Lecture 30

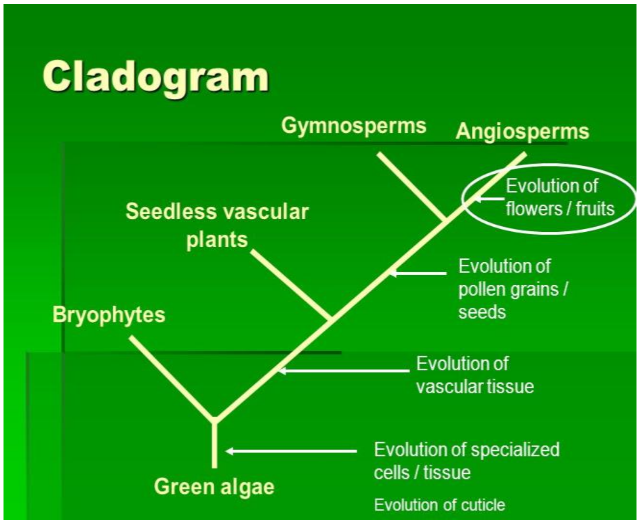
Gymnosperms and Angiosperms

Gymnosperms

Gymnosperms means "naked seed" and are are nonflowering plants. Their seeds that do not develop within an enclosed structure. Examples are conifers, cycads, Ginkgo, and Gnetales. Gymnosperm seeds develop either on the surface of scale or a leaf-like appendage of cones or at the end of short stalks.

Evolution of gymnosperms

Seed ferns were the first seed plants, protecting their reproductive parts in structures called capsules. Seed ferns gave rise to the gymnosperms during the Paleozoic Era, about 390 million years ago. Gymnosperms include the gingkoes and conifers and inhabit many, ecosystem such as the taiga and the alpine forests, because they are well adapted for cold weather. True seed plants became more numerous and diverse during the Carboniferous period around 319 million years ago; an explosion that appears to be due to a whole genome duplication event. Gymnosperms do not depend on water for fertilization (have air-borne pollen).

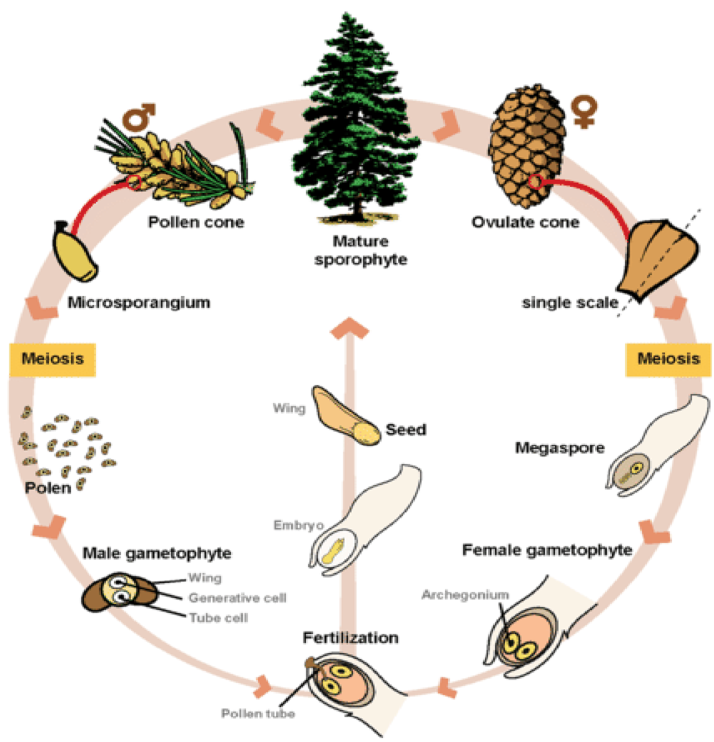


Life Cycle of Gymnosperms

1. Gymnosperms are vascular plants that produce seeds in cones. Examples include conifers such as pine and spruce trees. The gymnosperm life cycle has a dominant sporophyte generation. Both gametophytes and the next generation's new sporophytes develop on the sporophyte parent plant.

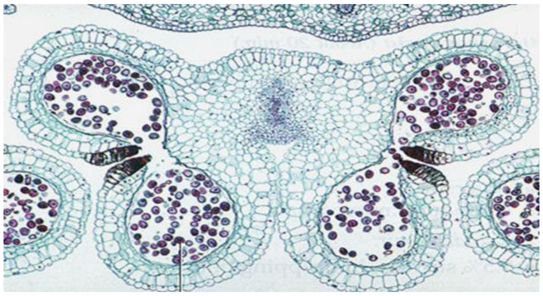
2. Cones form on a mature sporophyte plant. Inside male cones, male spores develop into male gametophytes. Each male gametophyte consists of several cells enclosed within a grain of pollen. Inside female cones, female spores develop into female gametophytes. Each female gametophyte produces an egg inside an ovule.

