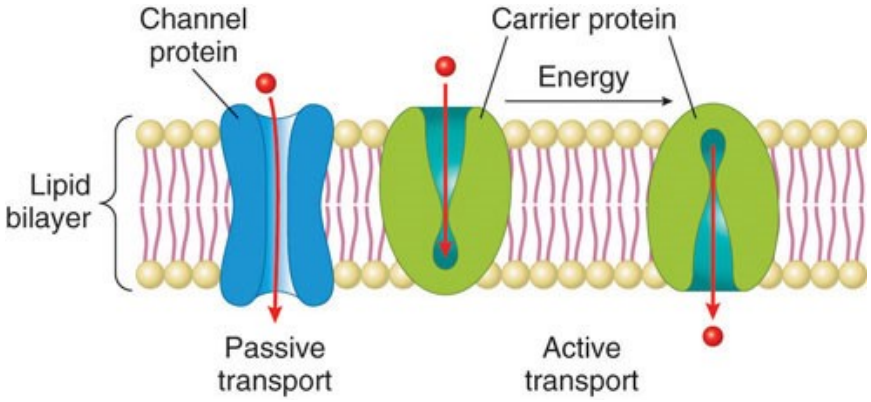
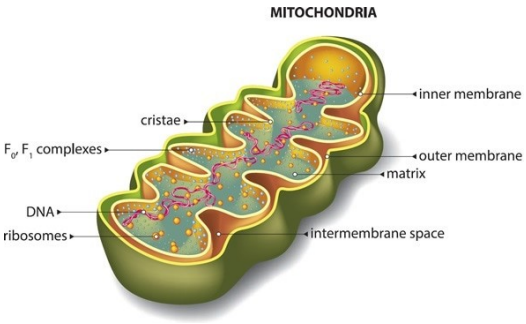
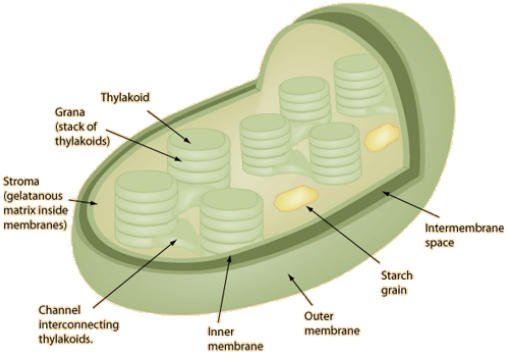
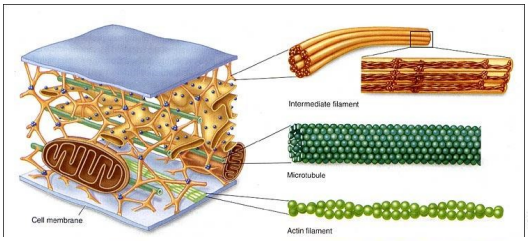
BIOL 004

