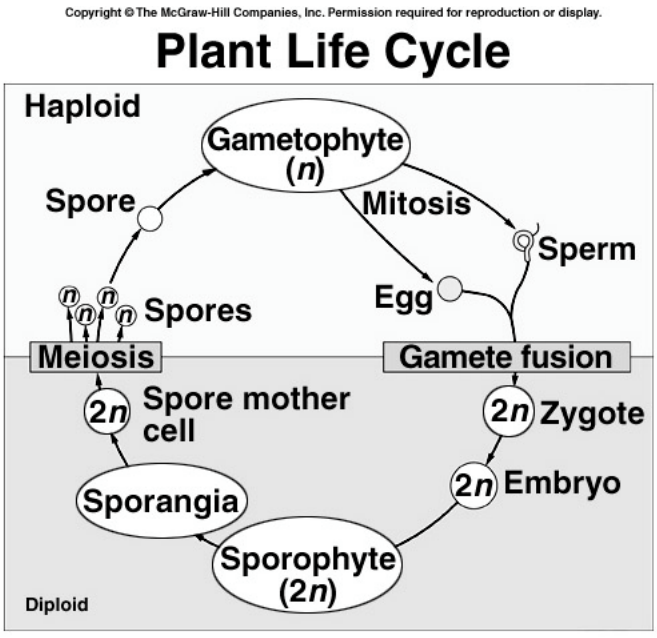
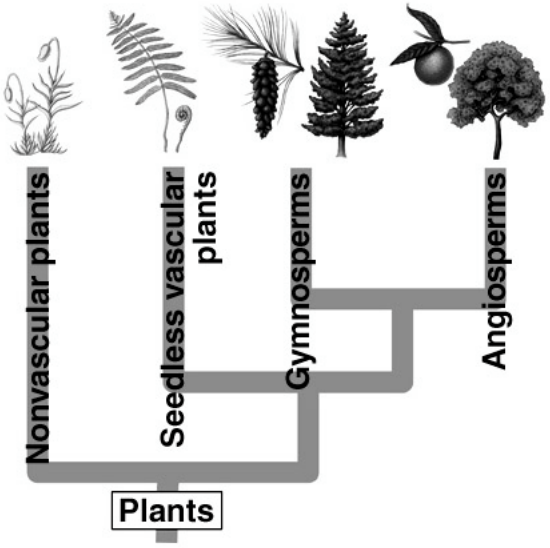
Kingdom Plantae

Characteristics

- chloroplasts with chlorophyll a & b, and carotenoids
- cellulose cell walls
- formation of cell plate during cell division
- starch used for carbohydrate storage
- Life cycle - sporic meiosis or haplodiplonic or alternation of generations
  - diploid stage (sporophyte) and haploid stage (gametophyte) are multicellular
  - dominant stage varies between groups
  - primitive plants - gametophyte is dominant
  - advanced plants - sporophyte is dominant
- primitive plants have poorly developed systems for conducting fluids - nonvascular plants
- more advanced plants (vascular plants) have well developed xylem and phloem for conduction



Major Groups of Plants



Ten phyla of plants

Three nonvascular (without water conducting vessels)
- P. Bryophyta - mosses
- P. Hepaticophyta - liverworts
- P. Anthocerophyta - hornworts

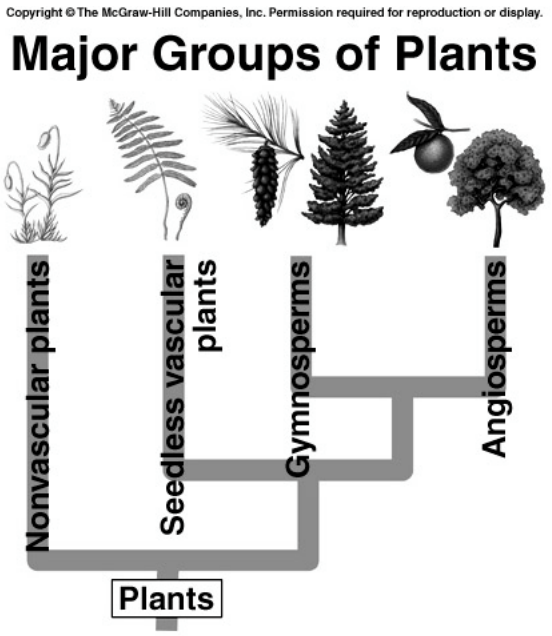
Nine vascular

Two seedless
- P. Pterophyta - ferns, whisk ferns, horsetails
- P. Lycophyta - club mosses

