Introduction to Plants

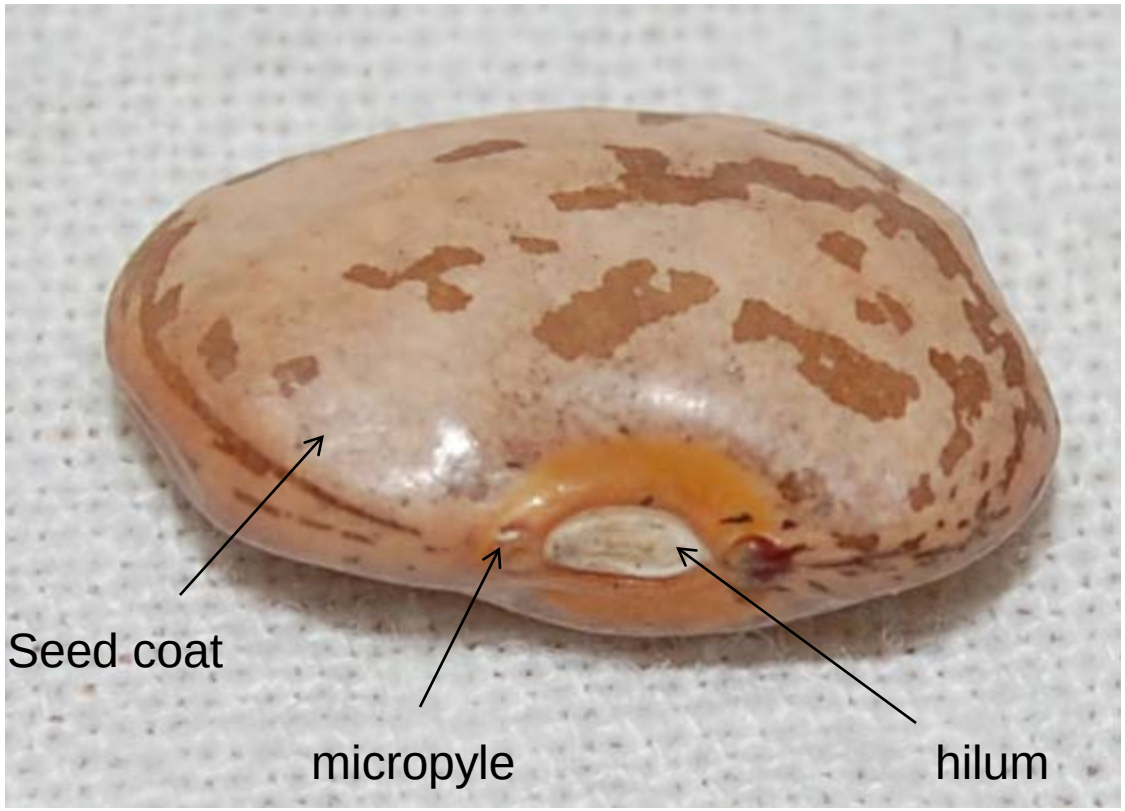
Chapter 21

(some 22, 23)

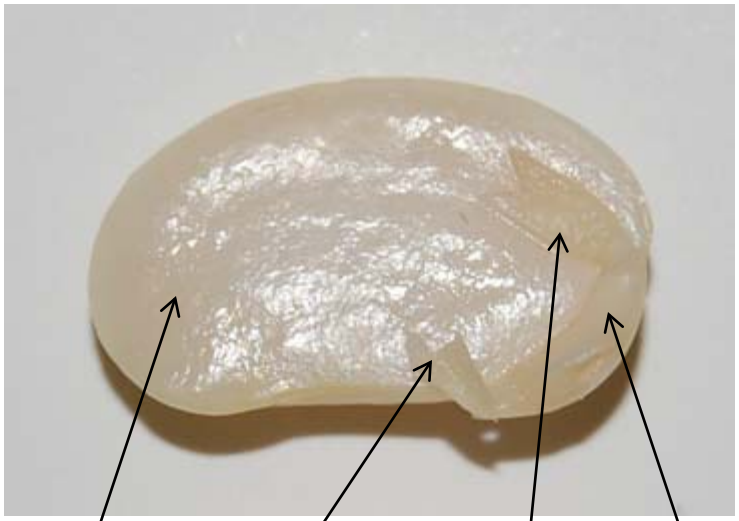
Plant Lab Terms

- **embryo** - developing plant still inside the seed. The embryo has cotyledons (embryonic leaves), a root cap, a food source and a plumule (shoot).
  hilum - the scar on a seed coat at the location where it was attached to the plant's stalk during development
  micropyle - the small pore in a seed that allows water absorption
  root (hypocotyl) - the part of the stem of a sprouting plant that is above the root and below the stalk of the cotyledon (seed leaves)
  seed coat (testa) - seed coat is the outer, protective layer covering the seed
  seed leaf (cotyledon) - the embryonic leaf within a seed
  pumule - the shoot of an embryo, its like a leaf in its early development
- **Radicle**- embryonic root – emerges first- develops into main root.

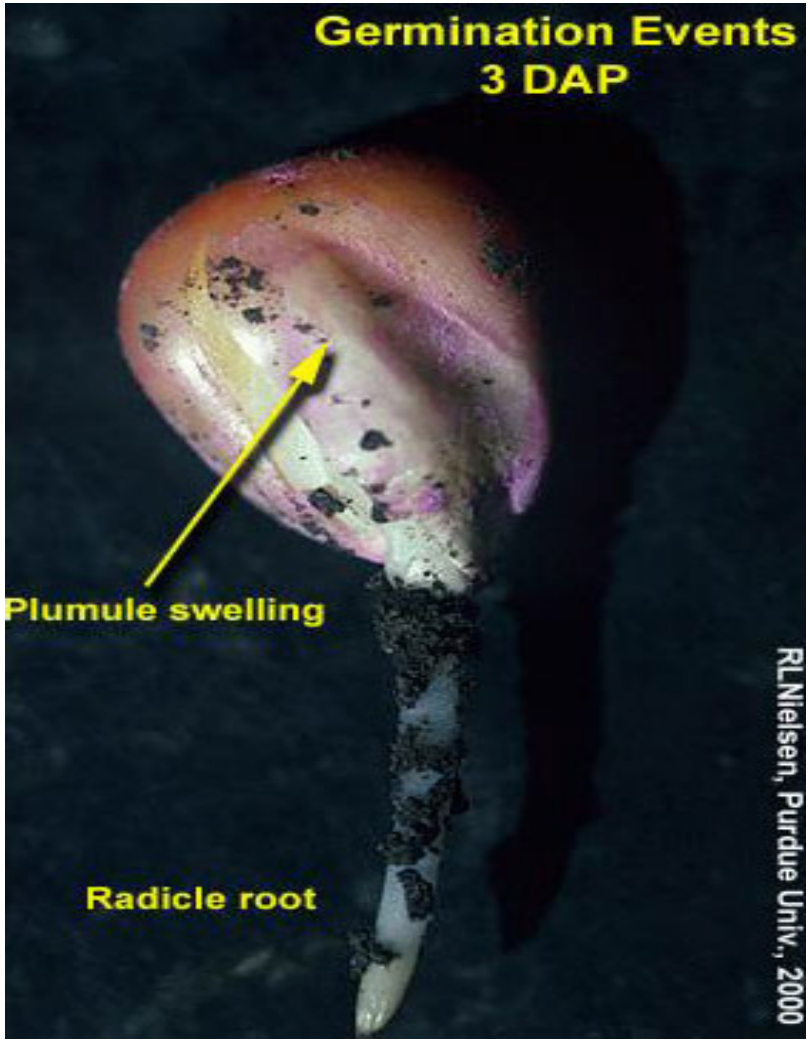
Label Seed



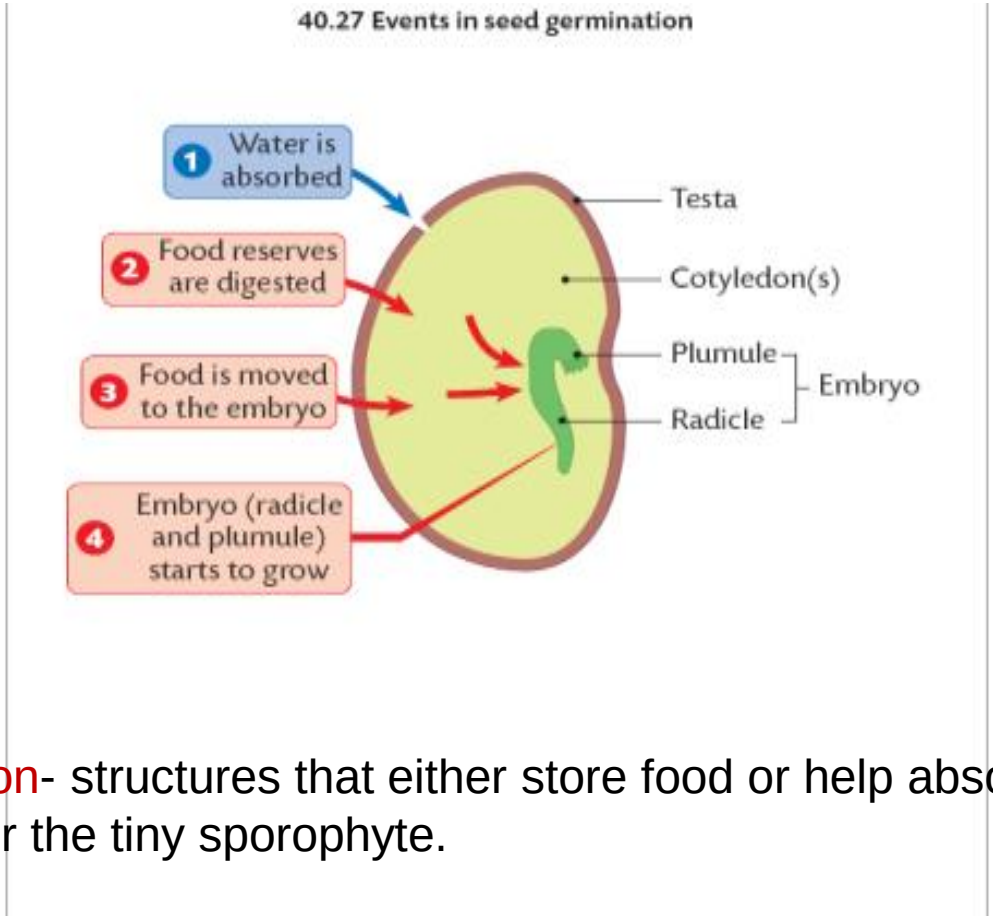
Label Seedling



Radicle Root and Plumule



Events in Seed germination



Cotyledon- structures that either store food or help absorb Food for the tiny sporophyte.