3. Pollination occurs when pollen is transferred from a male to female cone. If sperm then travel from the pollen to an egg so fertilization can occur, a diploid zygote results. The zygote develops into an embryo within a seed, which forms from the ovule inside the female cone. If the seed germinates, it may grow into a mature sporophyte tree, which repeats the cycle.



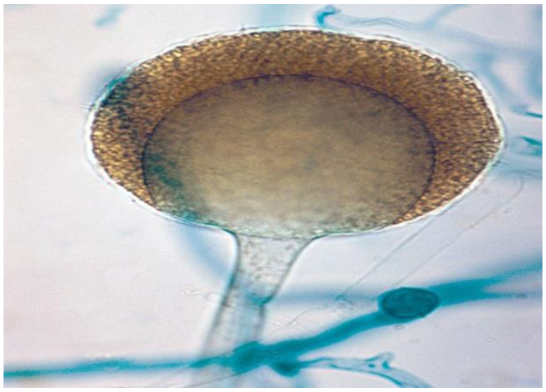
Sporophyte Generation
Sporophyte produces spores of two categories are termed as heterosporous generation.

1) Megasporangium
Megasporangium which undergoes meiosis to produce megaspores that is female gametophyte. It corresponds to the ovule or nucleus of seed plant.



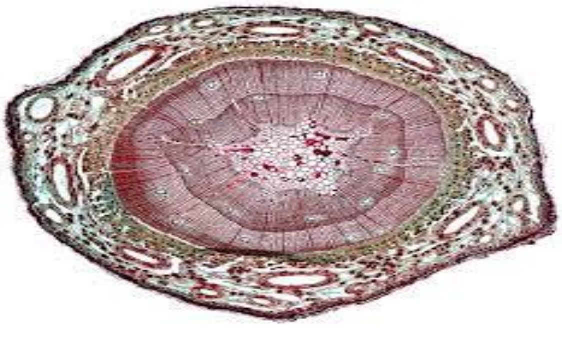
2) Sporangium

Sporangium is a structure in certain plants and other organisms that is charged with making and storing spores. Spores are haploid structures created in organisms that help to germinate and form new organisms.



Wood Manufactured by Gymnosperms

The wood is simpler than that of angiosperms; it consists primarily of elongated tracheids (water- and mineral-conducting cells) in the xylem and vascular rays in the phloem that store materials and provide for lateral conduction. The wood of gymnosperms is often called softwood to differentiate it from the hardwood angiosperms. The growth tissue of the stem and branches, known as the vascular cambium, contributes more xylem each growing season, forming concentric growth rings in the wood. Wood is formed from secondary growth.



Primary and Secondary Growth

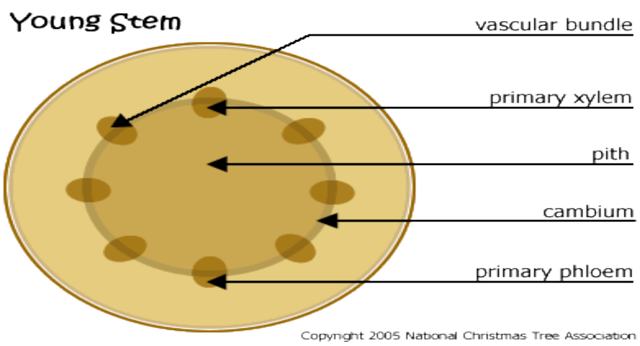
1) Primary growth

Growth in vascular plants resulting from the production of primary tissues by an apical meristem. The plant body grows lengthwise chiefly by the enlargement of cells produced by the apical meristem (rather than by cell division). Because they lack secondary tissues, most monocots and herbaceous plants grow solely by primary growth until they reach maturity, when growth stops.

2) Secondary Growth

Growth in vascular plants resulting from the production of layers of secondary tissue by a lateral meristem (the cork cambium or the vascular cambium). The new tissue accumulates and results in thicker branches and stems. Secondary growth occurs in gymnosperms, most eudicots, and woody magnoliids (such as the magnolia). Most monocots and herbaceous plants undergo little or no secondary growth but simply stop growing when their primary tissues mature.

Vascular tissue in Trees
Vascular tissue is a complex conducting tissue, formed of more than one cell type, found in vascular plants. The primary components of vascular tissue are the xylem and phloem. These two tissues transport fluid and nutrients internally. There are also two meristems associated with vascular tissue: the vascular cambium and the cork cambium. All the vascular tissues within a particular plant together constitute the vascular tissue system of that plant. Vascular tissue is present on the outer layers of the tree.