Five seeded
- P. Coniferophyta - conifers
- P. Cycadophyta - cycads
- P. Gnetophyta - gnetophyta
- P. Ginkophyta - ginkgo

this group is called the gymnosperms

- P. Anthophyta - flowering plants - angiosperms



Characteristics of nonvascular plants

lack vessels for conducting water and foodstuffs throughout plant

Gametophytes green, nutritionally independent of, and more conspicuous than sporophyte

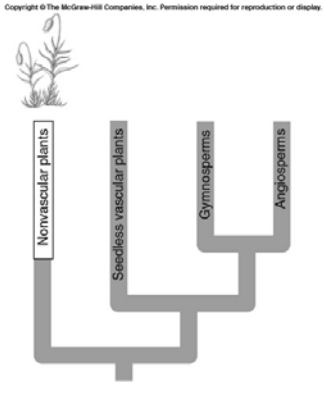
Sporophyte attached to gametophyte, partially nutritionally dependent

Homosporous - spores of equal size

Require external water for fertilization, only common in moist places

In total about 24,700 species

Three Phyla -
Bryophyta (mosses),
Hepaticophyta (liverworts),
Antherocerophyta (hornworts)
collectively called the
"bryophytes"



Terms:

Sporophyte - a multicellular diploid organism that produces spores by meiosis - spores germinate and grow into gametophytes

Gametophyte - a multicellular haploid organism that produces gametes by mitosis can be either male or female, females produce eggs, males produce sperms, fusion of gametes produces a zygote that grow into a multicellular sporophyte

Antheridium - the sperm producing organ of a gametophyte

Archegonium - the egg producing organ of a gametophyte

Homosporous - spores (produced by meiosis) are indistinguishable in size and may give rise to either male or female gametophytes

Heterosporous - spores differ in size
megaspores produce megagametophytes, which produce eggs
microspores produce microgametophytes, which produce sperms
fusion of an egg and sperm produces a zygote that can grow into a multicellular sporophyte

Phylum Bryophyta - mosses

Gametophytes small, spiral or alternate arranged leaves on central axis

Sporophytes grow as stalk from gametophyte

Anchored to substrate by rootlike rhizoids

Consists of several cells that absorb water

Leaves superficially resemble true leaves
green, flattened blade, slightly thickened midrib
one cell thick, lack vascular strands and stomata