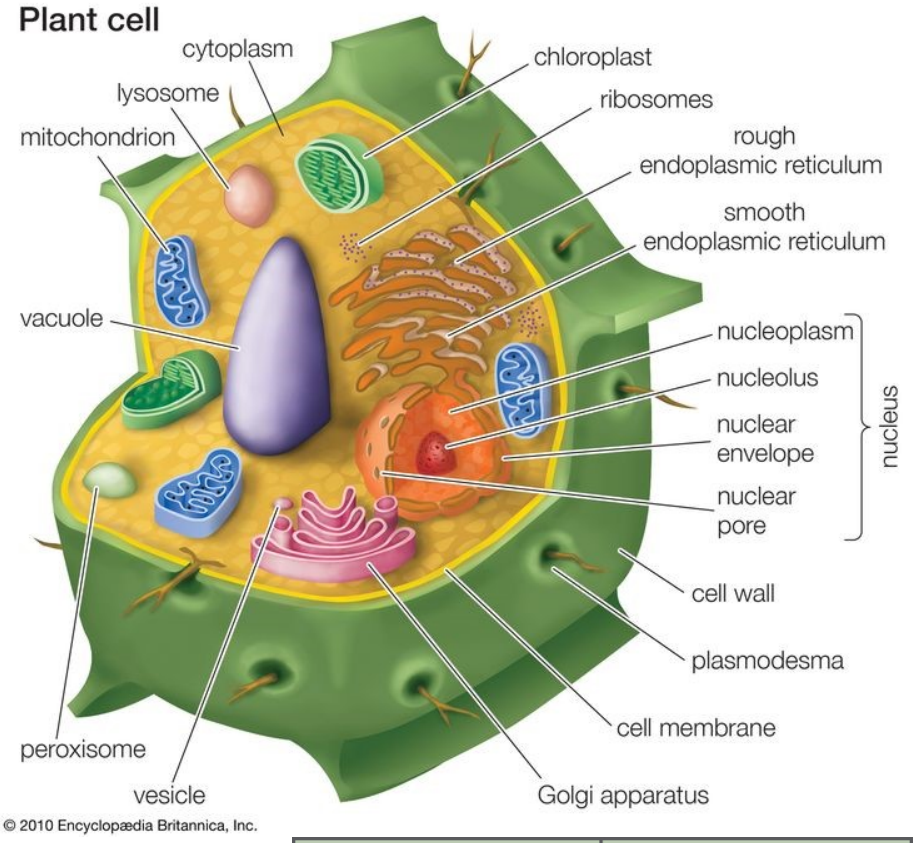
Plant Biology

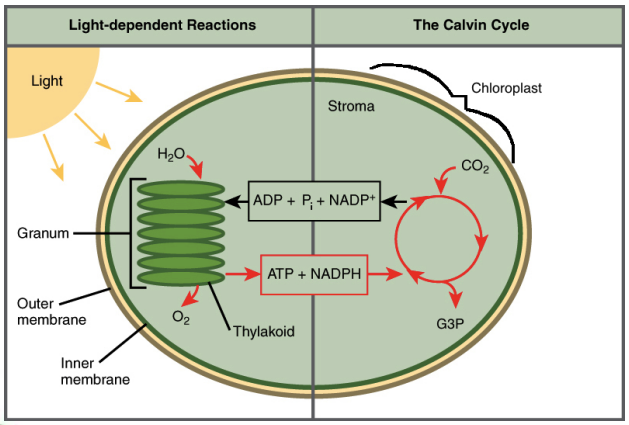


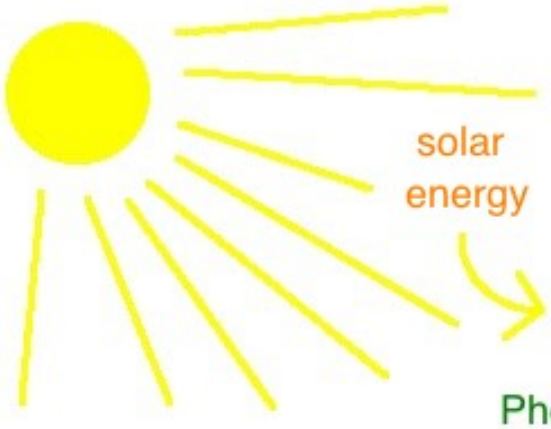












Photosynthesis

$$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

carbon dioxide — water — glucose — oxygen

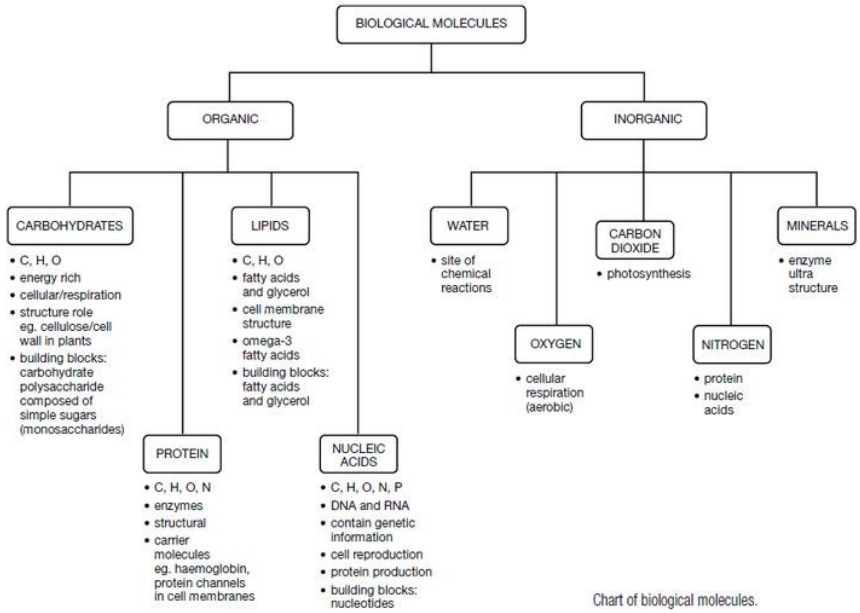
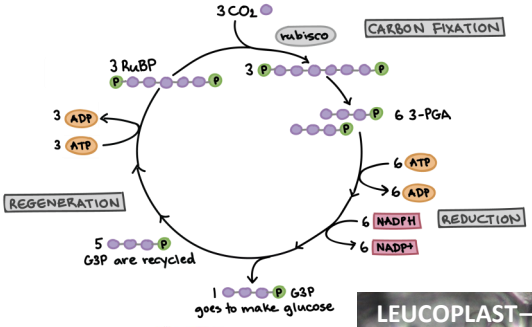
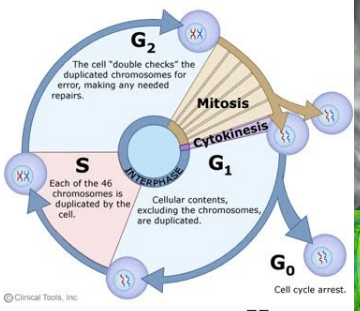
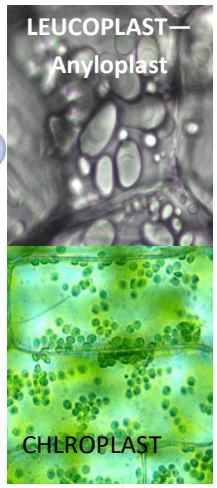


Chart of biological molecules.