Origins of Plants

- A plant is a multicellular eukaryote.
- Most plants can produce their own food in the form of glucose through the process of photosynthesis.
- Scientists hypothesize that all plants probably **evolved** from filamentous **green algae** that lived in the ancient oceans.

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Why do they think Plants evolved from Algae?

- Green algae and plants have **cell walls** that contain **cellulose**.
- Both groups have the same types of **chlorophyll** used in photosynthesis
- Both store food in the form of **starch.**

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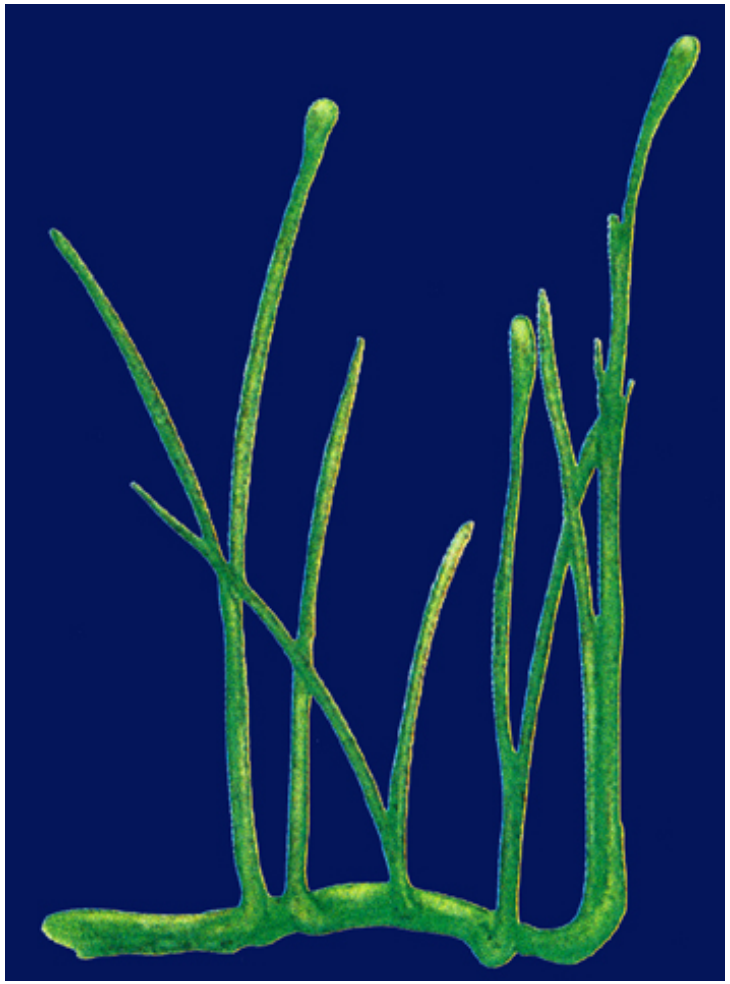
- Cell division that includes the formation of a **cell plate**.
- Similar **genes** for ribosomal RNA
- The same types of **enzymes** in cellular vesicles**.**

Origins of Plants

- These early plants were simple in structure and did not have leaves.
- They were probably instrumental in turning bare rock into rich soil.
- = pioneer species



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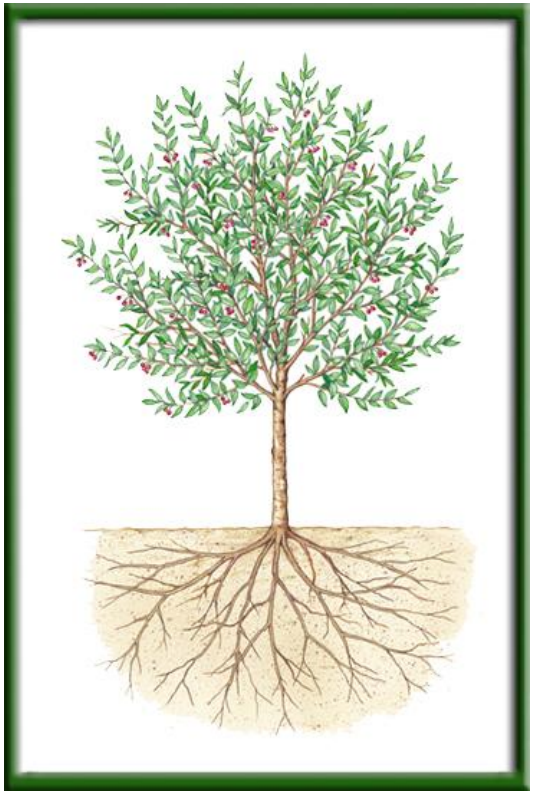
In order for plants to survive on land

- All organisms need water to survive. They had to be able to do three things:
- **Absorb nutrients-**from the soil, with their roots.
- **Prevent** their bodies from **drying out**.
- R**epro**duce without water to transmit sperm.



Preventing water loss

- Plant cells have thick cell walls made of cellulose.
- The stems and leaves of plants have a waxy waterproof coating called a cuticle.
- The cuticle does not let oxygen or carbon dioxide pass through it.

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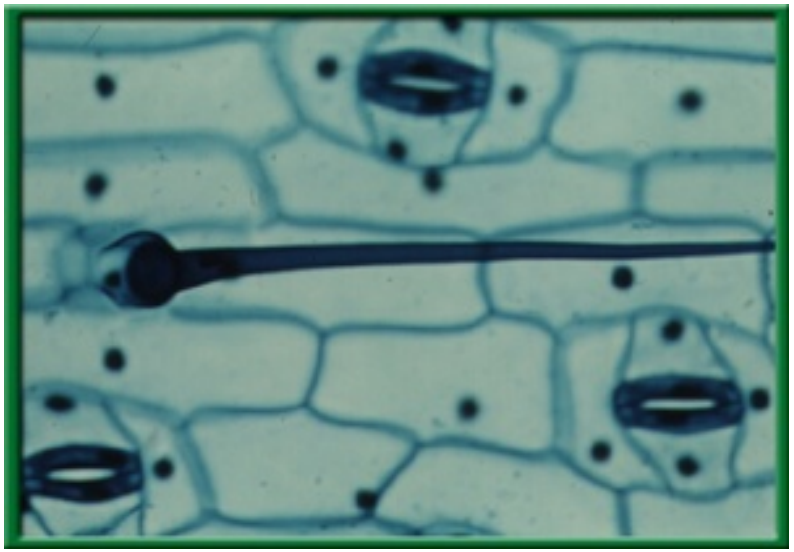
- Stomata (STOH mah tuh) (singular, stoma) are openings in leaf tissue that control the exchange of gases.

- Stomata are found on green stems and on the surfaces of leaves.



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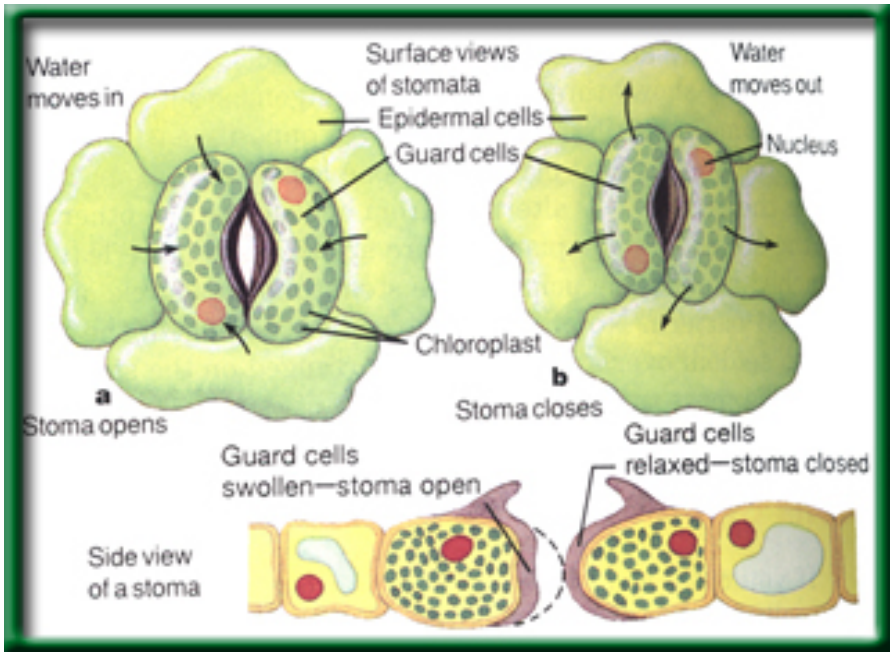
- Cells called guard cells control the opening and closing of stomata.

- The opening and closing of stomata regulates the flow of water vapor from leaf tissues.



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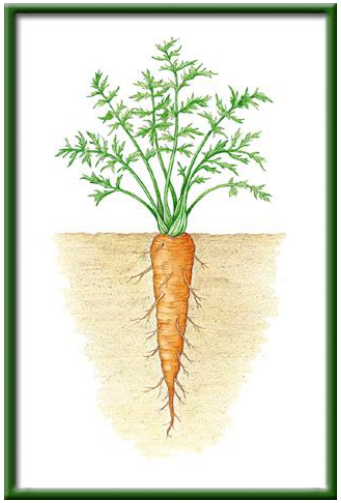
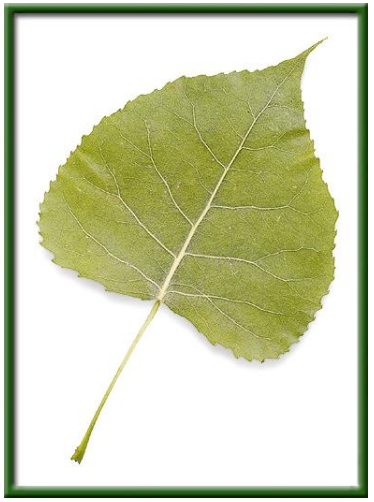
Plants later evolved

- In most plants, a root is a plant organ that absorbs water and minerals usually from the soil.
- The leaf, is a plant organ that grows from a stem and usually is where photosynthesis occurs.
- A stem is a plant organ that provides support for growth.





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Vascular Tissue, Seeds, and Flowers

- **Conducting Tissue** for transporting food, water, and other materials from one part of the plant to another.
- **Vascular Tissue**: internal system of interconnected tubes and vessels that carry water from the tips of roots to the tips of leaves.

- Vascular plants can live farther away from water than nonvascular plants.
- Also, because vascular tissues include thickened cells called fibers that **help support** growth, vascular plants can grow much larger than nonvascular plants.