Most water used by plant travels up on outside of plant, via capillary action

Some have specialized food conducting cells

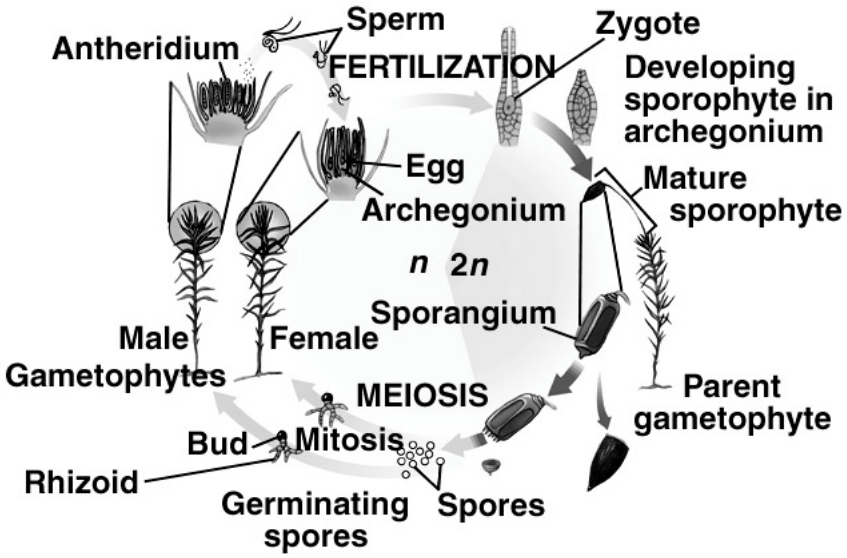
Can withstand long periods of drying

Most abundant plants in Arctic and Antarctic, rare in deserts

Mosses are sensitive to pollutants

Poor competitors in environments favorable to growth of higher plants

Moss Life Cycle



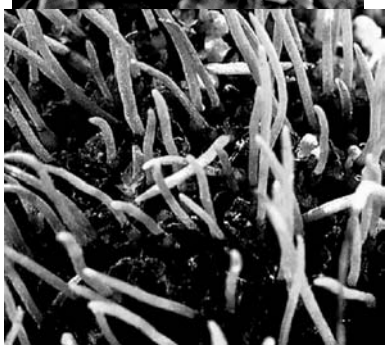
Other "bryophytes"

Phylum Hepaticophyta - Liverworts

similar reproduction to mosses

Phylum Anthocerotophyta Hornworts

among earliest land plants
Sporophyte has stomata, is photosynthetic, and provides much of plant's energy.



Vascular Plants - have vessels (tubes composed of elongated or cylindrical cells) for conducting water and food

xylem - conducts water from roots to leaves

phloem - conducts carbohydrates in solution from areas of photosynthesis (leaves) to support nonphotosynthetic areas roots, growing shoots, etc.

have a waxy cuticle over leaves to prevent water loss

have stomata (pores) in leaves for gas exchange

all have greater importance and increased size of sporophyte in life cycle than seen in bryophytes

Vascular plants divided into seedless and seeded

seed - resistant structures suited to protect an embryo from drought.

Seedless Vascular Plants -

increased importance of sporophyte in life cycle

large sporophyte nutritionally independent of small gametophyte

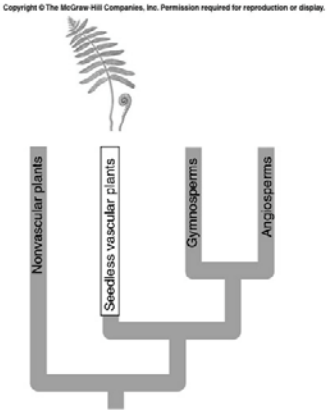
most are homosporous, spores produce gametophytes that produce sperm in antheridia and eggs in archegonia

swimming sperm, require water for fertilization

Two Phyla

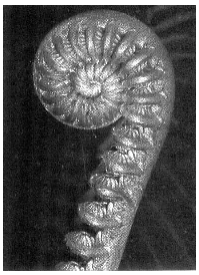
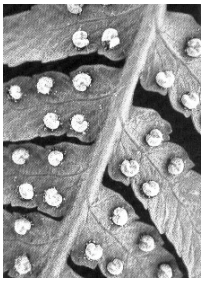
Pterophyta (ferns, whisk ferns, horsetails)
11,000 spp.

Lycophyta (club mosses)
1150 spp.



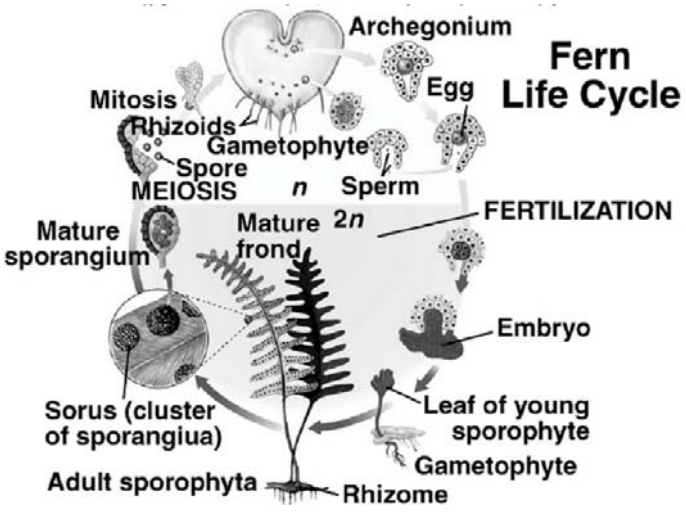
Phylum Pterophyta - the ferns, whiskferns, horsetails