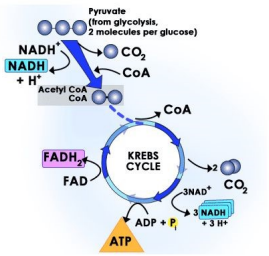


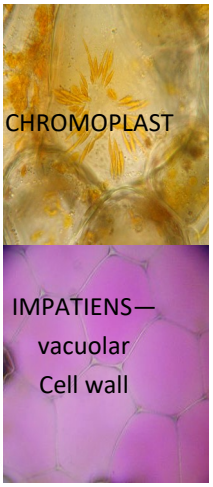


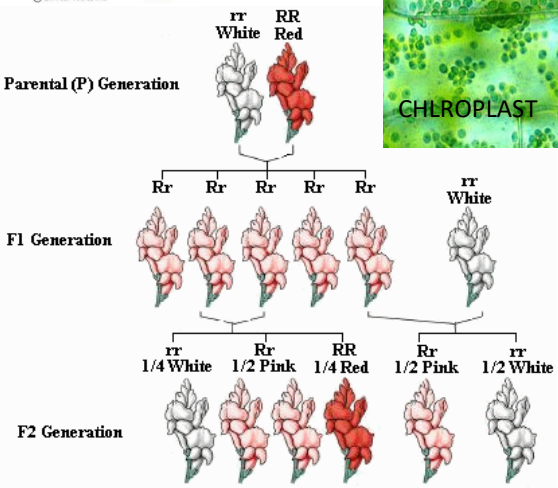


Krebs Cycle

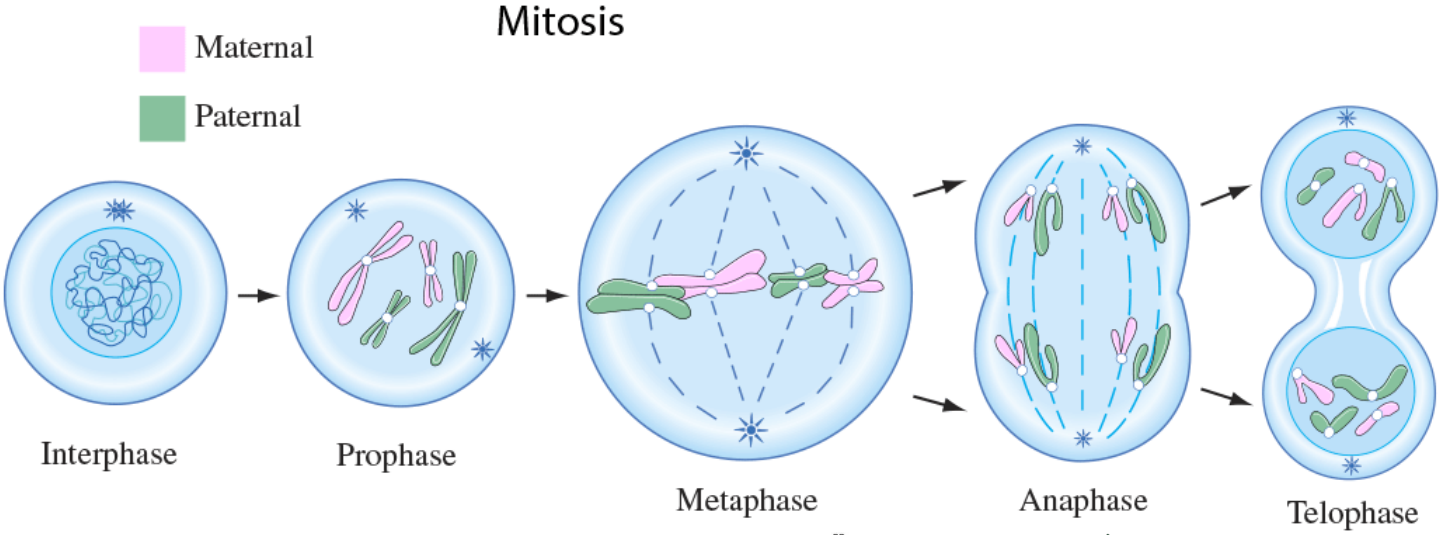
- In the mitochondria
- Also known as the citric acid cycle
- Pyruvic acid is broken down into carbon dioxide in a series of energy extracting reactions
- 2 Pyruvic Acid (enters mitochondria) → 2 Acetyl-CoA + 2 CO_2 + 2NADH
- Acetyl-CoA enters innermitochondrial membrane and is converted to citric acid
- Final products of Krebs cycle
  - 6 NADH
  - 2 $FADH_2$ (electron carrier)
  - 2 ATP
  - 2 CO_2

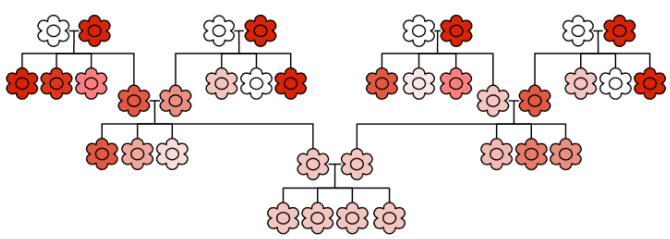


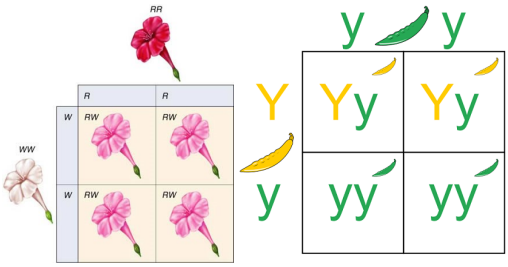


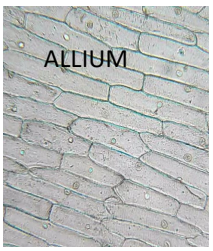


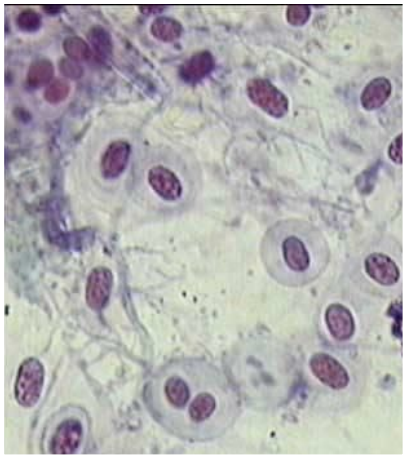
Mitosis











Gleocapsa

PROKARYOTES

Bacteria invented respiration, photosynthesis, etc.

Most abundant living thing on earth

Metabolically diverse

Small

Prokaryotic

Cell wall made up of **peptidoglycan**—protein sugar complex.

Most bacteria are Heterotrophic: eat dead stuff—decaying organic matter.

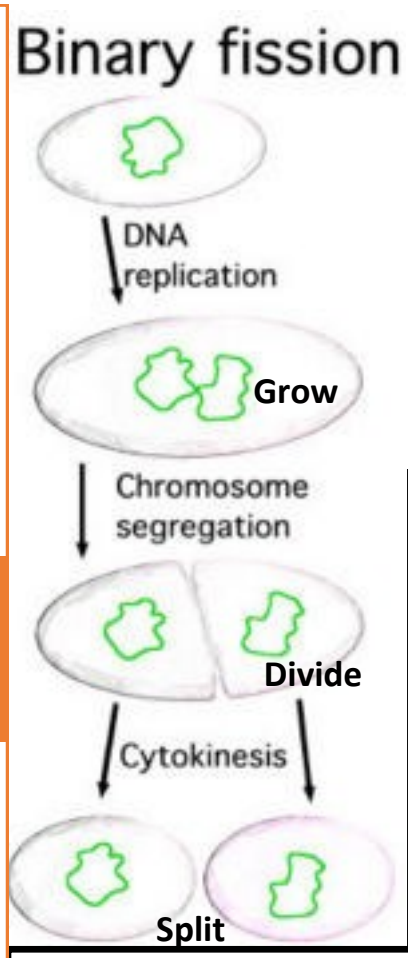
Chemoautotrophs use sulfer compounds as their food supply.

Cyanobacteria has chlorophyll a. accessory pigments: phycosyanin, phycoerythrin.

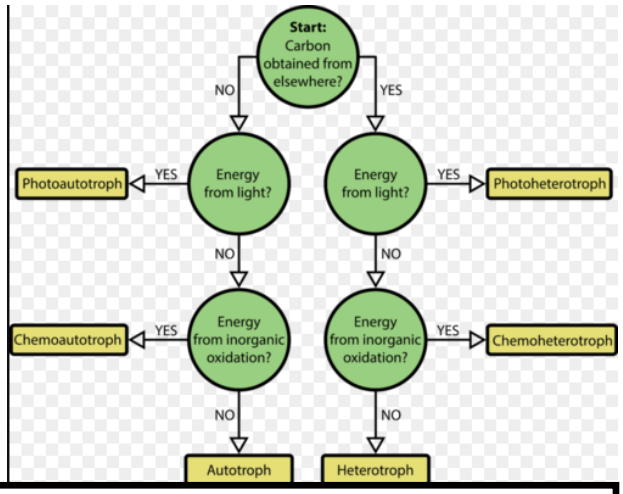
COCCI—Spheres

BACCILII—Cylindrical

SPIRILLI—Spirals.