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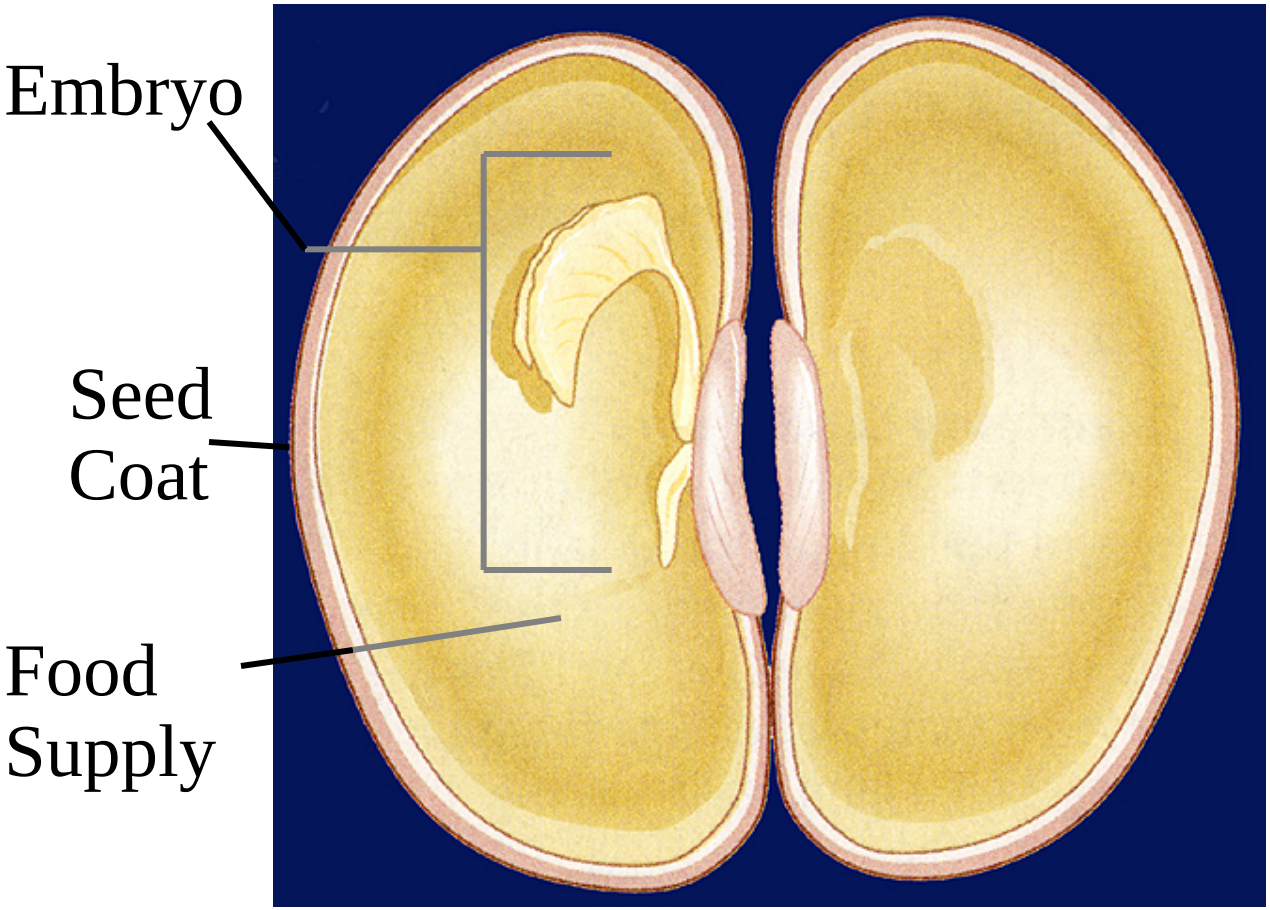
Advantages of Seeds

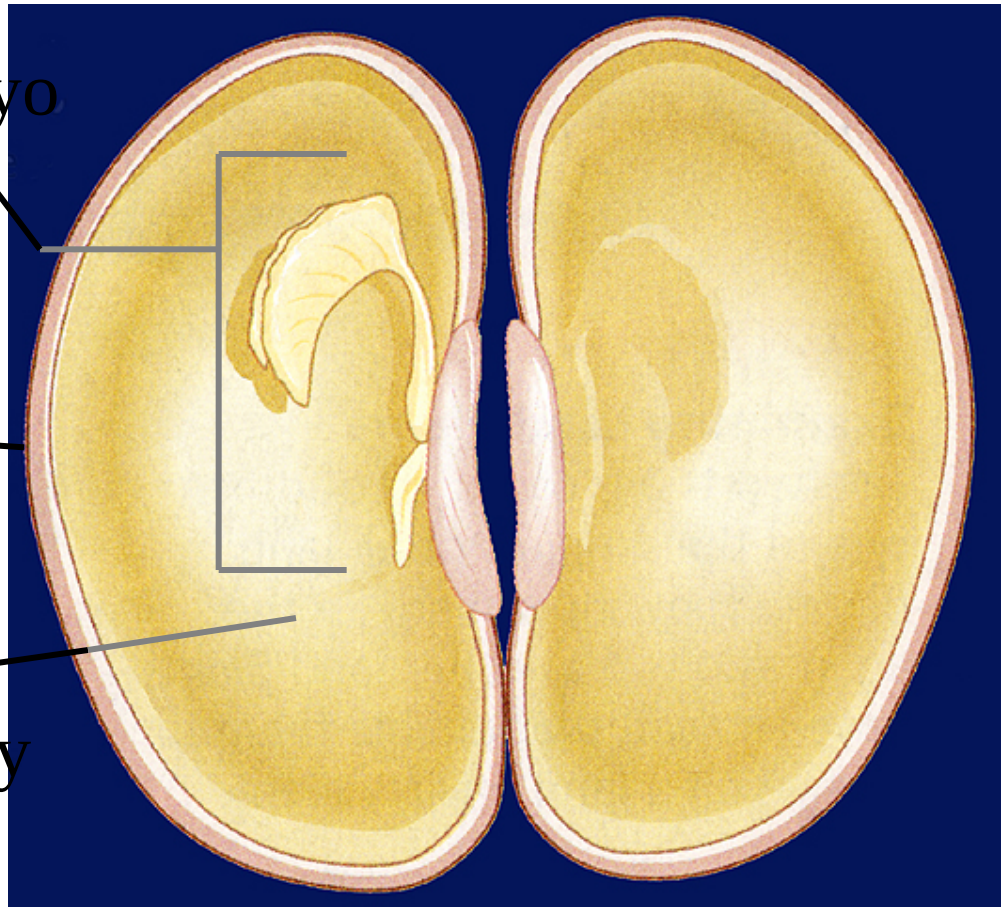


- Adaptations in some land plants include the evolution of seeds.
- Most plants living today are **seed plants.** **(=Vascular plants that produce seeds.)**

Reproductive Strategies

- Some land plants reproduce by spores
- A **spore**- is a haploid cell capable of producing an organism.
- **Water** is a limiting factor in the environment of these plants.
- The **gametophytes** of those land plants must have a film of water covering them for the sperm to swim to the egg.

Adapting to Life on Land



- A seed is a plant organ that contains an embryo, along with a food supply, and is covered by a protective coat.

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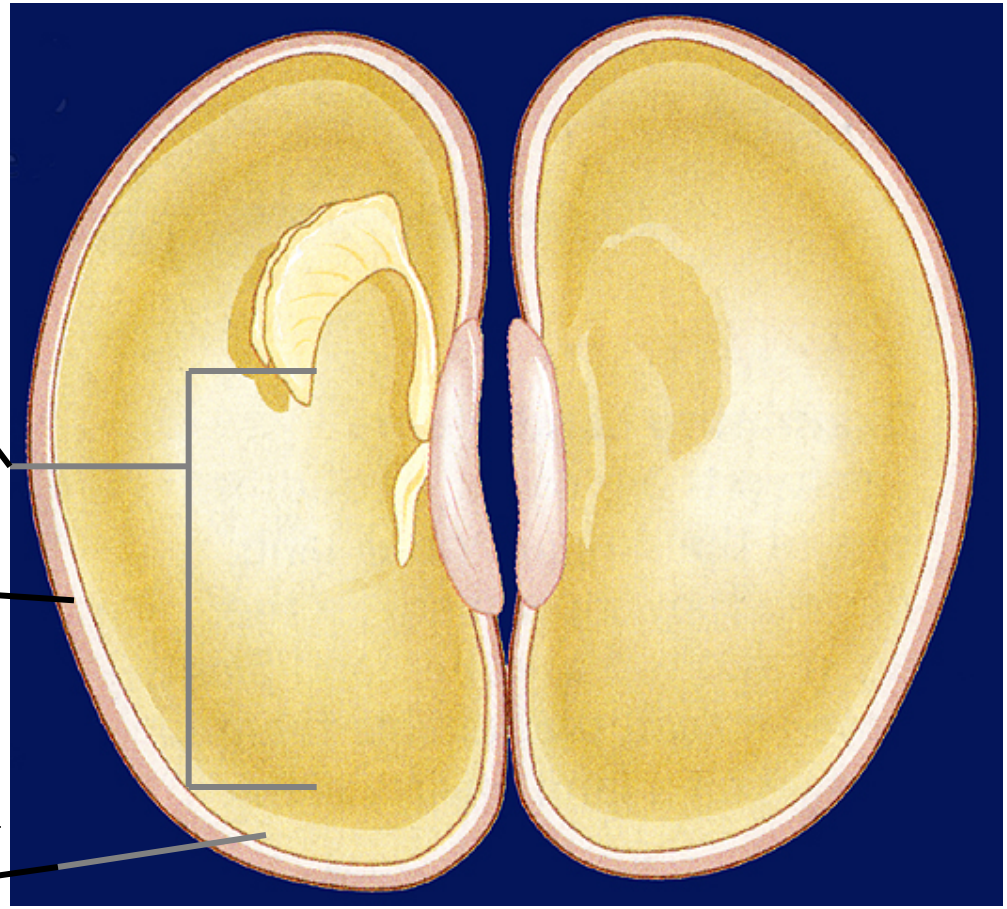
Adapting to Life on Land



- A seed coat **protects the embryo** from drying out and also can aid in its dispersal.
- **Nourishment** comes from within the seed until it can grow roots.

•**Delayed growth**-will not sprout until conditions are right.

Seed dispersal

- The dispersal of seeds is important because it reduces competition for sunlight, soil, and water between the parent plant and its offspring.

- Animals such as raccoons, deer, bears, and birds help distribute many seeds by eating fruits.

Seed dispersal

- Seeds that are eaten usually pass through the digestive system undamaged and are deposited in the animal's wastes.

- Plants that grow in or near water, produce fruits or seeds with air pockets in the walls that enable them to float and drift away from the parent plant.