Ferns: both sporophyte and gametophyte are photosynthetic
sporophyte is large with leaves (fronds)
gametophyte (prothallus) is small, one cell thick, heart-shaped
sporophyte has well developed roots, stems, and leaves
stems are underground - called rhizomes
leaves develop from rhizomes - "fiddleheads" - coiled leaves
leaves can possess spore producing sporangia
sporangia are commonly found in clusters (sori)
a cap (indusium) commonly covers immature sorus

Fern reproduction:

sporangia produce spores, germinate to produce prothalli,
prothalli produces eggs in archegonia, sperms in antheridia
sperm swim to eggs for fertilization,
sporophyte grows from archegonium as gametophyte dies



Whisk Ferns

remnants of earliest vascular plants

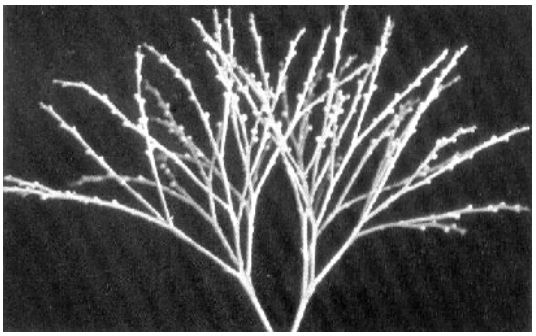
sporophyte consists of branching green stems

lack roots or leaves

Gametophytes found in soil beneath sporophytes

Colorless, filamentous form

Have saprobic or parasitic associations with fungi to obtain nutrients



Horsetails

Commonly called scouring rushes, "cajun kudzu"

A single genus, *Equisetum*

worldwide, mostly in damp places

Sporophytes are ribbed, jointed stems

Arise from underground rhizomes

Whorl of scalelike leaves at each stem node

Stems are hollow, contain silica deposits in epidermal cells

Two groups - branched and unbranched

branched form resembles a horse's tail

Spores have two ribbonlike elaters (wings)

aid in spore dispersal when dry

curl around spore when damp

Gametophytes are small

Numerous flagellated sperm swim to archegonia

Phylum Lycophyta: Club Mosses

Worldwide, most common in tropics & moist temperate regions
Resemble mosses, clearly different in internal structures
Sporophytes have leafy stems

Lycopodium is typical
- Sporangia produced in cone-like clusters on stems or in upper leaves
- Leaves (microphylls) are short, linear and in whorls or spirals
- *Lycopodium* gametophytes are tiny and carrot-shaped

some club mosses are used as ornaments (e.g. resurrection plant) many are now endangered species

Seed Plants

first appear in fossil record in rocks dating to about 425 million years old -

Seeds: have protective seed coat, protects embryo from drying out, from predators, provides for food storage for embryonic plant, many have adaptations for dispersal

All heterosporous, gametophyte dependent upon sporophyte
Microgametophytes are called pollen and contain sperm
Megagametophytes are multicellular, contain an egg, and are found within an ovule on the sporophyte
Pollination precedes fertilization and fertilization may be delayed

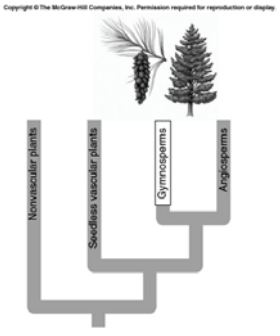
Divided into two informal groups
- gymnosperms (naked seeds) - ovule not enclosed in sporophyte tissue when first formed (ovule is naked)
- angiosperms (covered seeds) - ovule enclosed in sporophyte tissue when first formed (ovule is enclosed)

Gymnosperms comprise 4 phyla
- Coniferophyta (conifers) - 601 spp.
- Cycadophyta (cycads) - 206 spp.
- Gnetophyta (gnetophytes) - 65 spp.
- Ginkophyta (ginkgo) - 1 sp.

