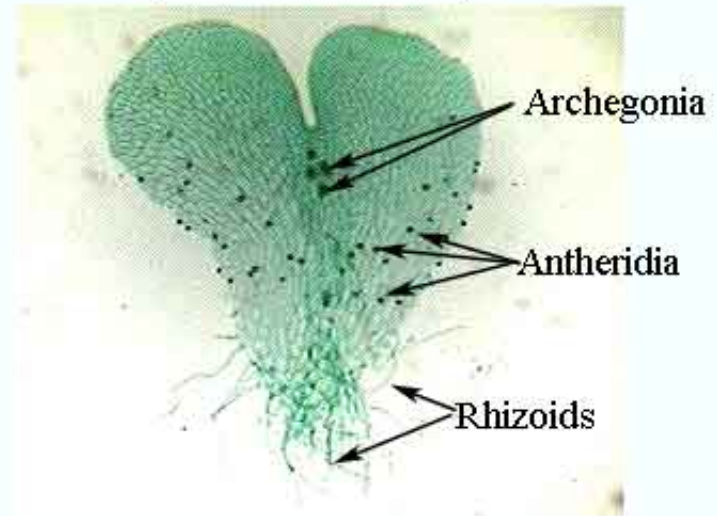
# Fern Sporangium

The sporangia have a conspicuous row of heavy-walled cells called an **annulus**. When the moisture in the cell changes, the **annulus catapults spores out into the environment** through the lip cells. The spores will develop into a **prothallus**. The spores develop into a gametophyte with both sexes. This is called **monoecious**.



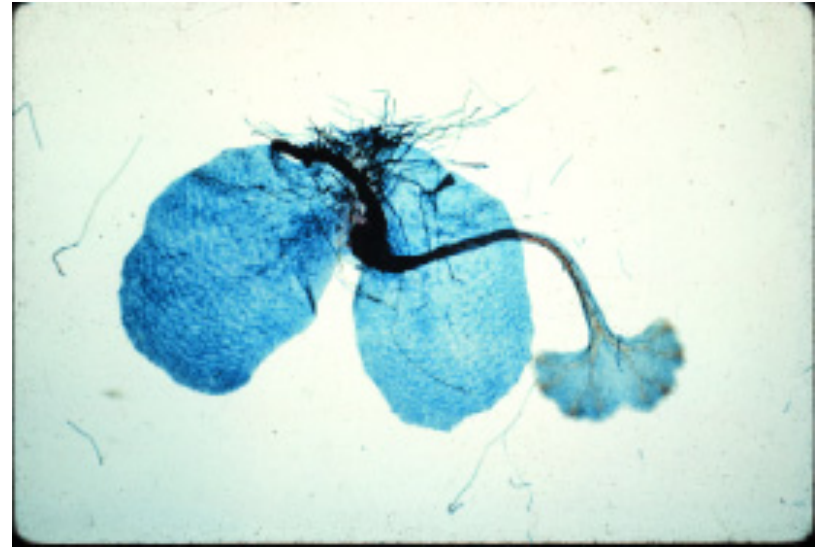
# Fern Prothallus

## Fern Gametophyte (Prothallus)



The heart-shaped gametophyte generation of a fern is called a **prothallus**. **Archegonia** (which produce eggs) are usually found near the **apical notch** and **antheridium** (which produce sperm) are usually produced near the rhizoids (for absorption and anchorage). Eventually the **sporophyte** will grow out of the archegonia.

# Fern Prothallus with a Sporophyte



On the prothallus, only one zygote will develop into a **sporophyte**. The simple structure consists of a **small leaf, a root and a foot** (the structure that attaches the sporophyte to the prothallus). The prothallus **will eventually die off** and the sporophyte generation will develop into a recognizable plant.

# Plant Classification (Seed Plants)

1. **General Characteristics and structures** – These organisms are **all multicellular eukaryotes that are autotrophs and acquire their nutrients by photosynthesis. They have plastids which contain chlorophyll A, Chlorophyll B, and carotenoids and the cells have walls consisting of Cellulose. Vascular plants first developed vascular tissue called xylem (for moving water) and phloem (for moving food).**
2. **Natural History** – **Vascular Seed Plants** first appear in the fossil record about **360 million years ago during the Devonian.**
3. **Biogeography** – The distribution of plants is worldwide; as a group, are found in all but the harshest conditions. They accomplished this by producing a durable layer of a polymer called **sporopollenin** which prevents drying out. The vascular seed plants developed **seeds which allowed plants to move away from the mother plant with both nourishment and protection.**

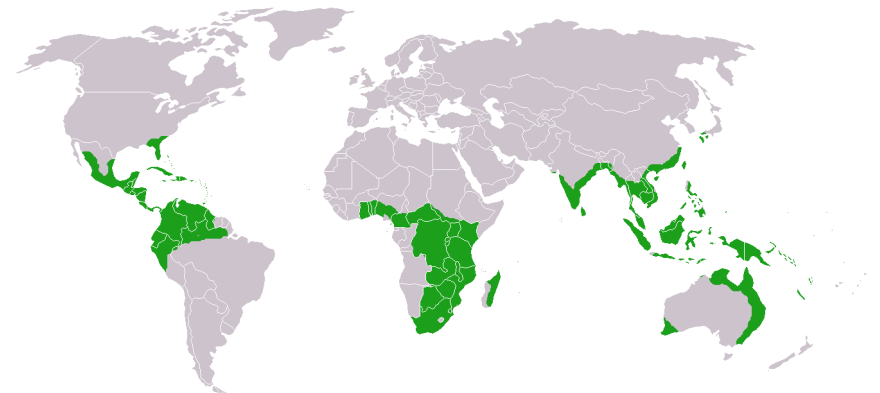
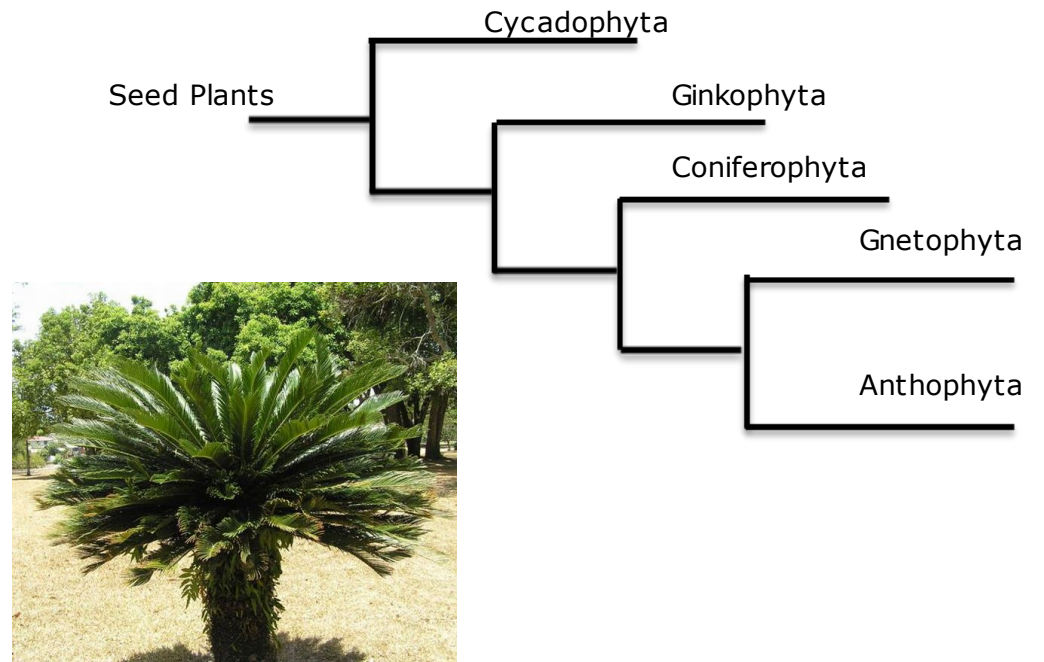