Coconut seed dispersal

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Seed dispersal

- The ripened fruits of many plants split open to release seeds with structural (appendages) adaptations for dispersal by wind or by clinging to animal fur.

Advantages of flowers

- The last important adaptation to appear was the **flower** (=reproductive structure that produces pollen and seeds.)*The first flowering plant appeared 130MYA.
- Make plant reproduction more efficient.
- Attract animals, insects, bats to help insure pollination.

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Pollination

- The pollen that attaches to them can be carried to another flower, resulting in pollination.

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Pollination

- Some of the bright, vivid flowers attract pollinators, such as butterflies and bees.

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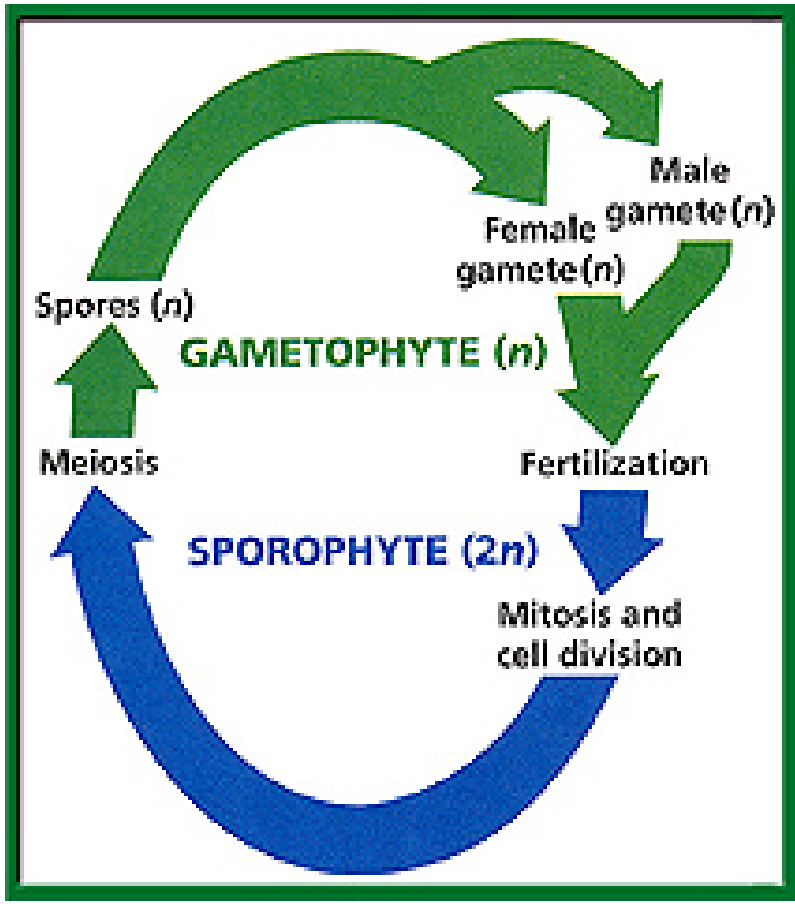
Alternation of Generations

A haploid stage followed by a diploid stage

Plant Life Cycles

- These spores undergo cell divisions and form a multi-cellular, haploid gametophyte.
- In Nonvascular plants, such as mosses the **gametophyte** phase is **dominant**.
- In Vascular plants such as the flowering plants the **sporophyte** generation is **dominant**.



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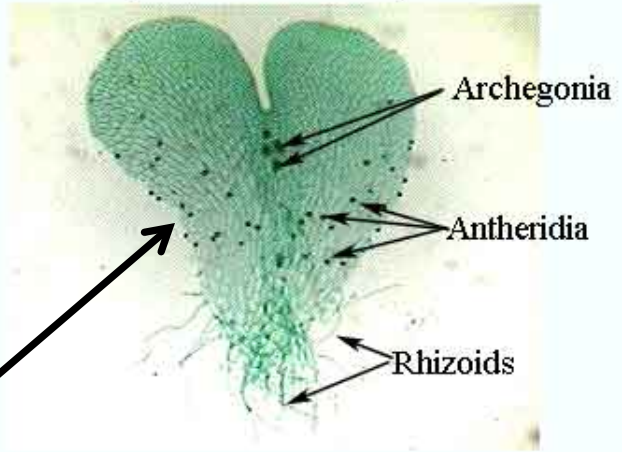
Alternation of Generations

Moss

Sporophyte

Gametophyte

Fern Gametophyte (Prothallus)



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Alternation of generations

- In **non-seed vascular plants** such as ferns, spores have hard outer coverings.
- Dominant phase in a fern is the sporophyte phase.

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Alternation of generations

- Spores are released directly into the environment where they can grow into haploid gametophyte plants.
- These plants produce male and female gametes.
- Following fertilization, the sporophyte plant develops and grows on the gametophyte plant.

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Alternation of generations

- In **seed plants**, such as conifers and flowering plants, spores develop inside the sporophyte and become the gametophytes.

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Alternation of generations

- The gametophytes consist of only a few cells.
- Male and female gametes are produced by these gametophytes.
- After fertilization, a new sporophyte develops within a seed. The seed eventually is released and the new sporophyte plant grows.
- During plant evolution, the **trend** was from **dominant gametophytes** to **dominant sporophytes** that contain vascular tissue.

Kinds of Plants- section 2

- Nonvascular plants do not have vascular tissues. 
- **Key Features of Nonvascular Plants**
- **Small size**
- The bodies of nonvascular plants are usually no more than a few cells thick, and water and nutrients travel from one cell to another by the process of osmosis and diffusion. (slow- don't grow tall)
- **Larger Gametophyte-**
- Hair-like projections called **rhizoids** anchor them to the surface they grow on.
- **Require a film of water for sexual reproduction** – so sperm can swim to egg.

Kinds of Nonvascular Plants

- Mosses and several other small, less familiar plants called hornworts and liverworts are usually classified as nonvascular plants.

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Adaptations in Bryophyta

- There are several divisions of nonvascular plants.
- The first division you'll study are the **mosses**, or bryophytes.
- Mosses are small plants with leaf-like extensions.
- Produce root-like, **multicellular rhizoids** that anchor them to the soil.
- Mosses never get very large, due to their water conducting cells carry water only short distances.

Adaptations in Bryophyta

- The leaves of mosses are usually one cell thick.
- The leafy green part is the gametophyte
- The bare stalk topped by a **spore capsule** is the sporophyte phase.

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Adaptations in Bryophyta

- Most Mosses have a cuticle, stomata, and some simple conducting cells in their stems.

- Mosses usually grow in dense carpets of hundreds of plants.

Adaptations in Bryophyta

- Some mosses form extensive mats that help retard erosion on exposed rocky slopes.
- Mosses grow in a wide variety of habitats.
- They even grow in the arctic during the brief growing season where sufficient moisture is present.
- A well-known moss is ***Sphagnum***, also known as peat moss.

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Adaptations in Bryophyta

- This plant thrives in acidic bogs in northern regions of the world.
- It is harvested for use as fuel and is a commonly used soil additive.

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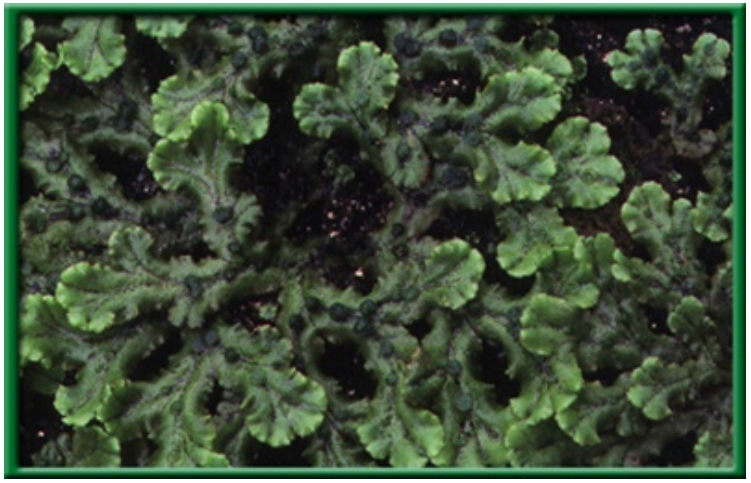
Adaptations in Hepatophyta

- Another division of nonvascular plants is the **liverworts**.



- They have **unicellular rhizoids**
- Liverworts are small plants that usually grow in clumps or masses in moist habitats.
- They lack conducting cells, cuticle, and stomata.
- The flattened body of a liverwort gametophyte is thought to resemble the shape of the lobes of an animal's liver.

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Adaptations in Hepatophyta

- A liverwort can be categorized as either thallose or leafy.
- The body of a thallose liverwort is called a **thallus**. It is broad and ribbonlike and resembles a fleshy, lobed leaf.
- Thallose liverworts are usually found growing on damp soil.
- The sporophytes of liverworts are very small and consist of a short stalk topped by a **spore capsule.**

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Adaptations in Anthocerophyta

- Anthocerophytes are the smallest division of nonvascular plants, currently consisting of only about 100 species.

- Also known as **hornworts**, these nonvascular plants are similar to liverworts in several respects.
- Completely lack conducting cells. But do have stomata and a cuticle.

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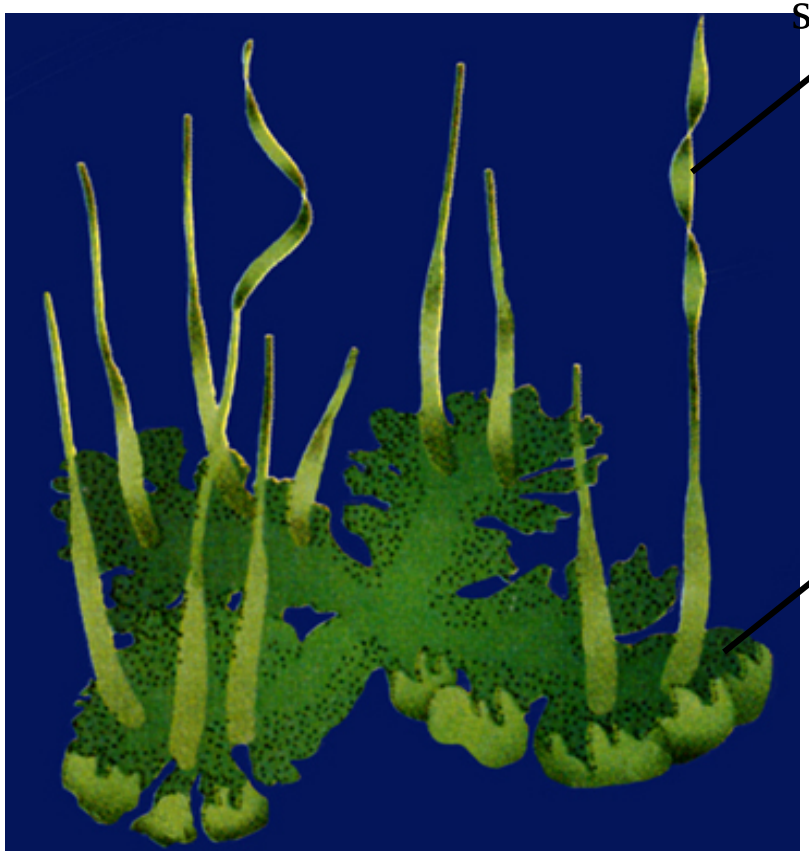
Adaptations in Anthocerophyta

- Hornworts have a thallose body.
- The sporophyte of a hornwort resembles the horn of an animal.