Conifers Adaptations
Conifer trees live in cold climates. This kind of cold weather can easily kill humans and other animals during prolonged exposure. Conifer trees are specially adapted to protect themselves from freezing.
One of the most notable adaptations of conifer trees is the presence of needle-like leaves. These leaves are adapted to survive in harsher and colder conditions compared to broad leaves. The needle leaf design is very similar to that of broad leaves, except everything is much more tightly packed, protecting the central vein of the leaf containing the vascular tissue. The central vein is surrounded by a sheath for protection.

Important Gymnosperms

Cycads

Cycads look like ferns and palms, but they're not really related to either of these plants. Cycads are more closely related to pine trees, and other cone-bearing plants. As mature plants, cycads bear cones, and are architectural plants that can look like living sculptures.

Ginkgo biloba

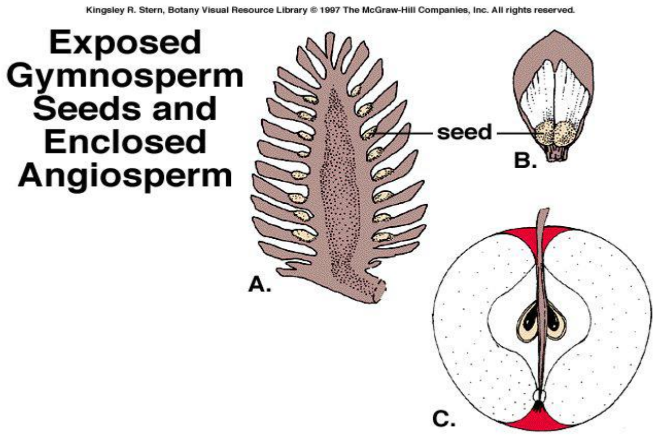
Ginkgo (*Ginkgo biloba*) is one of the oldest living tree species. It is also one of the best-selling herbal supplements in the United States and Europe. Ginkgo has a long history of use in treating blood disorders and memory issues. It is best known today as way to potentially keep your memory sharp.

Angiosperms

The angiosperms are one of the major groups of extant seed plants and arguably the most diverse major extant plant group on the planet, with at least 260,000 living species classified in 453 families. They occupy every habitat on Earth except extreme environments such as the highest mountaintops, the regions immediately surrounding the poles, and the deepest oceans. They live as epiphytes (i.e., living on other plants), as floating and rooted aquatics in both freshwater and marine habitats, and as terrestrial plants that vary tremendously in size, longevity, and overall form. They can be small herbs, parasitic plants, shrubs, vines, lianas, or giant trees. Angiosperms are the most successful and advanced plants on earth.

Evolutionary History of Angiosperms

Angiosperms evolved during the late Cretaceous Period, about 125-100 million years ago. Angiosperms have developed flowers and fruit as ways to attract pollinators and protect their seeds, respectively. Flowers have a wide array of colors, shapes, and smells, all of which are for the purpose of attracting pollinators. Once the egg is fertilized, it grows into a seed that is protected by a fleshy fruit. As angiosperms evolved in the Cretaceous period, many modern groups of insects also appeared, including pollinating insects that drove the evolution of angiosperms; in many instances, flowers and their pollinators have coevolved. Angiosperms did not evolve from gymnosperms, but instead evolved in parallel with the gymnosperms; however, it is unclear as to what type of plant actually gave rise to angiosperms.