Era	System & Period	Series & Epoch
<b>CENOZOIC</b>	Quaternary	Recent
		Pleistocene
	Tertiary	Pliocene
		Miocene
		Oligocene
		Paleocene
<b>MESOZOIC</b>	Cretaceous	
	Jurassic	
	Triassic	
<b>PALEOZOIC</b>	Permian	
	Carboniferous	Pennsylvanian
		Mississippian
	Devonian	
	Silurian	
	Ordovician	
Cambrian		
	Precambrian	



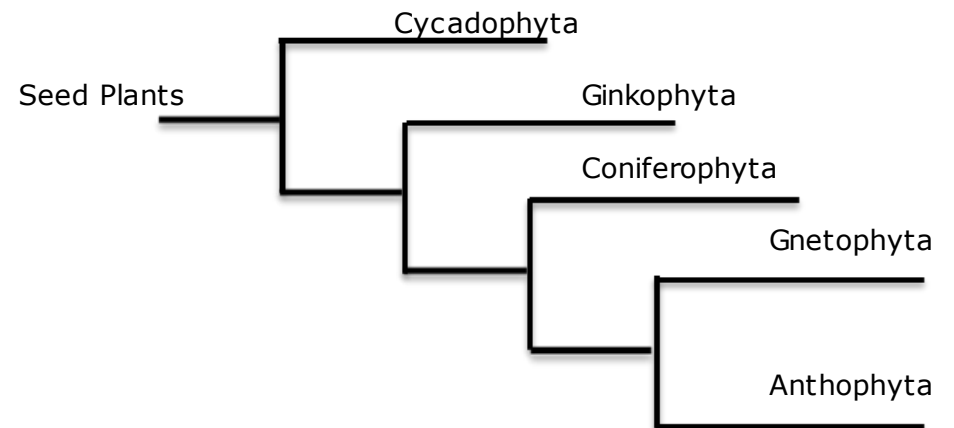
# Division: Cycadophyta

- 1. General Characteristics –** Cycads are vascular, seed plants that are palm-like and are called Sago Palms. The leaves are found in a cluster at the tops of the trunks.
- 2. Biogeography –** Cycads are found across much of the subtropical and tropical parts of the world. They are found in South and Central America, Mexico, southeastern United States, Australia, Japan, China, Southeast Asia, India, Sri Lanka, Madagascar, and southern and tropical Africa.
- 3. Unique Characteristics -** Cycads were first to show true secondary growth along plant's evolutionary history.



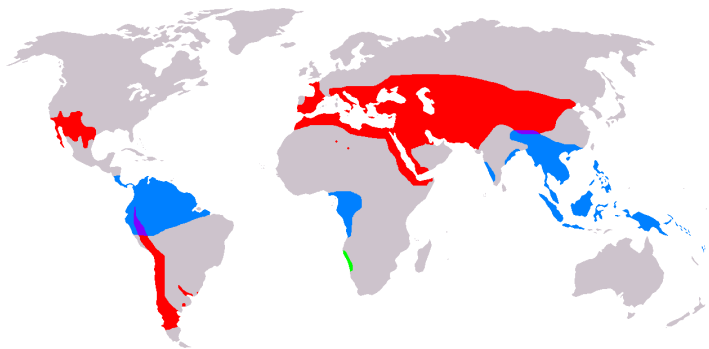
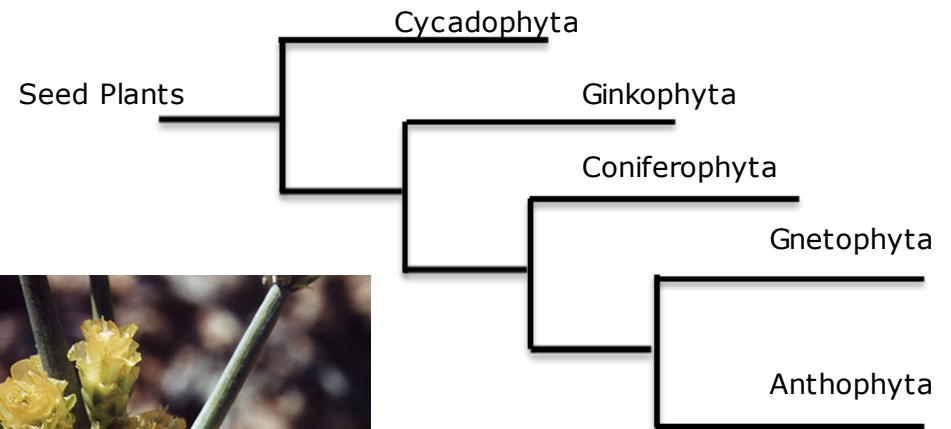
# Division: Ginkgophyta

- 1. General Characteristics –**  
The Ginkgo or Maidenhair Tree have characteristic **fan-like leaves**.
- 2. Biogeography –** There is only one species (**from China**) that has survived. These species developed in the Mesozoic era.
- 3. Unique Characteristics -**  
Only males are usually planted in yards **because the female plants have messy and foul smelling fruit**.