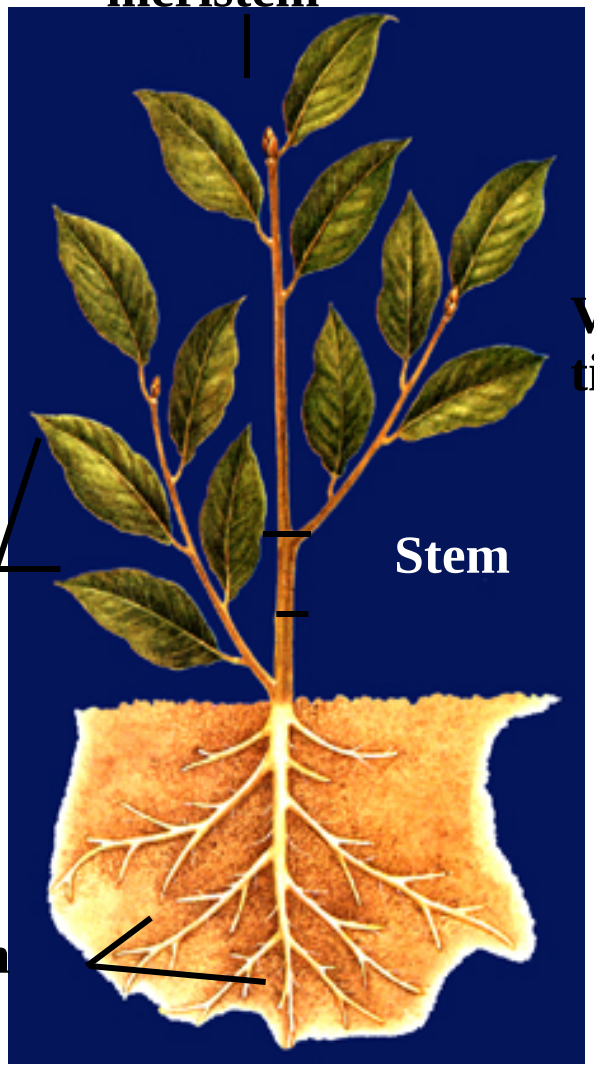
Adaptations in Anthocerophyta

- Another feature **unique** to hornworts is the presence of one to several chloroplasts in each cell of the sporophyte depending upon the species.

- Unlike other nonvascular plants, the hornwort sporophyte, not the gametophyte, produces most of the food used by both generations.

A Vascular Plant's Distinctive Body Plan

- All vascular plants have the same basic body plan. They are composed of cells, tissues, and organs.
- **Shoots**- grow upward
- **Roots**- grow downward
- **Meristems**-zones of actively dividing cells.



- Cells
- Tissues
- Organs

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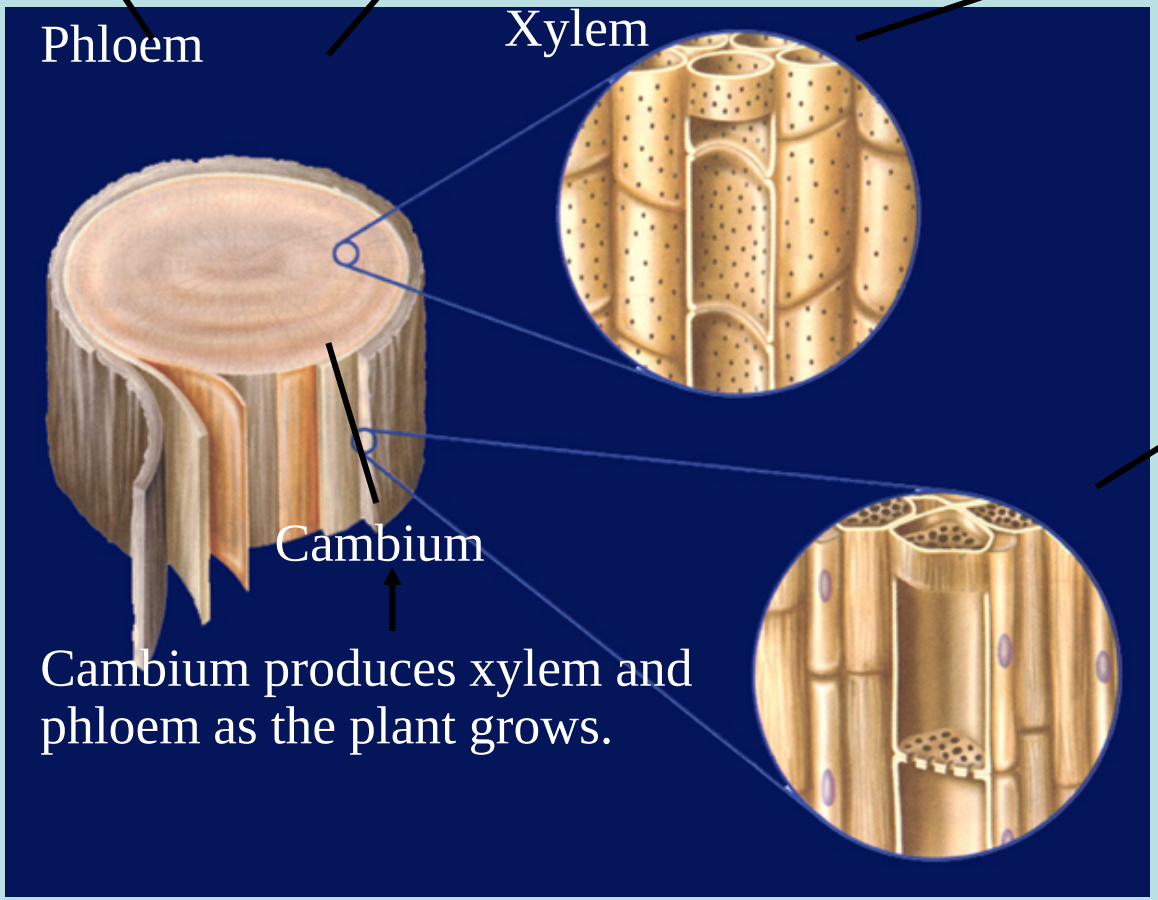
Transporting materials in the Vascular Plants



Xylem (hard walled) transports water and dissolved substances other than sugar throughout the plant.

Helps support the plant and enables them to grow to taller and bigger.

Phloem transports dissolved sugar throughout the plant.

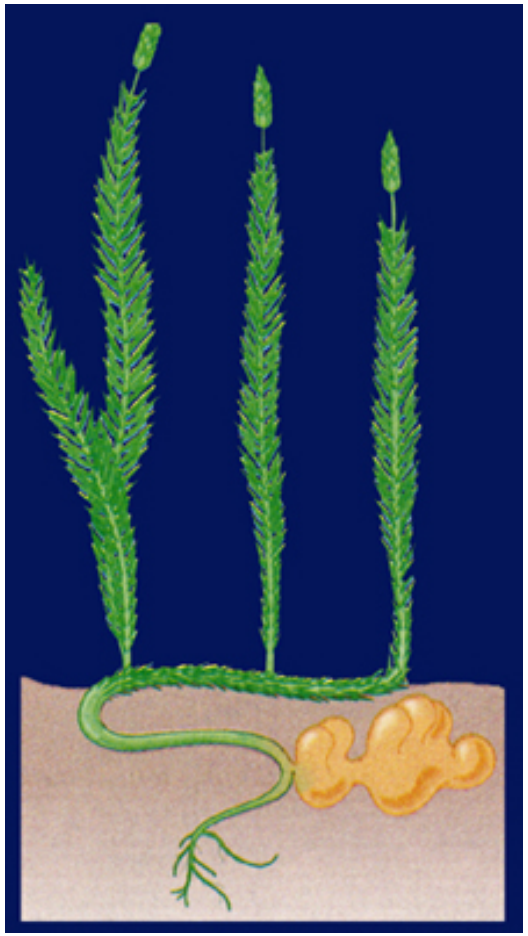
Key Features of Seedless Vascular plants

- The obvious difference between a vascular and a nonvascular plant is the presence of **vascular tissue.**
- Vascular tissue is made up of tubelike, elongated cells through which water and sugars are transported. (Xylem and Phloem)
- The xylem are reinforced with **lignin**, a major part of wood. Xylem tissue is **dead** at maturity!
- Vascular plants are able to adapt to changes in the availability of water, and thus are found in a variety of habitats.

Alternation of generations

- Vascular plants, like all plants, exhibit an alternation of generations.
- The **larger sporophyte** makes it easier for the wind to carry away spores, which makes dispersal more efficient.
- Water is needed for fertilization.
- **Drought Resistant spores-** have thickened walls that are resistant to drying. Therefore, they can live in drier habitats.

Alternation of generations



- Unlike nonvascular plants, the spore-producing vascular **sporophyte is dominant and larger in size** than the gametophyte.
- The gametophyte is smaller and develops on or below the soil.
- Water is needed for fertilization.

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Kinds of Seedless Vascular Plants

- According to fossil records, **ferns**—division **Pterophyta**—first appeared nearly 375 million years ago.
- Ancient ferns grew tall and treelike and formed vast forests.
- Ferns are the most common and most familiar .

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Adaptations in Pterophyta

Pterophyta

- Pterophytes (TER oh fites), **ferns**, are the most well-known and diverse group of non-seed vascular plants.

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Adaptations in Pterophyta

- Ferns range in size from a few meters tall, like tree ferns, to small, floating plants that are only a few centimeters in diameter.

Adaptations in Pterophyta

- Some ferns inhabit dry areas, becoming dormant when moisture is scarce and resuming growth and reproduction only when water is available again.

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Fern Structures

- They have leaves called **fronds** that vary in length from 1 cm to 500 cm.
- *The coiled young leaves of a fern are called* **fiddleheads.**
- The large size and complexity of fronds is one difference between pterophytes and other groups of seedless vascular plants.
- Although ferns are found nearly everywhere, most grow in the tropics.