EXAM II



Akinete: A vegetative cell that is transformed into a thick walled resistant spore in cyanobacteria

Autotroph: able to synthesize the nutritive substance it requires from inorganic substances in its environment.

Bacillus: rod-shapped bacterium

Coccus: A spherical bacterium

Heterocust: different bag. Perform nitrogen fixation. (LEGUMES).

Peptidoglycan: sugars & amino acids that form a cell wall.

Phycobilins: a group of water-soluble accessory pigments, including phococyanins and phycoerythrin. Found in the red algae and cyanobacteria.

Phycoerythrin: red pigment

Phycocyanin: blue pigment.

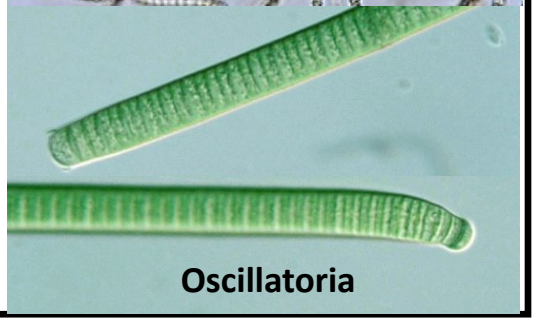
Spirillum: a long coiled or spiral bacterium.

Strict anaerobe: an anaerobe that is killed by oxygen. Can live only in the absence of oxygen.

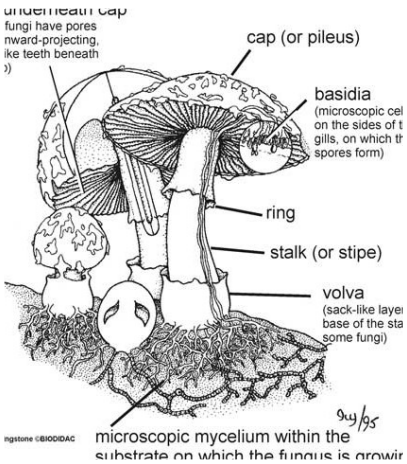
Viruses: Not alive, cannot replicate.

Endosymbiont theory: they live together to benefit both. Evidence: structural contain their DNA. A cell was engulfed and became an organelle.

Nostoc—Akinete/Heterocyst



Oscillatoria



FUNGI

Multicellular

Heterotrophic

All are Heterotrophic: They get nutrients from other things.

Mainly <u>saprobes</u>—decompose things

Some are parasitic.

Mostly terrestrial.

Mostly filamentous.

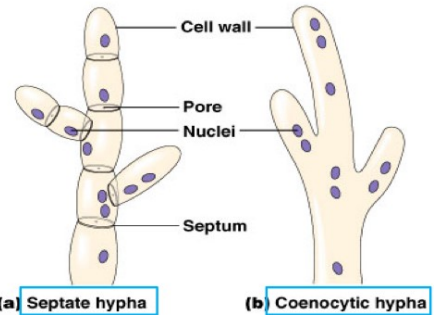
Hypheae: fungi fillaments—only grow at the tips, and spread fast.

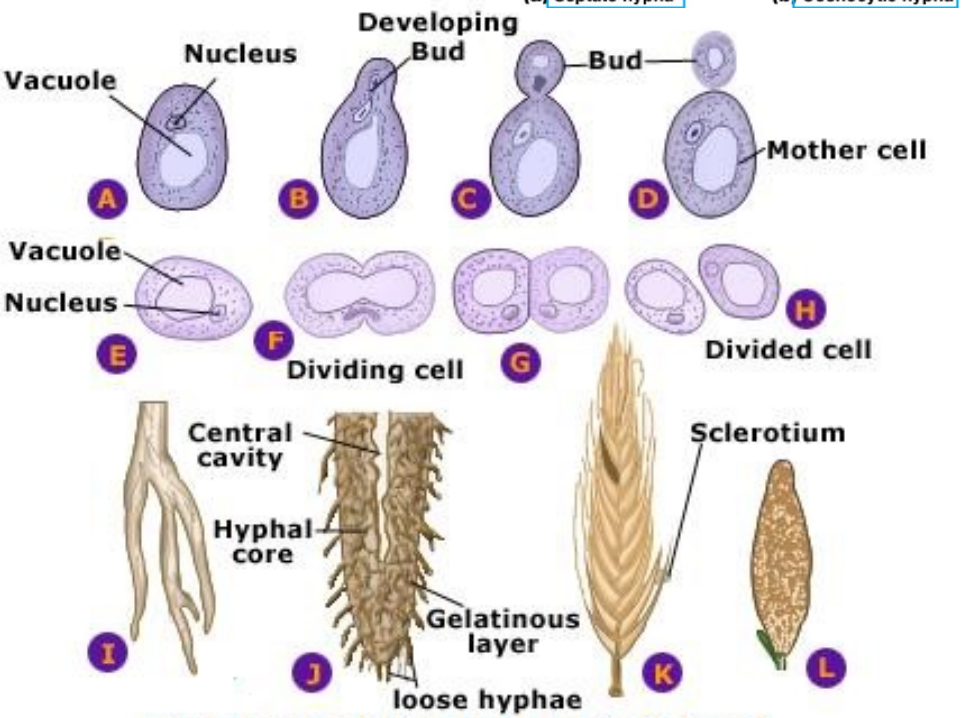
Mycelium: mass of hyphae.