# Division: Gnetophyta

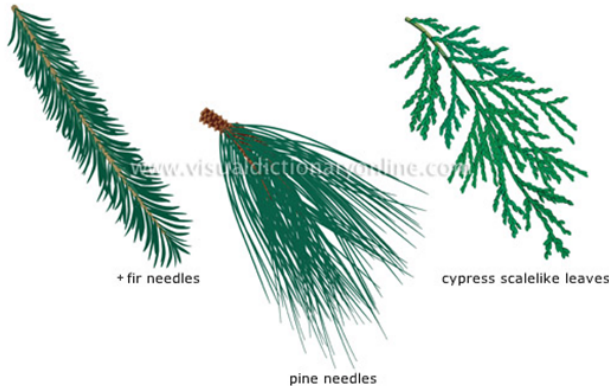
- 1. General Characteristics** – The Gnetophytes are unique gymnosperms because they have vessel elements which is why some believe they are closely related to flowering plants.
- 2. Biogeography** – There are about ninety species of gnetophytes. They are diverse in form and size, and their distribution varies widely, from moist, tropical environments to extremely dry deserts.
- 3. Unique Characteristics** - Our example is *Ephedra* or Mormon Tea. It produces a drug called ephedrine which raises the heart rate and raises blood pressure.



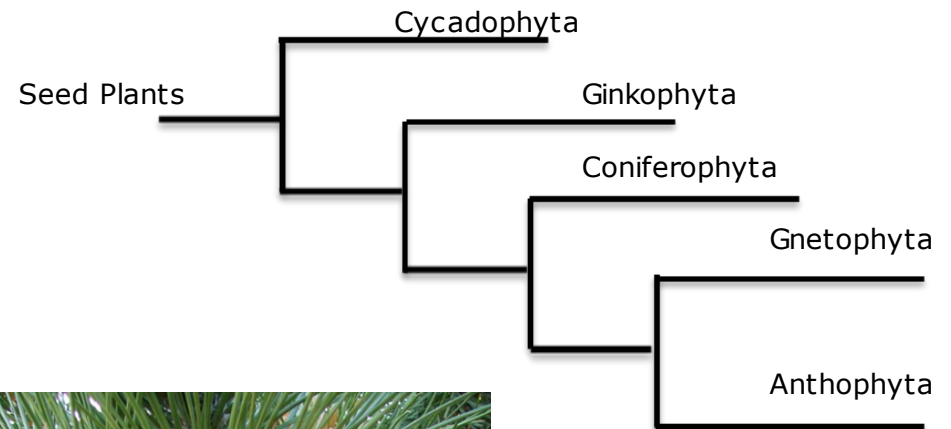
Distribution, separated by genus:  
Green – Welwitschia  
Blue – Gnetum  
Red – Ephedra  
Purple – Gnetum and Ephedra range overlap



- 1. General Characteristics** – The Conifers, which include pines, spruces, hemlocks, and firs, are woody trees or shrubs. Most conifers have leaves (megaphylls) that are modified into **needles or scales**.
- 2. Biogeography** – The conifers are found worldwide.
- 3. Unique Characteristics** - The Pine Tree contains both male and female cones. The pollen (staminate) cones are found **low in the tree and produce pollen**. The ovulate cones are **high in the tree and produce seeds**.



# Division: Coniferophyta



# Male Cones

The male (staminate) cone consists of protective scales called (microsporophylls) that contain microsporangia which go through meiosis to produce four haploid microspores. These microspores will develop into pollen.



# Pollen Grains

The microspores develop into **pollen grains**. Each pollen grain consists of four cells and a pair of **wings** which are **used for dispersal**.



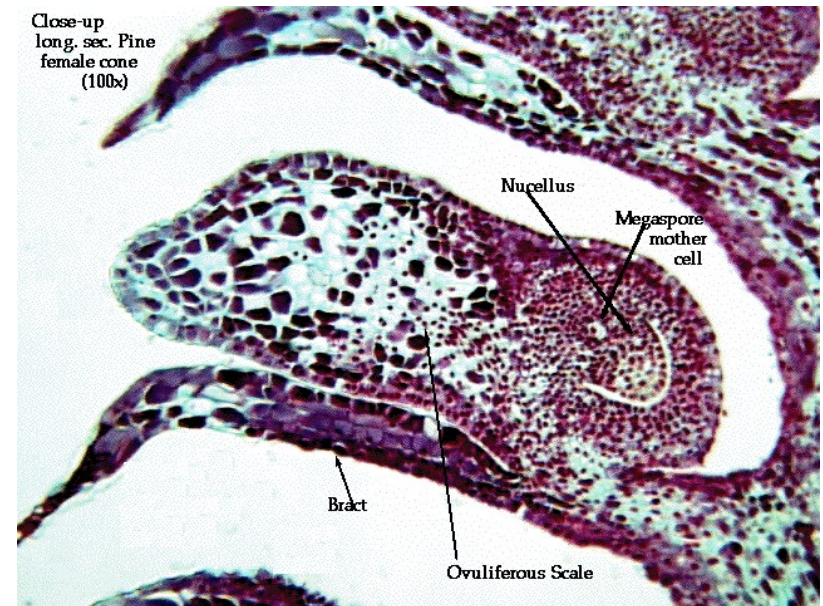
# Pollen Grains with Pollen Tube

Microsporangia produce pollen grains with 4 cells: 2 prothallial cells, 1 generative cell (which becomes a sterile cell and a spermatogenous cell) and one tube cell. The **spermatogenous cell** produces 2 sperm. Be able to recognize the **pollen grain, wings, pollen tube, and sperm.**