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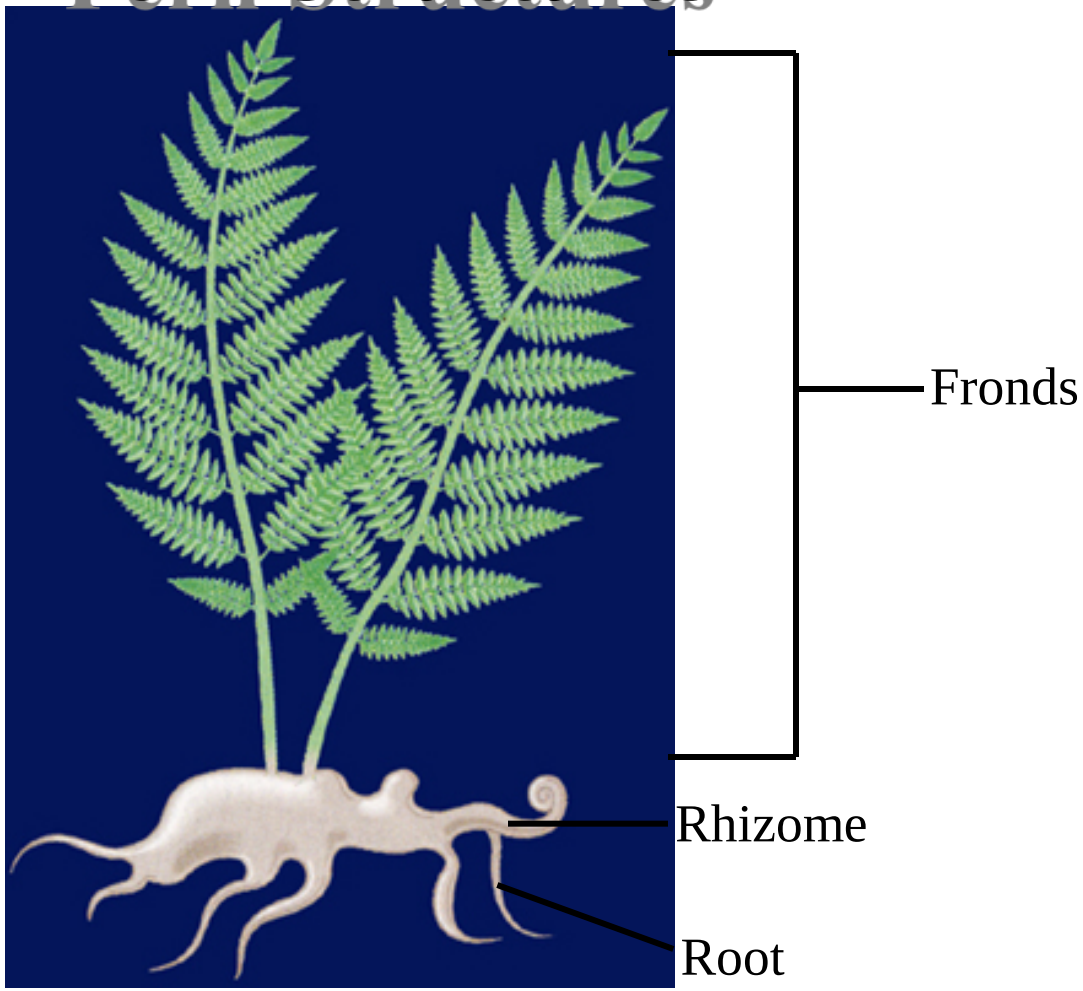
Fern Structures



- In most ferns, the main stem is underground. This thick, underground stem is called a rhizome.

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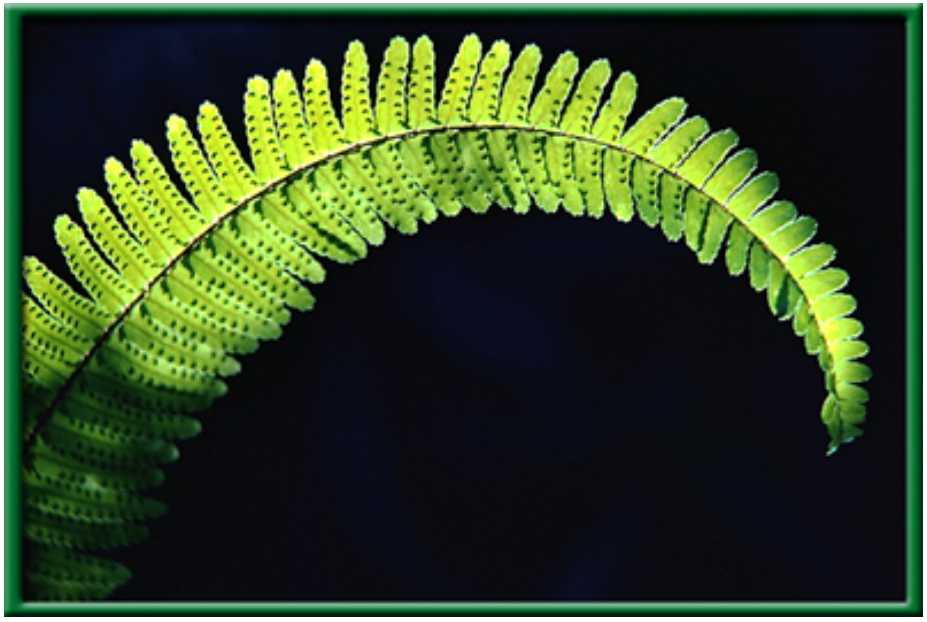
Fern Structures

- Fern spores are produced in structures called **sporangia.**



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Fern Structures

- Clusters of sporangia form a structure called a sorus (plural, sori). Sori are usually found on the underside of fronds but in some ferns, spores are borne on modified fronds.

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Adaptations in Lycophyta

- The **club moss**, *Lycopodium*, is commonly called ground pine because it is evergreen and resembles a miniature pine tree.
- Also called spike moss.

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Adaptations in Lycophyta

- It has roots, stems, and small leaflike structures.
- A single vein of vascular tissue runs through each leaflike structure.
- Their leafy green stems branch from an underground **rhizome.**
- Spores develop in **sporangia** that form specialized leaves.
- In some species a cluster of nongreen spore-bearing leaves form a **cone.**

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Adaptations in Sphenophyta

- **Horsetails,** represent a second group of ancient vascular plants.
- They also have roots, stems, and leaves.

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Non-Seed Vascular Plants

- The name horsetail refers to the bushy appearance of some species.
- These plants also are called **scouring rushes** because they contain silica, an abrasive substance.

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Non-Seed Vascular Plants

- Most horsetails are found in marshes, in shallow ponds, on stream banks, and other areas with damp soil.
- Spores are produced in **strobili** (cones) that form at the tips of non-photosynthetic stems.
- At each joint, there is a whorl of tiny, scalelike leaves.
- The stem structure of horsetails is ribbed and hollow, and appears **jointed.**

Adaptations in Psilotophyta

- **Whisk Ferns** this group most closely resembles the earliest vascular plants. (*Cooksonia*)

- Have highly branched stems and no leaves or roots.
- They produce spores in sporangia that form at the tips of short branches.

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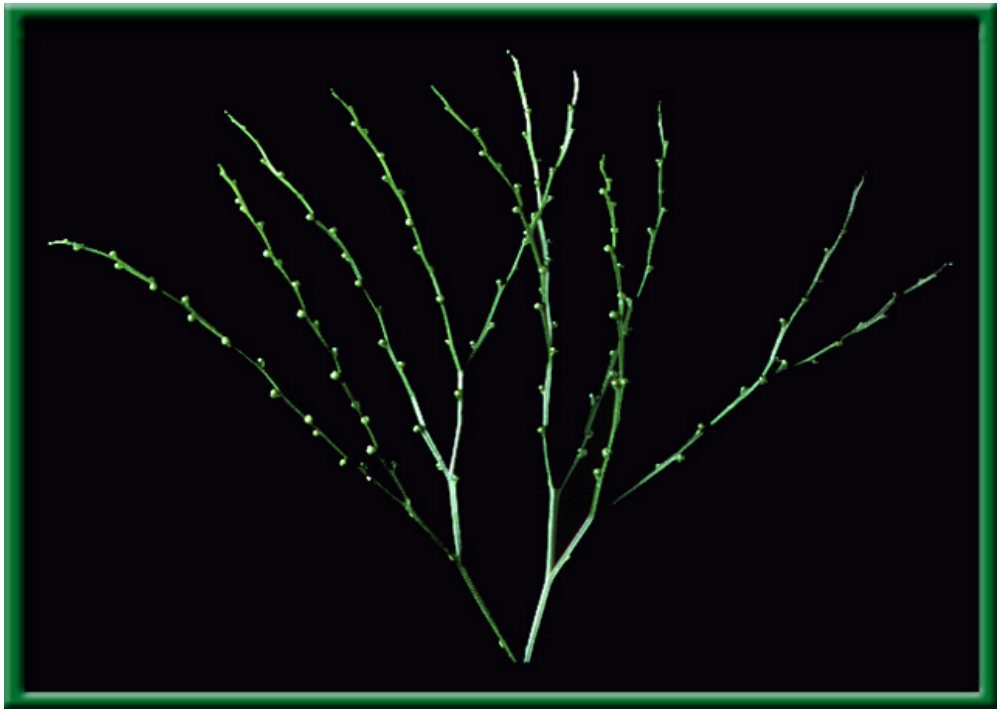
Psilophyta

- Psilophytes, known as whisk ferns, consist of thin, green stems.



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Diversity of seed plants

- This group of plants is sometimes referred to as **gymnosperms. (=naked seed)**

- The gymnosperm plant divisions you will learn about are Cycadophyta, Ginkgophyta, Gnetophyta, and Coniferophyta.

Key features of Gymnosperms (Seed Plants)

- Seed plants produce **seeds**, which in a dry environment are a more effective means of reproduction than spores.

- In conifers and some flowering plants, the embryo's food supply is stored in the cotyledons.

- The embryo is protected during harsh conditions by a tough seed coat.

- The seeds of many species are also adapted for easy dispersal to new areas.