Haustoria: parasitic hyphae (invade host)

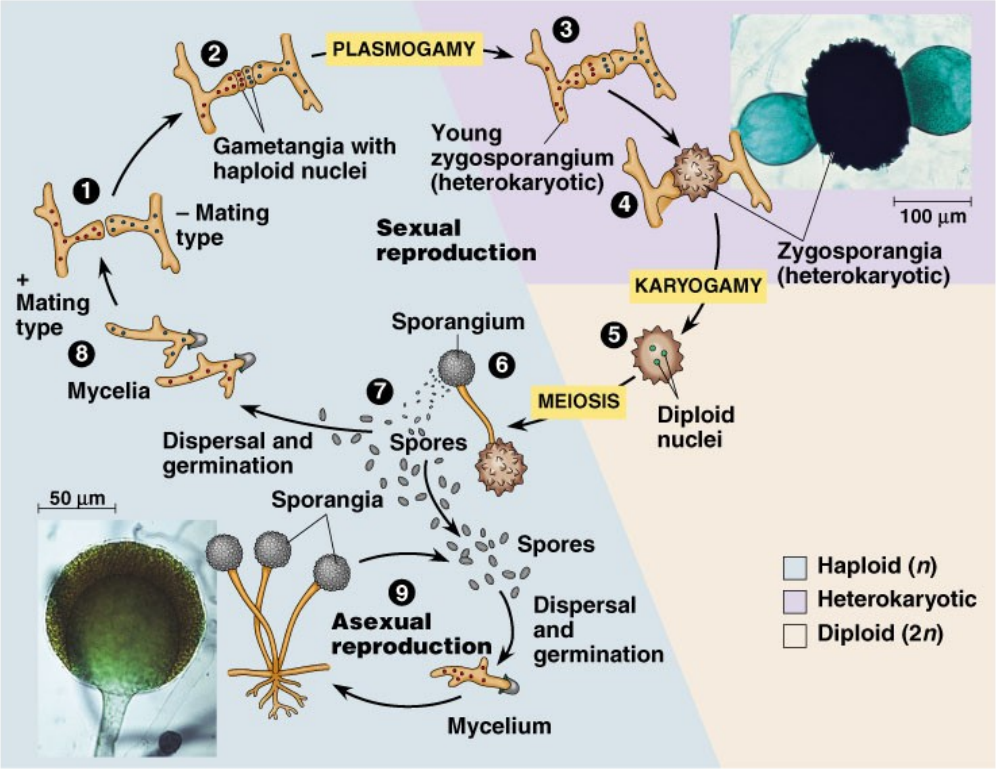
Reproduction: sexually and asexual. no genders (+ -)

DOMAIN: EUKARYA Kingdome: Fungi
ZYGOMYCOTA
ASCOMYCOTA
DEUTEROMYEOTA
BASIDIOMYEOTA





Modes of vegetative reproduction in fungi.
A-D. Budding. E-H. Fission. I-J. Rhizomorph; K-I. Sclerotia



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ZYGOMYCOTA

MOLD

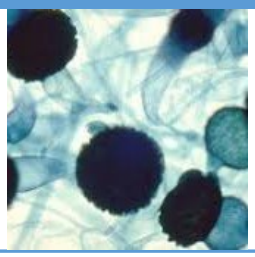
1060 spp

Some are parasitic.

Characterized by : Hyphae

Coenocutin (without + cell) no cross walls

Cell wall is made of chitin (no plants make this)



Hypal tip

Zygospore

ASCOMYCOTA

(YEAST)

33000 spp

Powdery mildew

Dutch elm disease

Chestnut blight

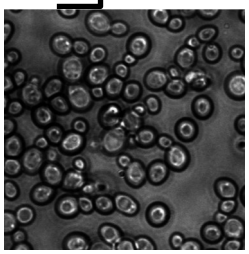
Truffles, morels

Ascoma produce asci, and that produces asciospores..

GROUP: Yeast—SACCHAROMYCES

Saccharomyces (sugar + fungus)

Cerevisiae C6H12O6—ethanol + Co2 (gas which makes it rise)



Mycelium: the fungal component of lichen.

Pileus: cap.

Rhizoid: extensions of fungi and algae that absorb water, food and nutrients.

Septate: divided across walls into cells or compartments.

Stripe: stalk. A supporting stalk, such as the stalk of a gill fungus.

Zygospore: The diploid (2n) cell resulting from the fusion of male and female gamets.

Ascus: A specialized cell, characteristic of the ascomycetes, in which two haploid nuclei fuse to produce a zygote that immediately divides by meiosis; at maturity, an ascus contains ascospores.

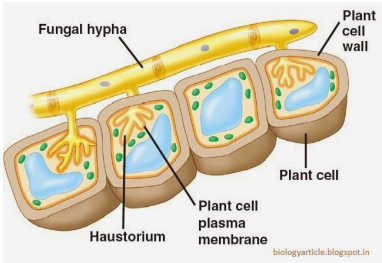
Basidioma: A multicellular structure, characteristic of the basidiomycetes, within which basidia are formed.

Basidium: A specialized reproductive cell of the Basidiomycota, often club-shaped, in which nuclear fusion and meiosis occur.

Conidia: An asexual fungal spore not contained within a sporangium; may be produced singly or in chains; most conidia are multinucleate.

Haustoria: “to drink” A projection of a fungal hypha that functions as a penetrating and absorbing organ.

Mycorrhizae: fungus + root. Finder’s fee.



DEUTEROMYEOTA

FUNGI IMPERFECTI

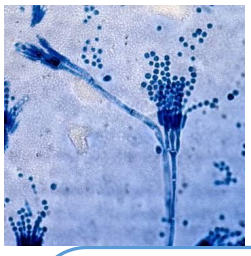
15000 SPP

Don't have a sexual phase we can look at. "conidial fungi—asexual spores.

PENICILLIUM

Conidia

conidi-
oshoria

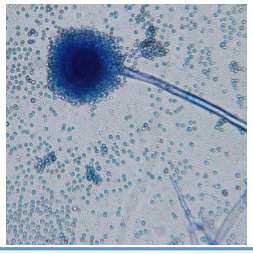


Source of 1st antibiotics

Cheese

ASPERGUILLUS

Conidial



Soy fermentation

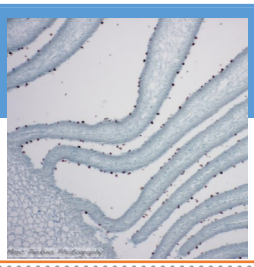
BASIDIOMYCOTA

25000 spp

(mushrooms)

Sexual structures:

Basidioma—basidium—basiospore



Basidiospores

Gills

AGARICUS:

Hymenomycetes

All the mushrooms

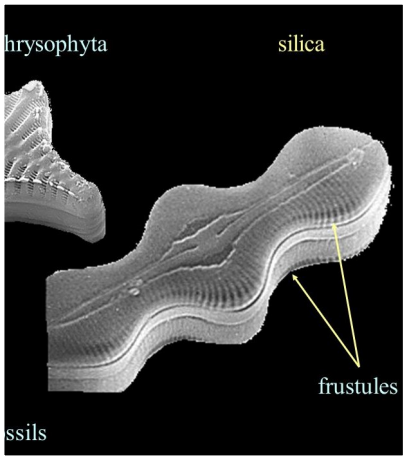
Teliomycetes

Wheat rust, smuts, corn.