# Female Cones

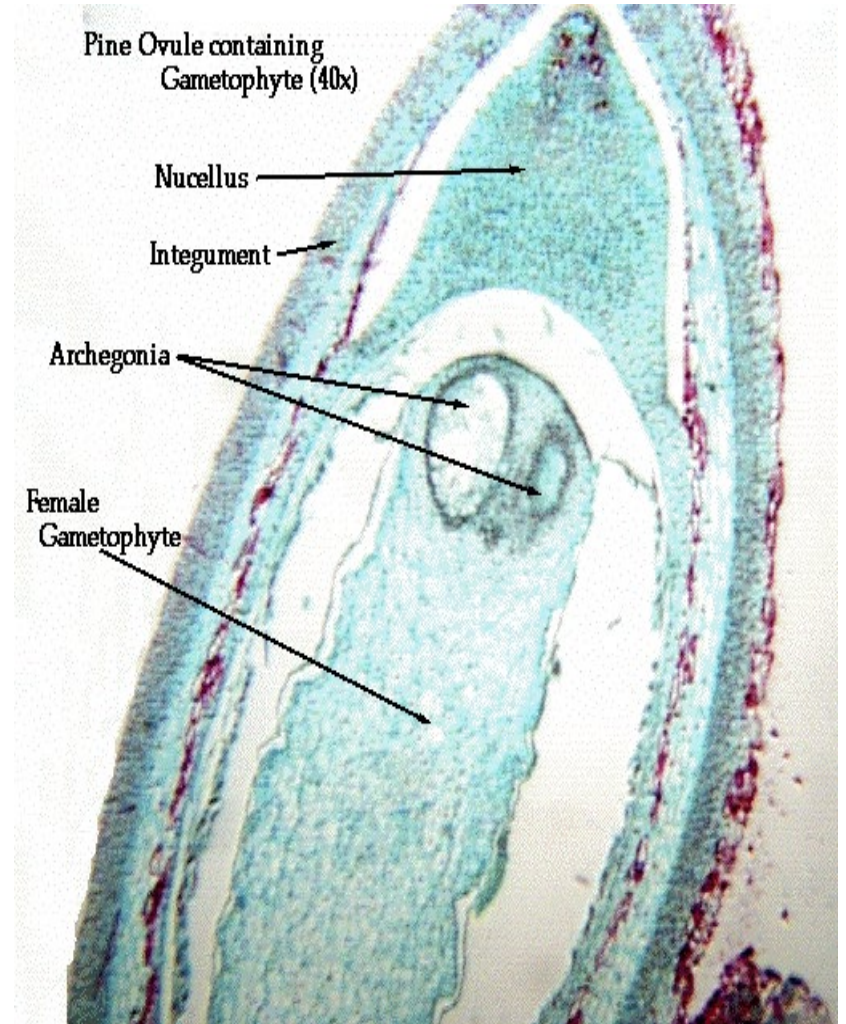
The female (ovulate) cone consists of protective scales called (megasporophylls) that contain megasporangia (ovules). The megaspore mother cells produce 4 megaspores through the process of meiosis. The megaspores are surrounded by a nutritional nucellus and a protective seed coat called an integument. The megaspores develop into a female gametophyte.





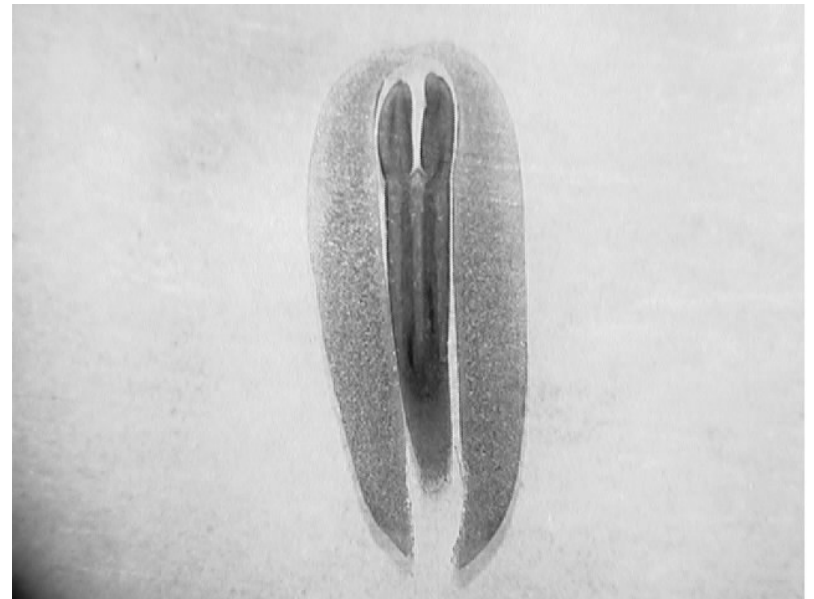
# Female Gametophyte

At the end of the female gametophyte ( $n$ ), an **archegonium** ( $n$ ) which contains two **eggs** ( $n$ ) that develop. They are surrounded by two layers of tissue, the **nucellus** ( $2n$ ) and the **integument** ( $2n$ ). The integument has a channel that allow sperm in (**a micropyle**) and the two layers are separated by a **pollen chamber**.



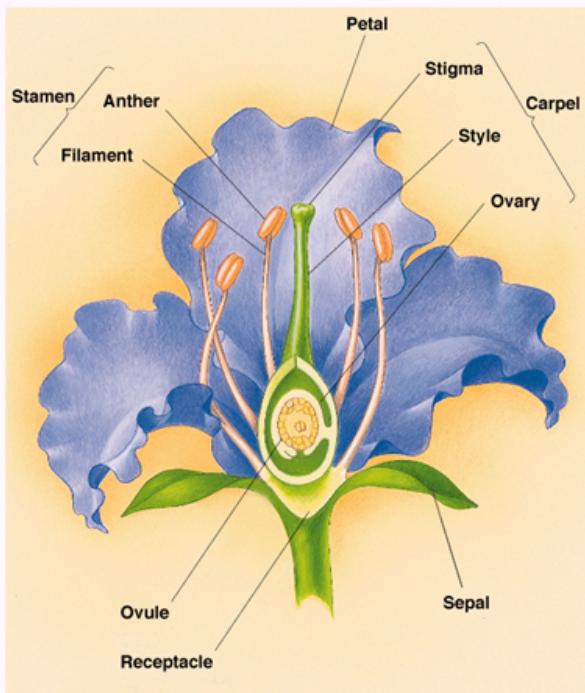
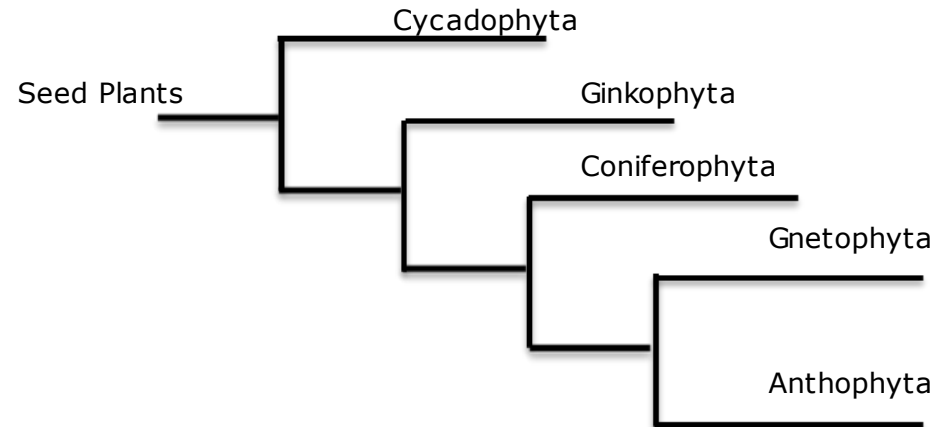
# Female Cone with Mature Embryo

The pine embryo consist of an integument, an endosperm (food source), cotyledons (food source), the hypocotyl (that develops into the shoot system), and the radicle (which develops into the root system). While developing, one of the layers of the integument will become a seed coat for the seed.