Ovule rests on exposed scale - "naked"

Seed may be covered with sporophyte tissue at maturity

Sperm may be flagellated but is delivered within pollen grain



Phylum Coniferophyta - the conifers

Includes pine, spruce, fir, hemlock and cypress
Redwood is tallest plant, bristlecone pine is oldest
Found in cooler, temperate, drier regions of world
Great economic value, timber, paper, resins, turpentine
One hundred species native to northern hemisphere

Most have needle-like leaves, in clusters of two to five needles - tough needles retard loss of water
have resins that deter insect and fungal attack
Wood consists primarily of tracheids
Lack vessels or fibers
absence of fibers causes wood to be "soft"
Thick bark is an adaptation to survive fires and subzero temperatures

Conifer reproduction:

heterosporous

Pollen grains produced in male cones, cluster at tips of lower branches

Male cones composed of small, papery scales arranged in spiral or whorl

Pair of microsporangia form within each scale

Microspore mother cells undergo meiosis, form four microspores

Microspores develop into 4-celled pollen grains with pair of air sacs

Conifer reproduction:

Female cones produced on upper branches

Larger than male cones, scales become woody at maturity

Two ovules develop toward base of each scale

Ovule contains megasporangium embedded in nutritive nucellus

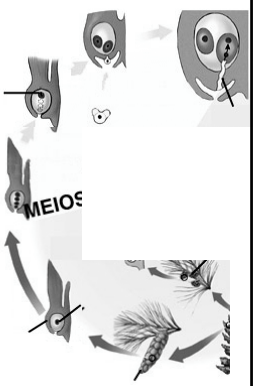
Nucellus completely surrounded by thick integument, opening called micropyle

One integument layer becomes seed coat

Single megaspore mother cells undergoes meiosis, forms row of four megaspores

Three break down, one develops into female gametophyte

Each gametophyte produces two to six archegonia, each contains an egg



Conifer reproduction:

Female cones may take two or more years to mature

During first spring are green, with scales spread apart

Pollen grains carried by wind, catch on fluid oozing out of micropyle

Pollen grains drawn through micropyle to top of nucellus

Scales then close

Archegonia and other female parts not mature for another year

Pollen tube emerges from pollen grain at bottom of micropyle

Digests through nucellus into archegonia

Conifer reproduction:

Pollen's generative cell divides by mitosis, one cell divides again

Last two cells function as sperm

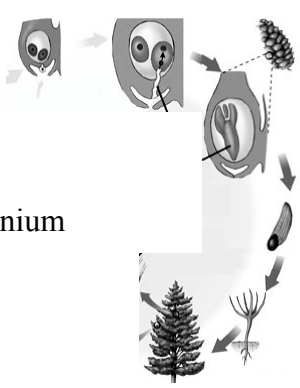
Mature male gametophyte is germinated pollen grain = pollen tube + two sperm