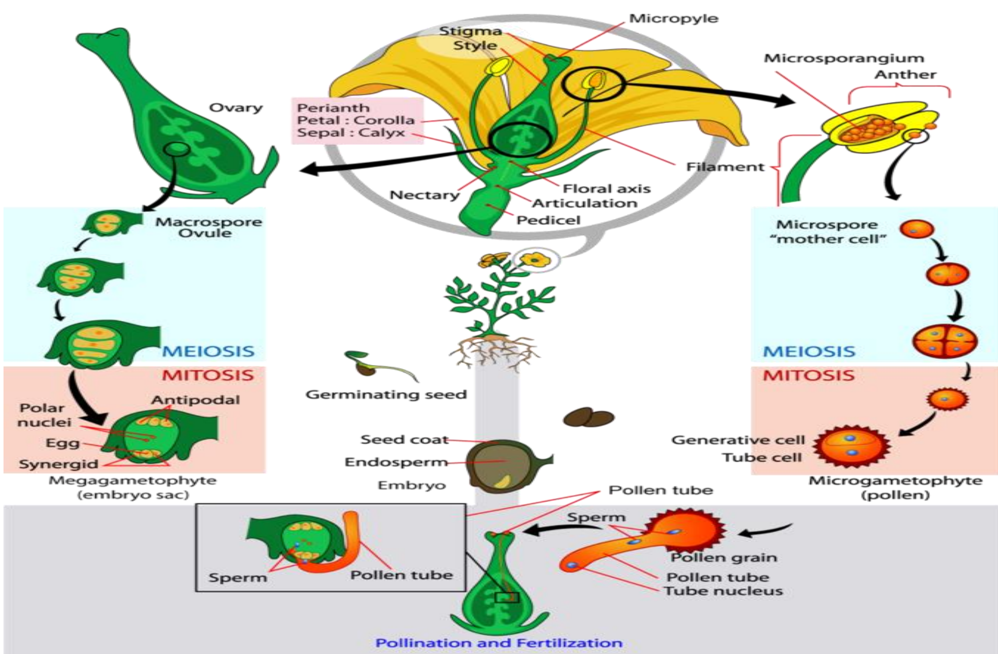
Life Cycle of Angiosperm

1. The adult, or sporophyte, phase is the main phase of an angiosperm's life cycle. As with gymnosperms, angiosperms are heterosporous. Therefore, they generate microspores, which will produce pollen grains as the male gametophytes, and megaspores, which will form an ovule that contains female gametophytes. Inside the anthers' microsporangia, male gametophytes divide by meiosis to generate haploid microspores, which, in turn, undergo mitosis and give rise to pollen grains. Each pollen grain contains two cells: one generative cell that will divide into two sperm and a second cell that will become the pollen tube cell.

2. The ovule, sheltered within the ovary of the carpel, contains the Megasporangium protected by two layers of integuments and the ovary wall. Within each megasporangium, a megasporocyte undergoes meiosis, generating four megaspores: three small and one large. Only the large megaspore survives; it produces the female gametophyte referred to as the embryo sac. The megaspore divides three times to form an eight-cell stage. Four of these cells migrate to each pole of the embryo sac; two come to the equator and will eventually fuse to form a 2n polar nucleus. The three cells away from the egg form antipodals while the two cells closest to the egg become the synergids.

3. The mature embryo sac contains one egg cell, two synergids ("helper" cells), three antipodal cells, and two polar nuclei in a central cell. When a pollen grain reaches the stigma, a pollen tube extends from the grain, grows down the style, and enters through the micropyle, an opening in the integuments of the ovule.

4. A double fertilization event then occurs. One sperm and the egg combine, forming a diploid zygote, the future embryo. The other sperm fuses with the 2n polar nuclei, forming a triploid cell that will develop into the endosperm, which is tissue that serves as a food reserve. The zygote develops into an embryo with a radicle, or small root, and one (monocot) or two (dicot) leaf-like organs called cotyledons.



Comparison of Monocotyledonous and Dicotyledonous plants

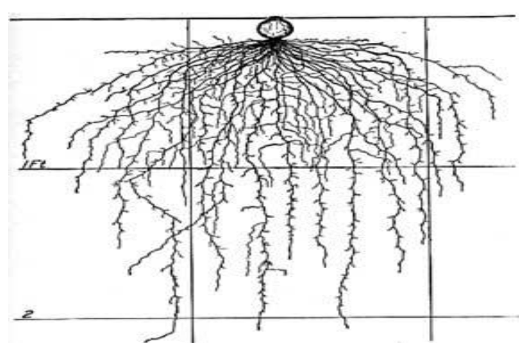
Angiosperms are divided into Monocotyledonous plants and Dicotyledonous plants.

Monocotyledonous plants vs Dicotyledonous plants

Monocotyledonous plants	Dicotyledonous plants
Seeds have a single cotyledon.	Seeds have two cotyledons
Adventitious root system present.	Tap root system present
Leaves have parallel venation.	Leaves have net venation or reticulate venation.
Flowers usually incomplete and trimerous (Floral parts are in the number of threes).	Flowers usually complete and pentamerous (floral parts in the number of fives).
Vascular bundles in stem are numerous and scattered.	Vascular bundles in stem are fewer and arranged in circles or rings.
No cambium, no secondary growth in stem.	Cambium is present, secondary growth occurs.
Stem usually hollow.	Stem usually solid
Seed germination normally hypogeal	Seed germination either hypogeal or epigeal.

Monocots

A monocot is a type of flowering plant that is characterized by having a single cotyledon, trimerous flowers, parallel leaf veins, Scattered, Herbaceous. Monocots have only one seed leaf inside the seed coat. It is often only a thin leaf, because the endosperm to feed the new plant is not inside the seed leaf. Examples (corn, lily, fibrous root etc).



Dicots

A dicot is a type of flowering plant that is characterized by having a two cotyledon, multiple flowers, and no parallel leaf veins. Dicots have two seed leaves inside the seed coat. They are usually rounded and fat, because they contain the endosperm to feed the embryo plant. Examples (bean, oak, tap root etc).

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