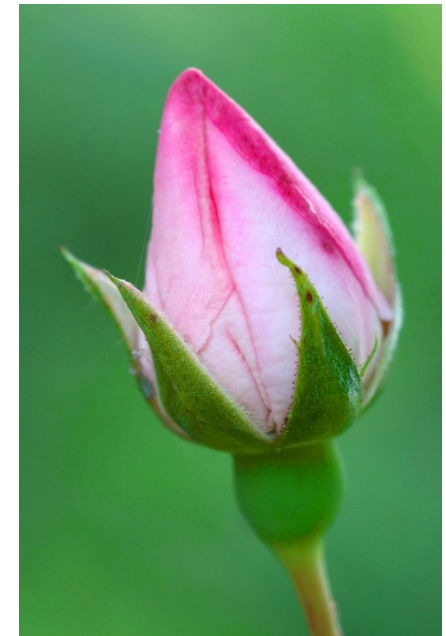


- 1. General Characteristics** – The flowering plants (angiosperms) belong to a single phylum with their key adaptations of flowers and fruits.
- 2. Biogeography** – The flowering plants are found worldwide and showed up 65 million years ago.
- 3. Unique Characteristics** - Be able to recognize the parts of a flower and know their functions

# Division: Anthophyta

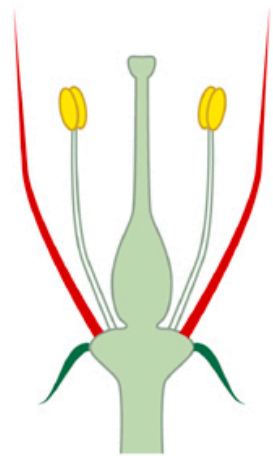


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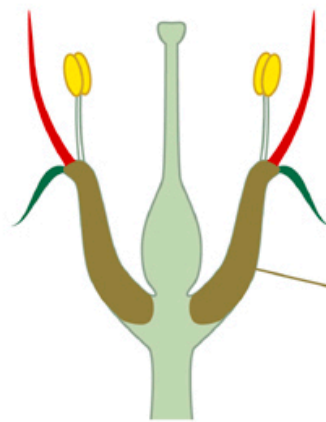


# Ovary Position

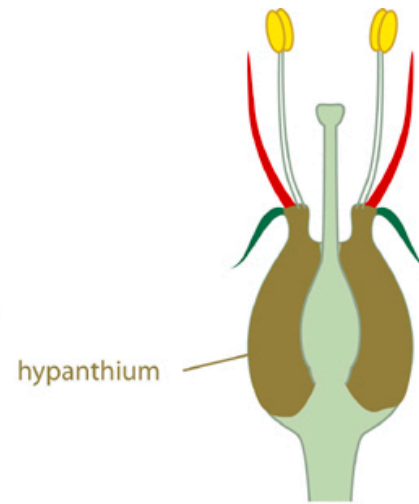
When the ovary is embedded below the calyx and corolla, it is called **epigynous**. When the ovary is produced on top of they parts, it is called **hypogynous**. When the ovary is centrally positioned it is called **perigynous**. Be able to recognize these positions on the drawing.



Ovary superior  
Flower hypogynous  
No hypanthium



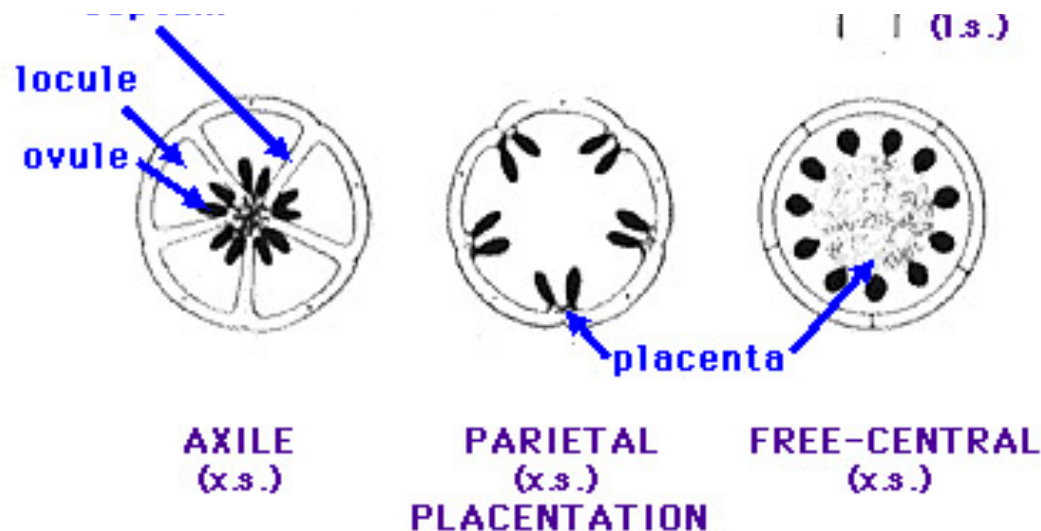
Ovary superior  
Flower perigynous  
Hypanthium present



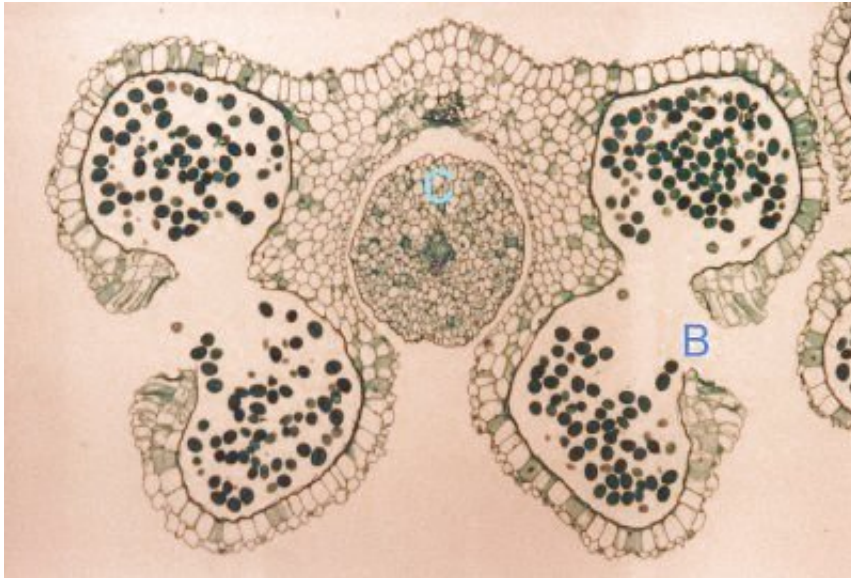
Ovary inferior  
Flower epigynous  
Hypanthium present

# Placentation

The position of the ovary where the ovules (seeds) attach is called placentation. There are three types of arrangements: **parietal (top)**, **axial (middle)**, and **free central (bottom)**. **pligynous**. Be able to recognize these positions on the drawing.