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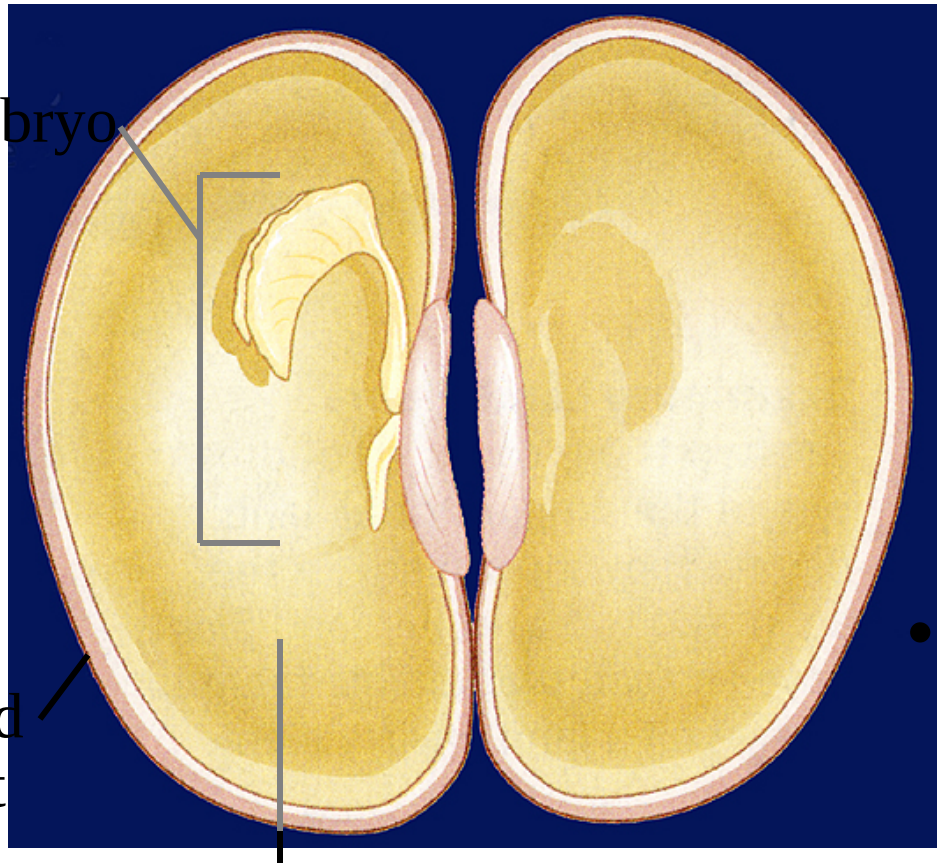
Seed Plants



- A seed consists of an embryonic plant and a food supply covered by a hard protective seed coat.
- All seed plants have vascular tissues.

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Key features of Gymnosperms

Greatly Reduced Gametophytes

- Two types of gametophytes: male and female.
- Male: Grains of pollen that form within the tissue of sporophytes,
- Female: form within the structures that become seeds.
- In most plants, these gametophytes develop in the scales of woody strobili called cones.

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Key features of Gymnosperms

Wind Pollination

- The sperm of gymnosperms do not swim through water to reach and fertilize eggs..
- The sperm are carried to the structures that contain eggs by pollen, which can drift on the wind.
- Wind pollination makes sexual reproduction possible even when conditions are very dry.

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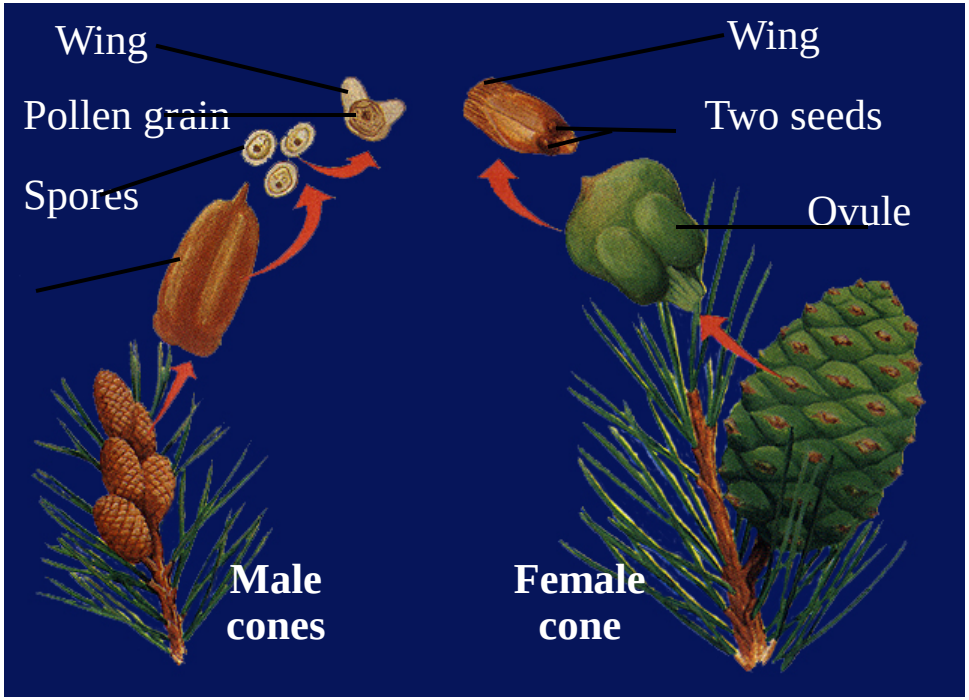
Kinds of Gymnosperms
Coniferophyta

- The **conifers** are trees and shrubs with needlelike **or** scalelike leaves.

- Conifers are vascular seed plants that produce **seeds in cones.**

Adaptations in Coniferophyta

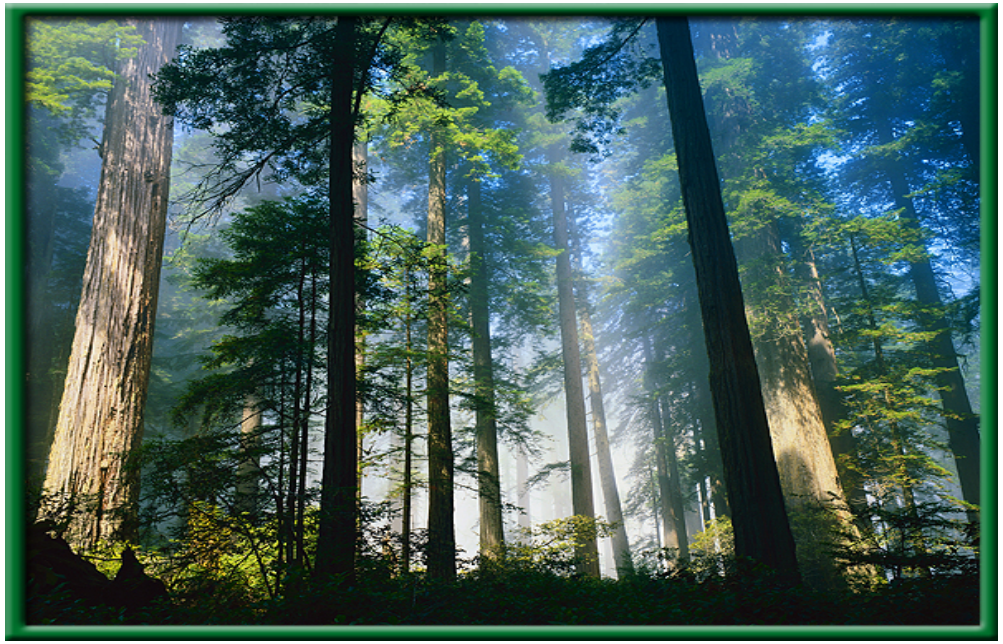
- The reproductive structures of most conifers are produced in cones.



Adaptations in Coniferophyta

- Most conifers have male and female cones on different branches of the same tree.
- The male cones produce pollen.
- Female cones are much larger. They stay on the tree until the seeds have matured.
- Conifers are the most familiar and most successful gymnosperm.

Coniferophyta



- These are the conifers (KAH nuh furz), cone-bearing trees such as pine,juniper,firs spruce, yew, larch,cypress, and redwood.

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Coniferophyta

- **Bristlecone pines**, the **oldest** known living trees in the world, are members of this plant division.

- Another type of conifer, the **Pacific yew**, is a source of **cancer-fighting drugs.**

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Pacific Yew

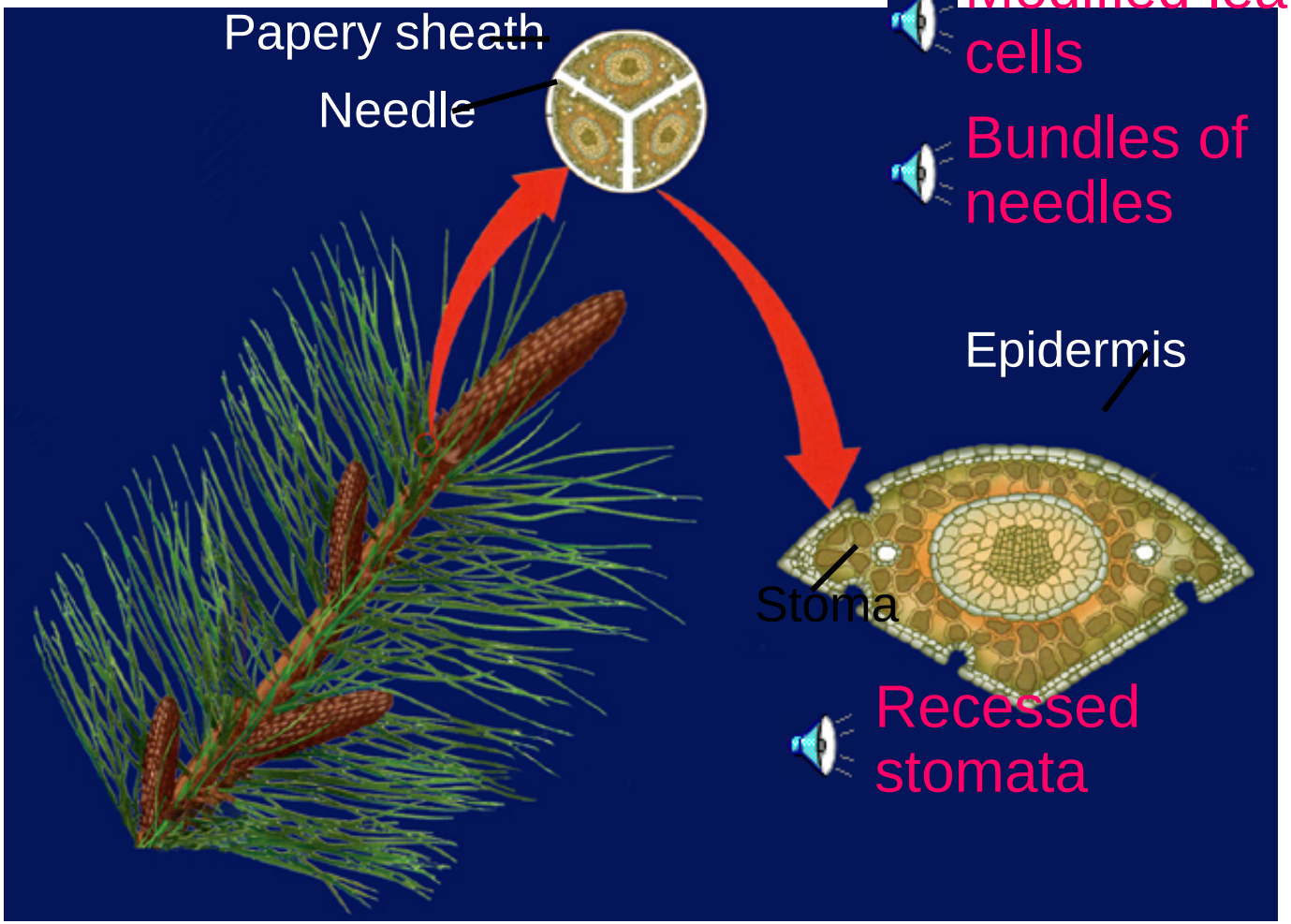
- Another type of conifer, the **Pacific yew**, is a source of **cancer-fighting drugs.**

Pine Needles

- The needles of pines have several adaptations that enable the plants to conserve water during the cold dry winter and the dry heat of the summer.