Puccinia graminis

MYCORRHIZAE—(finders fee)

1. Endomycorrhizae: zugomycota (200 spp). 80% of all land plants. Hyphae grow into host cells
2. Ectomycorrhizae: hyphae form net around host cells.



PROTISTA

The Garbage Dump

Agar: A gelatinous substance derived from certainred algae: used as a solidigying agent in the preparation of nutrient media for the growth of microorganisms.

Alginic acids: an important polysaccharide component of brown algal walls.

Chrysolaminarin: The storage product of the chrysophytes and diatoms.

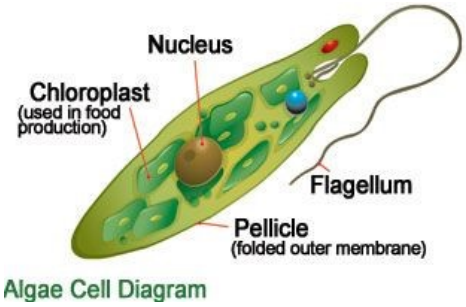
Fucoxanthin: seaweed + yellowish-brown.

Kelp: A common name for any of the larger members of the order Laminariales of the brown algae.

Mannitol: One of the storage molecules of the brown algae; an alcohol.

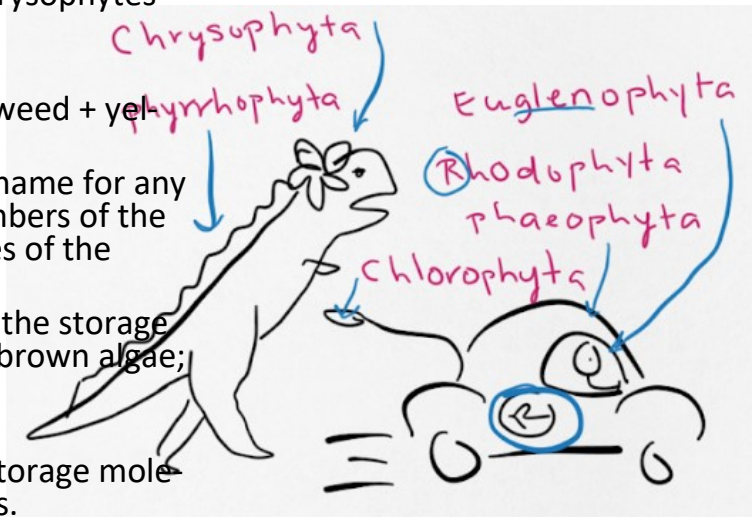
Paramylon: The storage molecule of euglenoids.

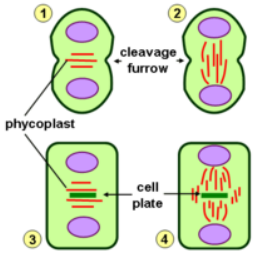
Plankton: Free-floating, mostly microscopic, aquatic organisms.

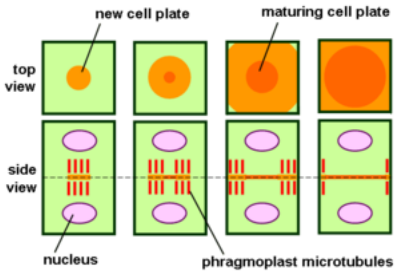


Starch: to stiffen. A complex insoluble carbohydrate; the chief food storage substance of plants; composed of thousands or more glucose units.

Saxitoxin: algae bloom PST in shellfish







Algae

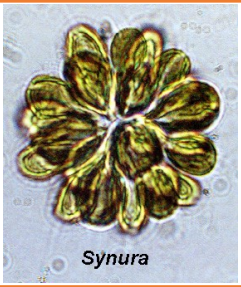
Mainly unicellular, mostly aquatic. Algae=photosynthetic Protista.

CHRYSOPHYTA

Photosynthetic. Marine & Fresh Water. Chlorophyll a & c. Carotenoids—accessory pigment; fucoxanthic (golden brown). Storage product :Chrysolaminarin (glucose polymer)

Chrysophyceae

"Golden Algae" Fresh water, cold & unpolluted. Mostly asexual reproduction (typically spores).



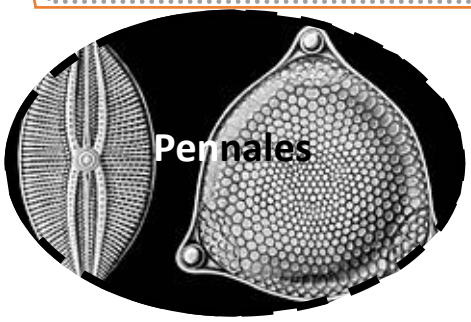
Xanthophyceae

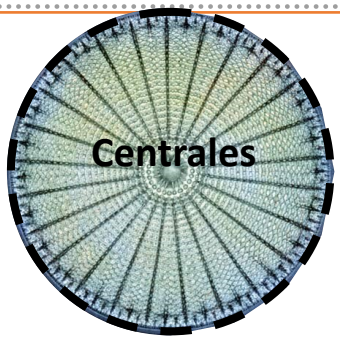
Coenocytic (Without + cell) filament . Lack fucoxenthin. Yellow-green algae. Non0motile, but swimming gametes uaucheria.

Chloroplast

Bacillariophyceae (diatoms)

Chlorophill a & c. Cell wall—silica (main component in glass) =frustule. Non-motive (float to tope during the day) mostly marine. Orders: (P) bilateral symmetry (C)_radial symmetry.



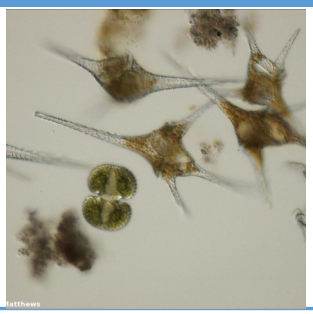


PYRRHOPHYTA (DINOPHYTA)

Mostly marine, unicellular. Chl a & c. Well wall: naked cellulose plates **(theca).** Carotenoids—peridinin. Storage: Starch. DNA always condenses—unlike interphase.