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Illinois Natural History Survey



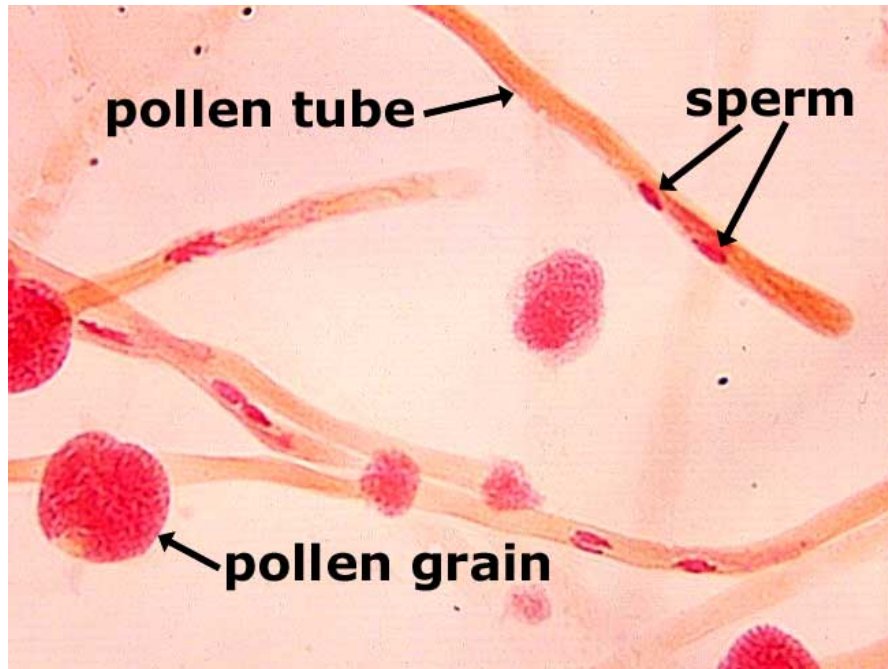
# Male Gametophyte

The male gametophyte in flowering plants is a **pollen grain**. They are produced in **anthers**. The anthers have four chambers that produce **quartets of pollen**. The quartets break into individual pollen grains.

# Fertilization

The majority of plants do not self-fertilize themselves. They depend on **cross fertilization: the transfer of pollen from one individual plant to another.** The most common mechanism to keep plants from fertilizing themselves is called **self-incompatibility.** This works similar to an animal's immune system where a biochemical block prevents the pollen from completing its development.

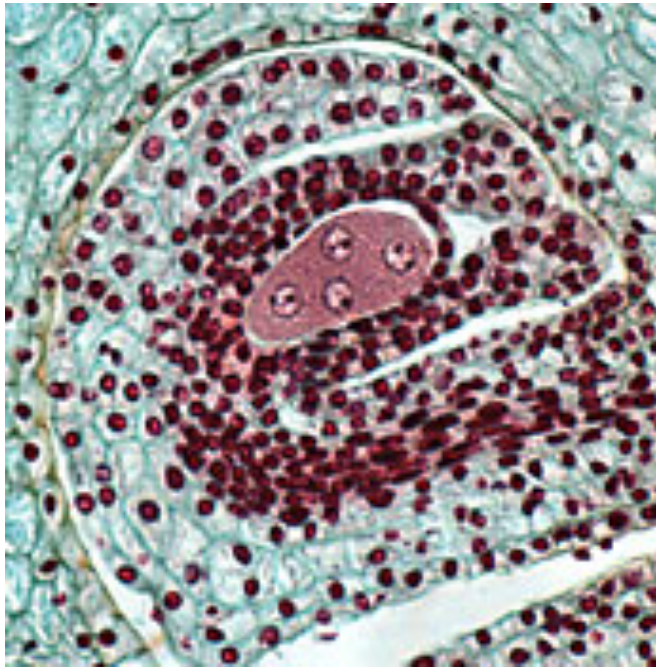
# Germinating Pollen



Under suitable conditions, the tube cell grows into a pollen tube (with a **tube nucleus**) inside the style of another flower. As the tube grows, the generative nucleus lags behind and eventually produces **two sperm**.



# Female Gametophyte



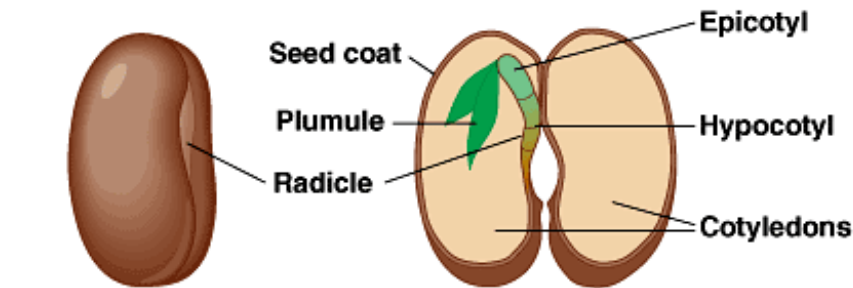
In the female gametophyte, the ovule (surrounded by the ovary wall) develops an embryo sac which goes through the process of meiosis to create a megaspore. The megaspore then goes through mitosis twice to produce the four-nucleate stage.