In 15 months pollen tube reaches an archegonium

Discharges contents into it

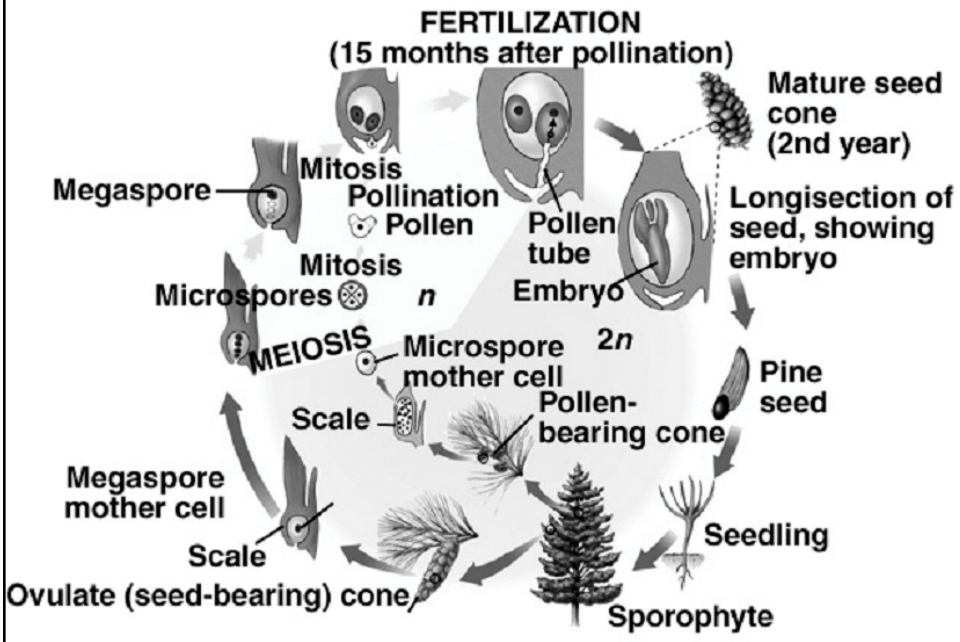
One sperm unites with egg forming zygote

Other sperm and other cells degenerate



Zygote develops into embryo within a seed

Seed disperses, germinates, grows into new sporophyte tree



Phylum Cycadophyta: Cycads
Slow growing, found in tropics and subtropics
Cycads resemble pines, ferns and palms

Reproduction
Produce cones, have life cycle similar to pines
Female cones develop upright among leaf bases
Sperm have thousands of spirally arranged flagella
Sperm conveyed to archegonium by pollen tube
Several species facing extinction
Sago palm is used in landscaping

Phylum Gnetophyta: Gnetophytes
Closest living relative of angiosperms
They sre the only gymnosperms with vessels in their xylem
Gnetophytes differ greatly from one another
Welwitschia stem shaped like large, shallow cup
- Tapers into tap root
- Two strap-shaped, leathery leaves that grow continuously
- Reproductive structures are cone-like, appear at bases of leaves
- Produced on separate male and female plants

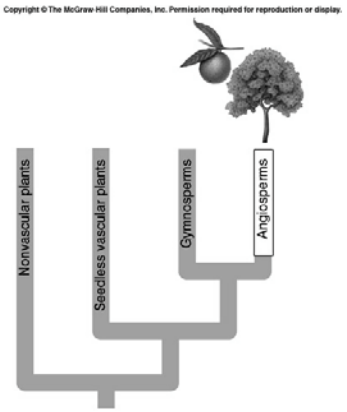
Ephedra comprises more than 35 species
- Common in arid regions of U.S and Mexico
- Shrubby plants with jointed stems, scalelike leaves at each node
- Natural source for drug ephedrine

Phylum Ginkgophyta: Ginkgo
Fossils show species once widely distributed
Only one species remains: *Ginkgo biloba*
Historically found in Japan and China
Commonly used in landscaping but no longer exists in wild
Fan-shaped leaves resemble leaflets of fern
Reproductive features
- Sperm have flagella
- Reproductive structures produced on separate trees
- Fruits have foul odor
- Male plants generally planted, propagated from shoots
- Very resistant to air pollution, often planted in cities

Angiosperms - one phylum

Phylum Anthophyta - flowering plants - 250,000 spp.
Flowers, heterosporous, double fertilization
ovule and seeds enclosed in sporophytic tissue - carpel
at maturity carpels form fruit around seed