Pine Needles

Cross section of needle bundle



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Evergreen conifers

- Most conifers are evergreen plants—that retain some of their leaves for more than one year.

Deciduous trees lose their leaves

- A few conifers, including larches and bald cypress trees, are deciduous.

- **Deciduous plants** drop all their leaves each fall or when water is scarce or unavailable as in the tundra or in deserts.

- Dropping all leaves is an adaptation for reducing water loss. However, a tree with no leaves cannot photosynthesize and must remain dormant during this time.

Cycadophyta

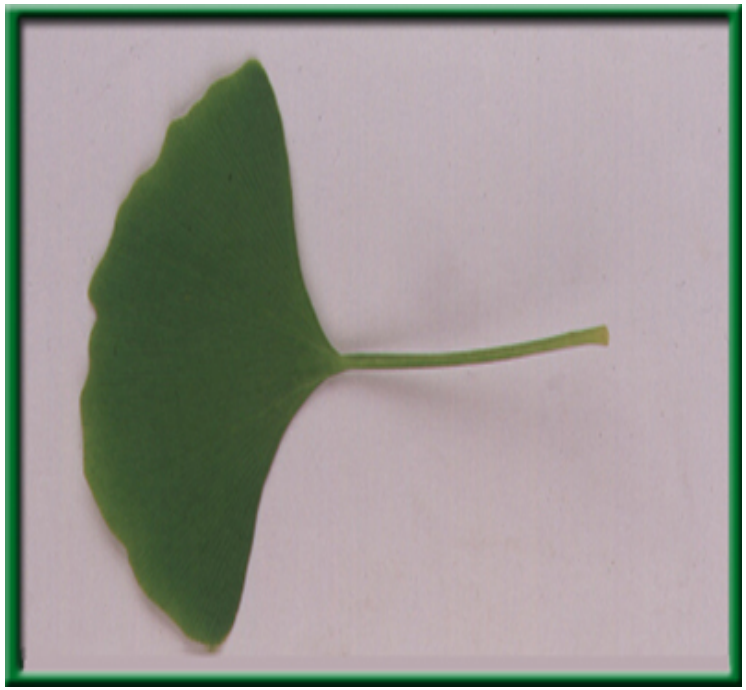
- **Cycads** (SI kuds) were abundant during the Mesozoic Era. Today, there are about 100 species of cycads.
- They are **palmlike** trees with scaly trunks and can be short or more than 20 m in height.
- Cycads produce male and female cones on separate trees.

Adaptations in Cycadophyta

- The male system includes cones that produce pollen grains, which produce motile sperm.
- Cycads are one of the few seed plants that produce motile sperm.
- The female system includes cones that produce ovules.

Ginkgophyta

- This division has only one living species, *Ginkgo biloba*, a distinctive tree with small, **fan-shaped leaves.**



Ginkgophyta

- **Ginkgoes** (GING kohs) have male and female reproductive structures on separate trees. 
- The seeds produced on female trees have an unpleasant smell, so ginkgoes planted in city parks are usually male trees.
- Ginkgoes are hardy and resistant to insects and to air pollution.
- Ginkgoes often are planted in urban areas because they tolerate smog and pollution.

Gnetophyta

- There are three genera of **gnetophytes** (NEE toh fites) and each has distinct characteristics. Can live as long as 2000 years!!!
- *Gnetum* (Nee tum) includes about 30 species of tropical trees and climbing vines.
- There are about 35 *Ephedra* (eh FEH dra) species that grow as shrubby plants in desert and arid regions.
- The third species *Welwitschia* (wel WITCH ee uh) has only one species, which is found in the deserts of southwest Africa.

Angiosperms –"enclosed seeds"– The flowering Plants

Anthophyta

- **Anthophytes** (AN thoh fites), commonly called the flowering plants, are the largest, most diverse group of seed plants living on Earth.
- They first appeared 130 million years ago.
- Angiosperms are the most recent group of plants to evolve.

Anthophyta

- There are approximately 250 000 species of anthophytes. (90 % of all living plants)
- Unlike conifers, anthophytes produce **flowers** from which **fruits** develop.
- **Flowers**=male and female parts develop in flowers.
- -promote pollination
- **Fruits- (mature ovary)** provide protection for developing seeds. Provide Food!!!!
- -their primary function is to promote seed dispersal.
- **Endosperm**- The seeds supply of stored food.

Anthophyta

- A fruit usually contains one or more seeds.

- This division has two classes: the **monocotyledons** (mah nuh kah tul EE dunz) and **dicotyledons** (di kah tul EE dunz)

Life Spans

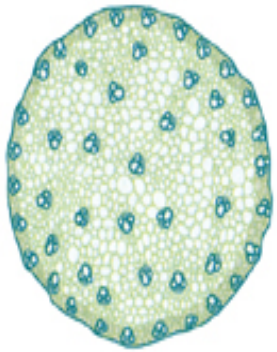
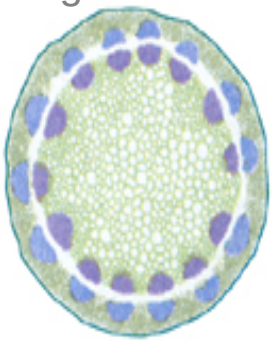
- **Annual plant-** completes its life span – sprouts from a seed, grows, produces new seeds, and dies in **one** growing season.
- This year of life is dedicated to reproduction!! (makes new seeds and many many flowers)
- **Biennial plant-** life spans two years. First year it produces leaves and a strong root system. (ex: carrots, beets, and turnips)
- If the above ground tissues die if it is not harvested.
- In the second year, stems, leaves, flowers and seeds grow. The plant's life ends the second year.

Life Spans Cont…..

- **Perennial Plants-** live for several years and usually produce flowers and seeds yearly.
- Dies back to the junction between stem and root every year, and then regrows every subsequent season to bloom again?
- Ex: fruit and shade trees , shrubs, irises, peonies, roses, and many types of berries.

Monocots and dicots (eudicot)

Distinguishing Characteristics of Monocots and Dicots

	Seed Leaves	Vascular Bundles in Leaves	Vascular Bundles in Stems	Flower Parts
Monocots	One cotyledon 	Usually parallel 	Scattered 	Multiples of three 
Dicots	Two cotyledons 	Usually netlike 	Arranged in ring 	Multiples of four and five 

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Monocots and dicots (eudicot)

- Moncots include grasses, orchids, lilies, irises and palms.

Monocots and dicots (eudicot)

- Dicot species include nearly all of the familiar shrubs and trees (except conifers), cacti, wildflowers, garden flowers, vegetables, and herbs.

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Plants in Our Lives

- **Plants as Food**

- Fruits and Vegetables-
- A **fruit** is the reproductive part of the plant that contains seeds
- A **vegetative** part is any non reproductive part of the plant.
- Botanically a tomato and corn are both **fruits**.

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Root Crops

- A tuber is a swollen, underground stem that has buds from which new plants can grow.
- Rhizomes also are underground stems that store food.(starch)
- Examples: potatoes, carrot, radish, turnips, beets.
- *The potato can grow by vegetative propagation*

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Legumes

- Members of the pea family
- Produce **protein** –rich seeds in long pods.
- **Peas**, peanuts, and many different types of **beans** are the seeds of legumes.
- **Soybean** is the most important one grown for food.(45% protein)
- **Alfalfa**, which is fed to livestock, has nitrogen – fixing bacteria, which add nitrogen compounds to the soil.

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Cereals

- Are grasses that are grown as food for humans and livestock.

- A **grain** contains a single seed with a large supply of endosperm.
- Each grain develops from a flower.
- A grain is covered by a dry, papery husk called the **bran**.(=which contains the wall of the ovary and the seed coat.)

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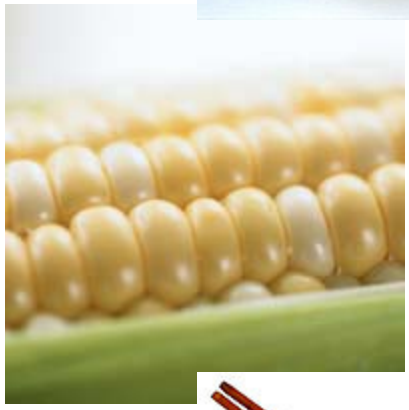
Wheat , Corn and Rice

- Over half of the calories humans consume come from these three **cereals**.
- **Wheat-** is commonly ground into flour and used to make breads and pasta.
- **Corn** –is the most widely cultivated crop in Iowa,Neb, Mn, Illinois, Indiana.
- Margarine is made from corn.
- Most of the corn crop is used for **livestock.**
- **Rice-** -low in protein it is an excellent source of energy.



Non food Uses of Plants

- **Rubber-** was first made from latex, the milky white sap of tropical trees of the genus *Hevea.*
- **Wood**- lumber, paper, rayon-made from the pulp of wood, fuel, for heating and cooking.
- Most valuable non food product obtained from plants.
- Wood is not the main source of heating in the US but it is in ¼ of the worlds people.

- **Medicines-**
- Aspirin- Willow tree bark (salicin is used to make aspirin)
- Caffeine-tea leaves
- Codeine
- Cortisone
- Ephedrine- ephedra
- Taxol-yew tree bark
- Vinblastine-(used to treat Hodgkin's disease),
- *Catharanthus roseus and rosy periwinkle*- is the source of two cancer treatment drugs.
  - Cassava- tapioca
- Fox glove- treats cardiac disorders.
- **Fibers**- these fibers are strands of cellulose from the fruit of a cotton plant.
- Clothes (cotton) and rope (hemp)