# Female Gametophyte

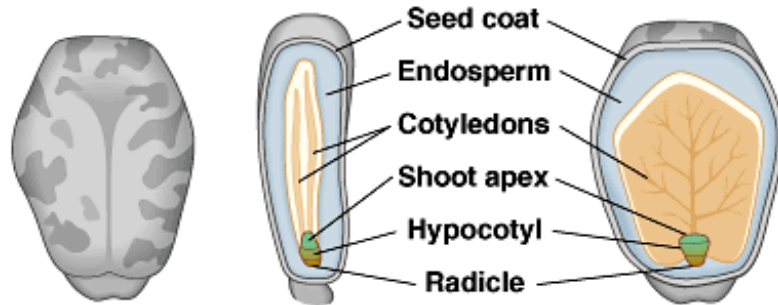


The **8-nucleate stage** ovary. The embryo is located within the **embryo sac** which contains **3 antipodals** (which disappear after fertilization), **2 polar nuclei** (which join with a sperm that produces the **endosperm** ( $3n$ ), **2 synergids** (which disappear), and an **egg** (which is fertilized). Because a sperm joins an egg and another fuses with the polar nuclei in flowering plants, it is called **double fertilization**.

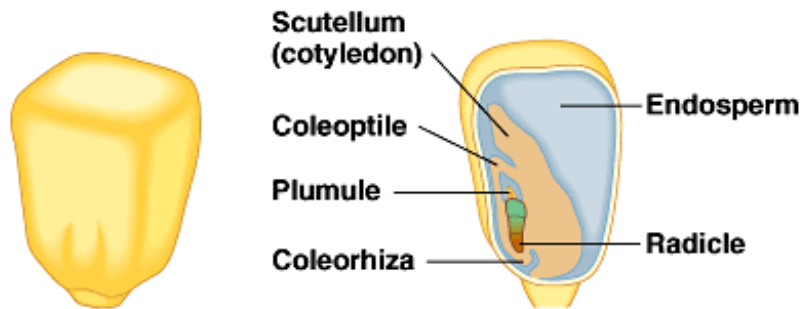
# Seeds



(a) Common bean



(b) Castor bean



(c) Corn

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Be able to recognize the parts labeled in the diagram to the right.

# Fruit and Seed Dispersal

## Dispersal by Wind:

Many fruits have a wing to allow for dispersal and may be carried up to six miles away. Fruits that are too large may even be rolled along the ground due to the wind. Seeds themselves may be winged or small enough to be moved by a slight breeze.





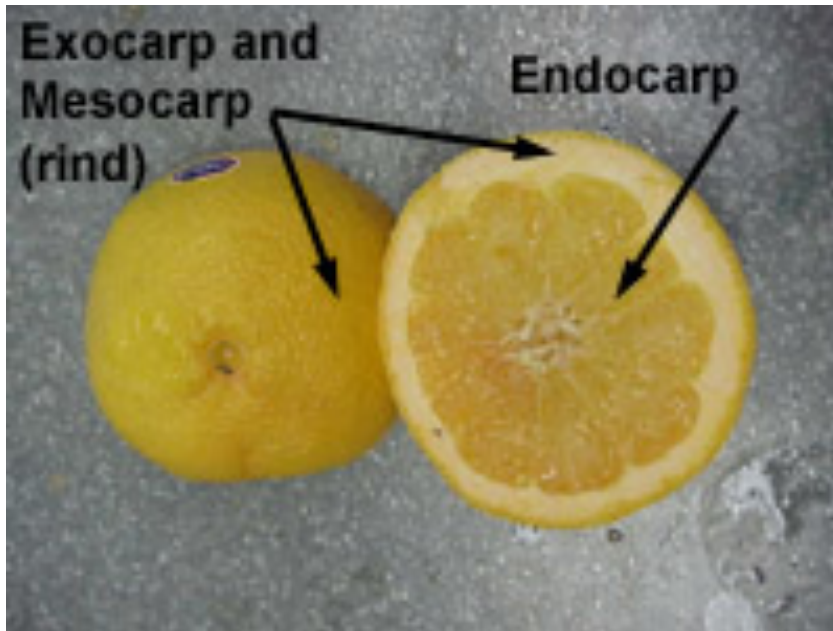
# Fruit and Seed Dispersal

## Dispersal by Animal:













Birds, mammals and ants all act as dispersal agents. These seed or fruits can be carried and dropped, collected and stored, eaten and passed through a digestive tract, or stuck in a mammal's fur or a bird's feathers. **Humans** are the most efficient transporters of fruits and seeds.

# Fruit Wall

The fruit wall is a mature ovary. The skin forms the **exocarp** while the inner boundary around the seed(s) forms the **endocarp**. The area between these two areas is called the **mesocarp**. The three regions collectively are called the **pericarp**. In dry fruits, the pericarp is often very thin.

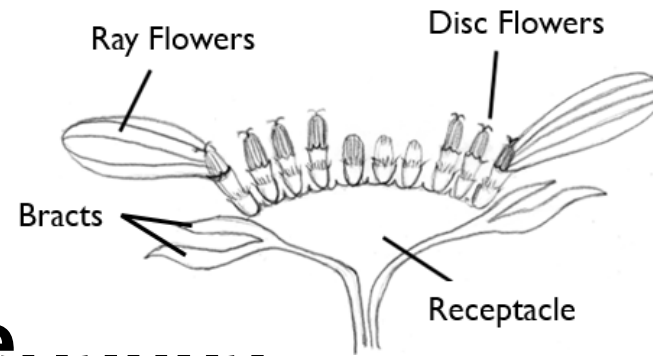


# Angiosperm Classification: Monocots and Eudicots

	Embryos	Leaf venation	Stems	Roots	Pollen	Flowers
<b>Monocot Characteristics</b>	 One cotyledon	 Veins usually parallel	 Vascular tissue scattered	 Root system usually fibrous (no main root)	 Pollen grain with one opening	 Floral organs usually in multiples of three
<b>Eudicot Characteristics</b>	 Two cotyledons	 Veins usually netlike	 Vascular tissue usually arranged in ring	 Taproot (main root) usually present	 Pollen grain with three openings	 Floral organs usually in multiples of four or five