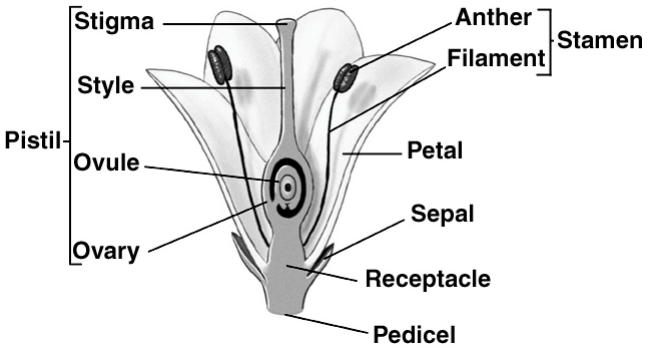
Great variety:
huge trees, tiny duckweed,
microscopic seeds to
coconuts
mostly photosynthetic
autotrophs, some parasitic



Flower structure:
modified stems bearing modified leaves
base is pedicel, with receptacle, to which all other parts attach
four whorls of modified leaves: calyx composed of sepals,
corolla composed of petals,
androecium composed of stamens,
gynoecium composed of carpels or pistils

Ovary completely encloses ovule

Stigma is to accept pollen
Anther produces pollen
Many flowers produce nectar

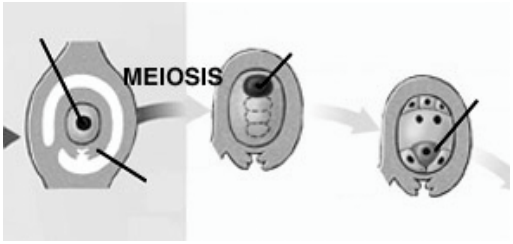


Angiosperm life cycle

Megaspore mother cell produces four cells via meiosis
Three disintegrate, one survives, divides mitotically
Each daughter nucleus divides twice resulting in eight haploid nuclei - arranged in two groups of four
One nucleus from each group migrates to center - polar nuclei
Cell membranes and walls form around remaining nuclei
Cell closest to micropyle functions as egg - others called synergids

Integument layers become seed coat - with small opening - micropyle

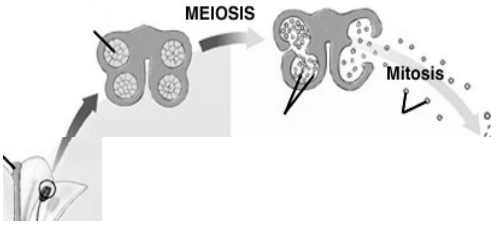
The mature female gametophyte is called an embryo sac - with eight nuclei in seven cells



Angiosperm life cycle

Male gametophyte develops in the anthers
Anthers have four patches of tissue
Each patch composed of many diploid microspore mother cells
- Undergo meiosis to produce four microspores each
- Nucleus of each divides once by mitosis
- Two layered wall develops around each microspore
- Binucleate microspores are now pollen grains
- Outer layer called exine, sculpted, contains chemicals

May also have apertures through which pollen tube may emerge



Pollination:

The movement of pollen from the anther to the stigma

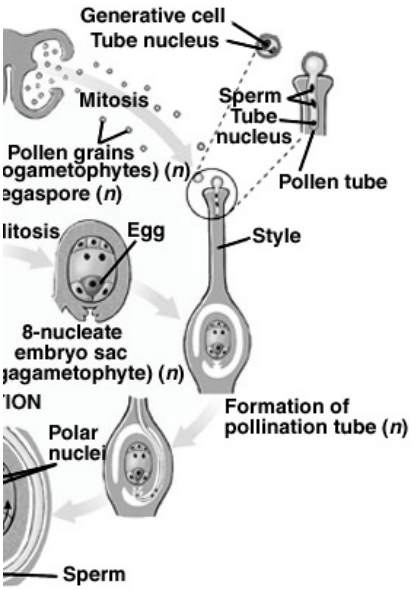
Pollen grain contains two nuclei:
- tube nucleus
- generative nucleus

Tube nucleus begins formation of pollen tube - extends into style

Generative nucleus follows and divides to form two sperm nuclei - pollen now considered mature gametophyte