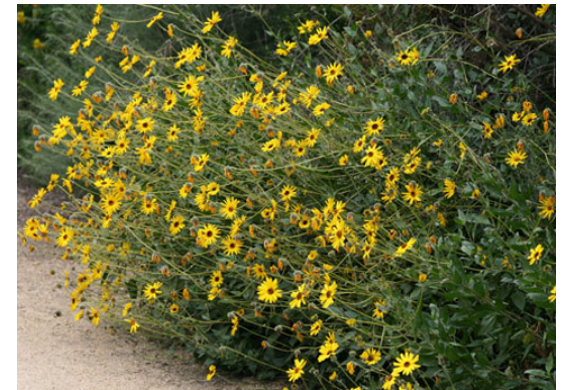
# Family Asteraceae

- Sunflower family
- ~ 23,000
- Eudicots



## Distinguishing character.....

- Composite flowers  
– Ray and disk flower



- **Includes:**
- Lettuce, sunflower,
- *Encilia*, California sage brush



# Family Poaceae

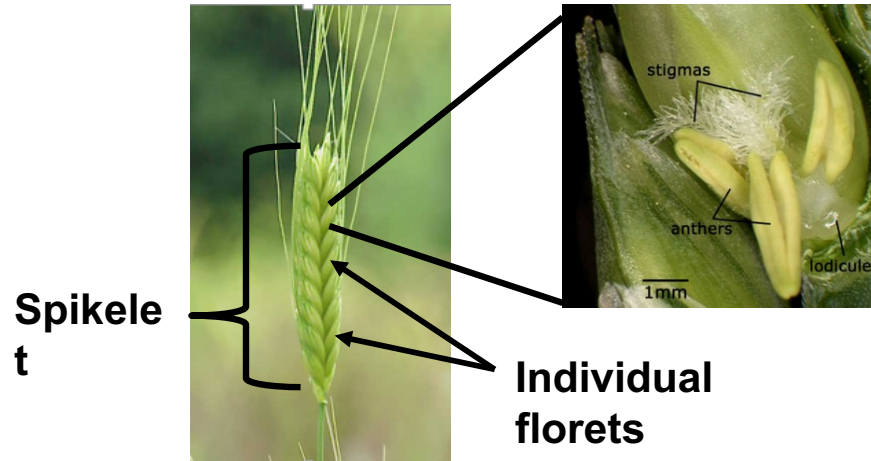
- Grasses
- ~10,000 species
- Monocots

## Distinguishing characteristics:

- Spikelet flower arrangement
  - Florets
- Alternate leaves
  - Silica
- Most wind pollinated

## Includes:

- Corn, wheat, barley, rice
- Pampas grass



# Family Roseaceae

- Rose family
- ~2,800 species
- Eudicots

## Distinguishing characteristics:

- 5 sepals and 5 free petals
- **Hypanthium**: floral cup

## Includes:

- Apples, pears, almonds, peaches, plums, cherries
- Catalina cherry

Hypanthium



# Family Fabaceae

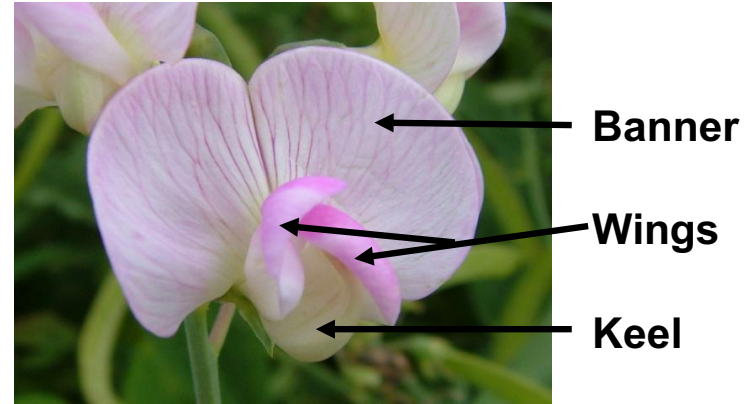
- Pea or legume family
- ~13,000 species
- Eudicot

## Distinguishing characteristics:

- Irregular flower with 5 petals
  - Banner, wings, keel
- **Legume**: pea-pod fruit
- Leaves usually alternate, compound

## Includes:

- Soybean, sweet pea, beans, alfalfa
- Mesquite, Palo Verde



# Family Lamiaceae

- Mint family
- ~3,000 species
- Eudicots

## Distinguishing characteristics

- Square stalk, and simple, opposite leaves
- Aromatic volatile oils
  - Menthol



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## Includes

- Basil, rosemary, lavender, thyme, mint, peppermint, spearmint
- White sage, black sage, horehound



# Family Anacardaceae

- Cashew family
- ~ 800 species
- Eudicot

## Distinguishing characteristics:

- Resin canals in bark
- Alternate leaves

## Includes:

- Cashew, pistachio, mango
- Poison oak, laurel sumac, lemonade berry



# Family Cactaceae

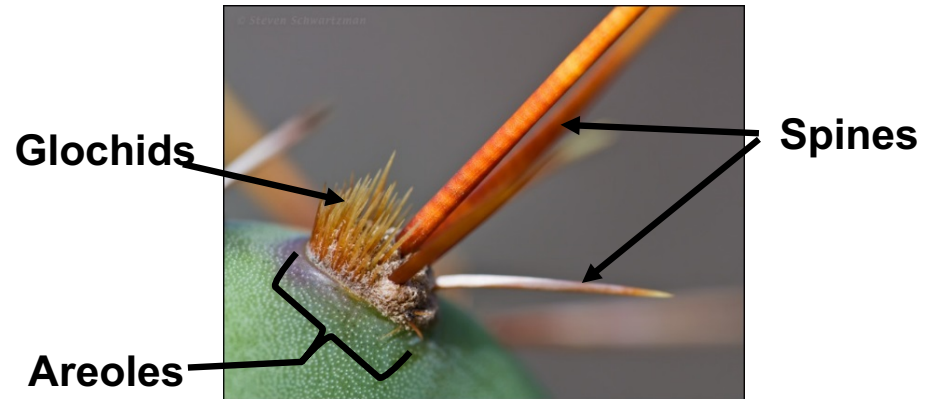
- Cactus family
- ~1,500 species
- Eudicot
- Native to Americas

## Distinguishing characteristics:

- Succulent stems
- **Spines:** modified leaves
  - **Areoles:** reduced branch that produces spines and **glochids** (hair-like spines)

## Includes:

- Prickly pear, beaver tail



# Family Brassiceae

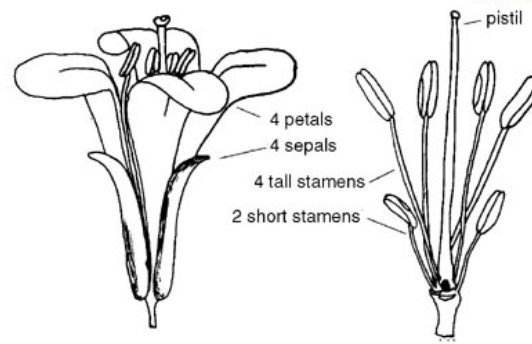
- Mustard family
- ~3,200 species
- Eudicots

## Distinguishing characteristics:

- 4 petals and 6 stamens (4 tall and 2 short)
- **Silique**: seed pod that opens on both sides
- Simple, alternate leaves

## Includes:

- Cabbage, cauliflower, kale, broccoli, Brussel sprouts
- Black mustard



One week after 2008 complex fire



Five months after 2008 complex fire