Tube nucleus enters embryo sac at micropyle

Sperm nuclei follow

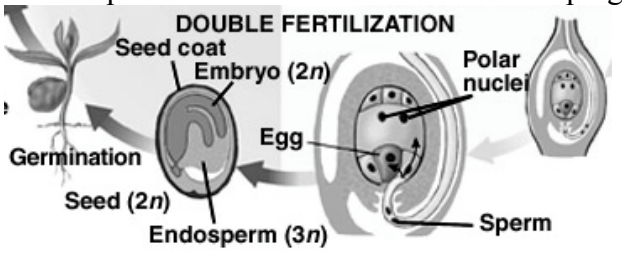


Double fertilization:

One sperm nucleus fuses with egg to form zygote

The other sperm nucleus fuses with both polar nuclei to form triploid (3N) endosperm nucleus

Endosperm multiplies to serve as nutrition for developing embryo



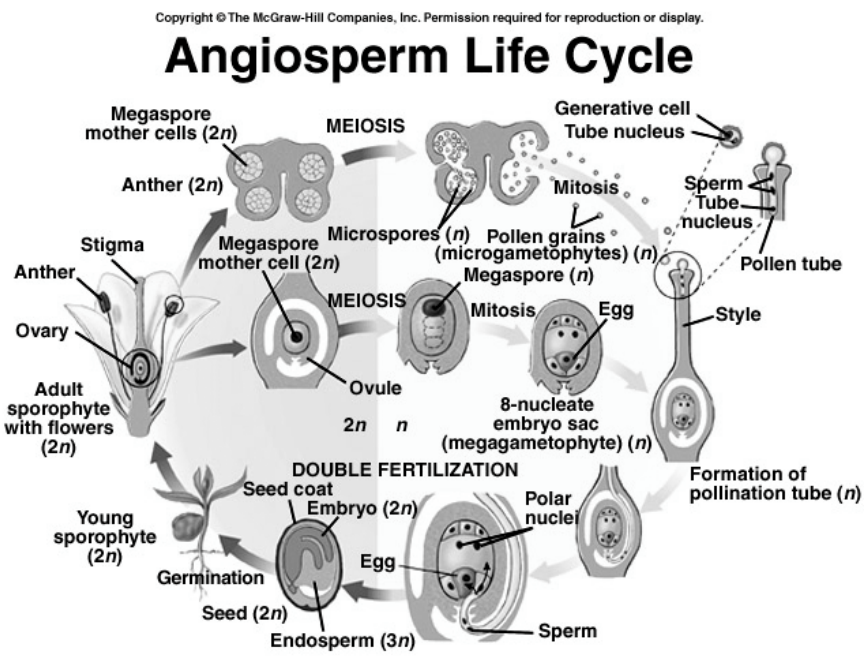
Seed consists of:

diploid embryo - derived from a sperm and egg

triploid endosperm - derived from a sperm and two polar nuclei

diploid seed coat - derived from sporophyte parent

Fruit develops from ovary - is derived from sporophyte parent



Angiosperm success:

First appeared about 200 million years ago (Jurassic) and became dominant plant group by the end of the Cretaceous (70 million yeas ago).

First pollinating insects appeared about 50 million years ago.

Flowers attract pollinators and allow more efficient dispersal of pollen

Fruits protect seeds and aid in seed dispersal

Endosperm provides additional nutrition for developing embryo

Classes of Angiosperms:

Class Monocotyledonae - “monocots” - 65,000 spp. - lilies, grasses, palms, agaves, yuccas, orchids, irises, bananas

Class Dicotyledonae - “dicots” - 175,000 spp. - most familiar flowering plants - most trees and shrubs, most familiar flowers and garden plants

Monocots:
one cotyledon - “seed leaf”
parallel venation in leaves
lateral meristems rare - no lateral growth
flower parts in multiples of 3
few annual species
many with bulbs or underground storage organs
no true wood (secondary xylem)

Dicots:
two cotyledons
netted venation in leaves
lateral meristems common
flower parts in multiples of 4 or 5
many annual species
few underground storage organs
true wood in many species