Peridinin is a light-harvesting apocarotenoid, a pigment associated with chlorophyll and found in theperidinin-chlorophyll-protein (PCP)

Ceratium



Anterion flagellum

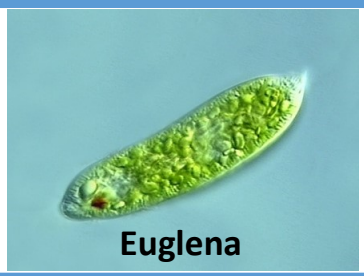
nucleus

Noctiluca.

EUGLENOPHYTA

FW. 1/3 are photosynthetic. No cell wall—has pellicle. It forms proteinaceous strips that supports plasma membrane from inside. No known sexual reproduction. Asexual.

Paramylon: The storage molecule of euglenoids.



Euglena

Nucleus

RHODOPHYTA

"red Algae", mostly marine. Only chl. A and have **phycobilins.** Storage: **Floridean starch** (like glucogen) Cell wall– inner (cellular) outer, mucilaginous, agar + carrageenan (holds h2O) **Coral.**

Polysiphonia

tetrespores

Tetrasporophyte

Carpospor(ophyte)angiom

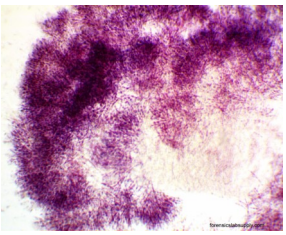
Spermatangia

spermatia

Nemalion

HYPLOID!

Most algae are hyploid

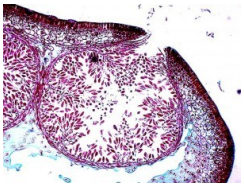


Nemalion

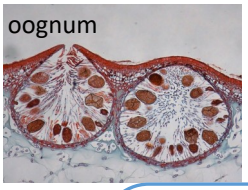
PHAEOPHYTA

"Brown Algae" All marine. Cold water. Storage: laminarin (glucose polymer). Mannitol—used as sweetener. Cell wall inner: cellulose/ outer: mucilaginous. Alginates etc.

Focus

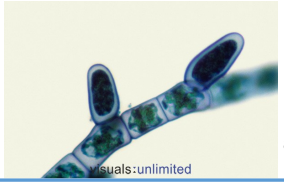


antheridium

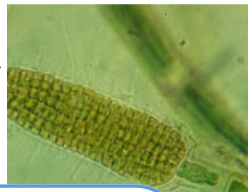


Mannitol: One of the storage molecules of the brown algae; an alcohol.

Ectocarpus



Unicular/ pleurolocu-lar sporan-gia

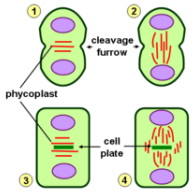


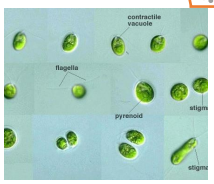
CHLOROPHYTA

"Green Algae" FW, marine, soil borne, airborne, Resemble plants: by 1. Chl. A & b . 2. Store starch. 3. Cell walls of cellulose.

Chlorophyceae

Microtubilas **phycoplast** (horizontal instead of vvertical) higher plants, unicellular, colonials, filaments.



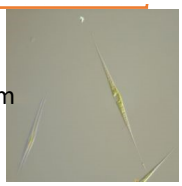


Chlamydomonas

Volvox

Hydro-

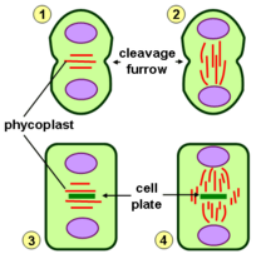
Oedogonium



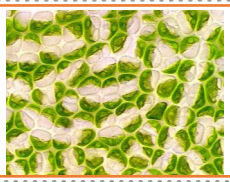
Ankistrodesmus

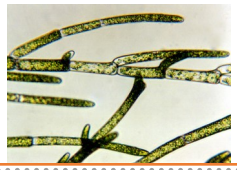
Ulvophyceae

Marine, flat sheets, large coenocytes. Ulva (genus), phycoplast.



Ulva



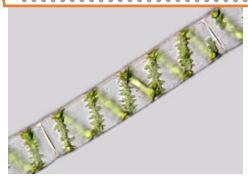


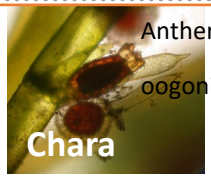
Cladophora

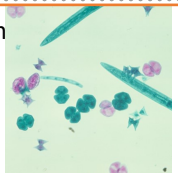
Charophyceae

Has **phragmoplast** (like plants). Plates of cells. Calvin cycle exactly like higher plants. Multicellular reproductive structure.

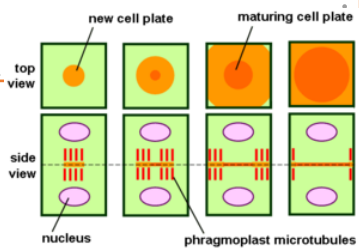
Spirogyra

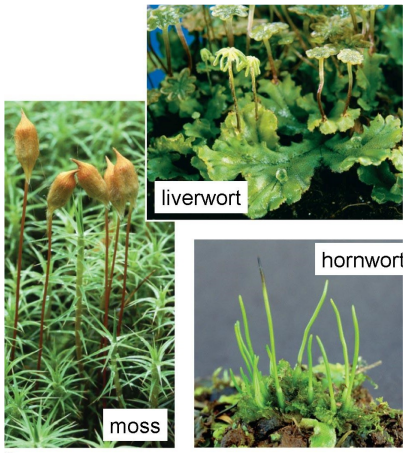






Desmids





PLANTAE

Non-vascular:

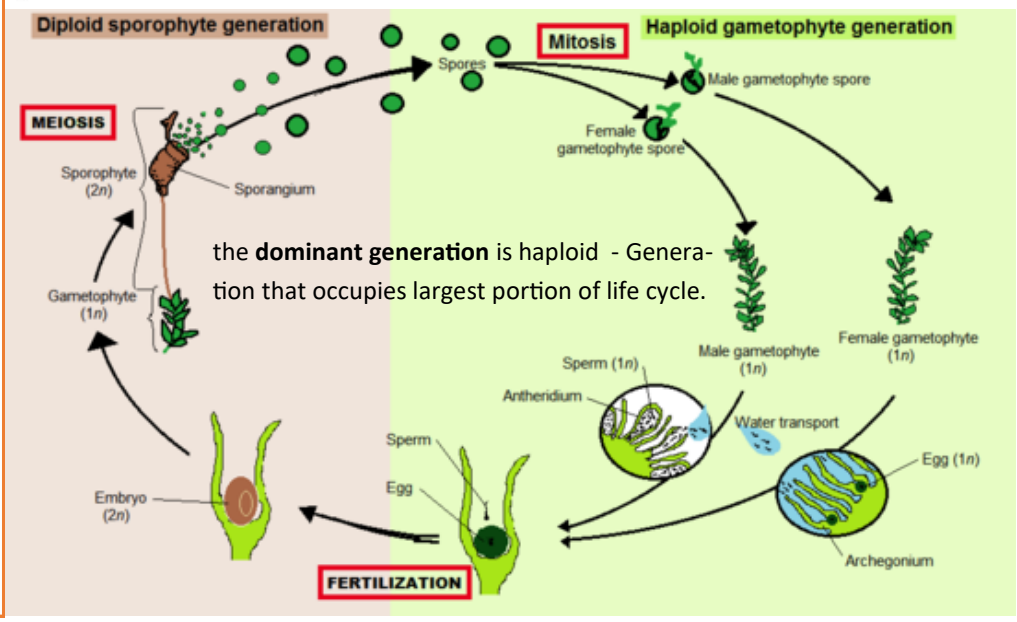
ANTHOCEROPHYTA (hornworts)
HEPATOPHYTA (liverworts)
BRYOPHYTES (mosses)

Transition to land.

1. Sterile jacket layers of cells around reproductive structures. Antheridium (male)/ Archegonium (female).
2. Embryo is retained in achegonium
3. Aerial portions of plant are covered by a cuticle.
4. Specialized cells for H2o transportation.

TABLE 1 A Comparison of the Structure of the Three Bryophyte Lineages

Feature	*Liverworts*	*Hornworts*	*Mosses*
gametophyte	flat or "leafy"	flat	erect "stem" and "leaves"
stomata	no (have pores)	yes	yes
distinguish D-methionine	no	yes	yes
hydroids & leptoids	no	no	yes
axial gametophytes	no	no	yes
protonema	no in general	no	yes
"leaves"	1 layer, overlapping	none	1 layer, spiral, with midrib
chloroplast	many	1 large	many
symbiotic bacteria	some	yes	no
cuticle	no	yes	yes
determinate sporophyte	yes	no	yes



Anthocerophyta: The phylum of angiosperms.

Bryophyta: The **mosses**, liverworts, and the hornworts (worts meaning herb)

Calyptra: covering for the head (see image pg. 12)

Gametophyte: In plants that have an alternation of generations, the haploid (n), gamete-producing generations, or phase.

Gemmae: A small mass of vegetative tissue; an outgrowth of the thallus.

Hydroids: Water-conducting cells of the moss hadrom; they resemble the tracheary elements of vascular plants, except for their lack of specialized wall thickenings.

Leptoids: Food-conducting cells associated with the hydroids of some moss gametophytes and sporophytes; they resemble the sieve elements of some seedless vascular plants.

Protonema: The first stage in development of the gametophyte of mosses and certain liverworts; protonemata may be filamentous or platelike.

Rhizoids: extensions of fungi and algae tht absorb water, food and nutrients.

Sporophyte: The spore ptoducing diploid (2n) phase in a life cycle characterized by alternation of generations.

HEPATOPHYTA

Liverwarts.
5200 spp

Mostly tropical. **Gametophyte is dominant.** Doctrine of Signatures (things that look like other parts).

Small inconspicuous—can form large mats. Simplest of all plants.

No cuticle.

No stromata (instead, each cell has a pore that is open all the time.

Don't have roots, instead have rhizoids—each plant to substrate, DO NOT ABSORB WATER.

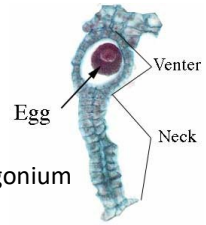
Sperm must swim to egg, mostly reproduce asexually.

Water splashes into the gemma cup.

Mitosis from mother cells.

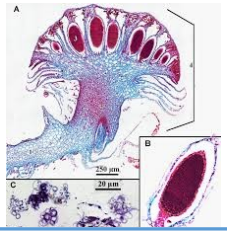
Gemma cups and spores

archegonia

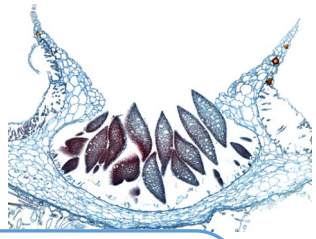


archegonium

antheridia



Thallus , gemma cup gemmae



ANTHOCEROPHYTA

Hornworts

300 spp

Algae-like: each cell has one large chloroplast.

Plant like: have cuticle. Have stomata

BRYOPHYTA

Mosses

Tropics—high humidity.

Sensitive to air pollution

Gametophyte dominant

Needs water

Gametophyte—2 morphological phases.

1. **Protonema** (green filament) filamentous, then grows and branches out.
2. **Leafy gametophyte.**

Peristome: distinguishing characteristic of bryidae: spore dispersal (pic).

Sporangium: capsule– something that makes spores

Tissue they use in transport is n t the same that we se e in other plants

IN SOME MOSSES:

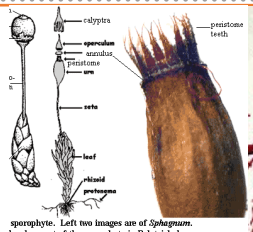
Hydroids: move H2O

Leptoids: move sugars

Bryidae

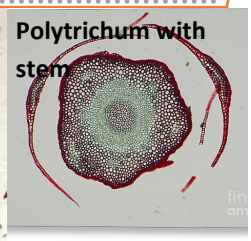
True Mosses

12800 spp



sporophyte. Left two images are of *Sphagnum*.
levelopment of the sporophyte in Polytrichales

Polytrichum sporo-phyte



Polytrichum with stem

Sphagnidae

Peat Mosses

Protonema is a plate of cells (round circular discs)

No rhizoids—free floating

Forms **peat bogs** (looks like root -beer.

Absorbs about 20x its weight in water

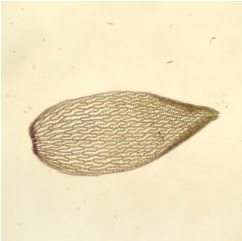
Used as wound dressing—it is anti0ceptic because of it' 2-3 acidity on scale (7 is neutral).

First energy source

2-3% of earth landmass is covered with it.

Peat Bog: Professor brought in a dry sample. Like a condensed rooted dark brown brick.

Peat bog

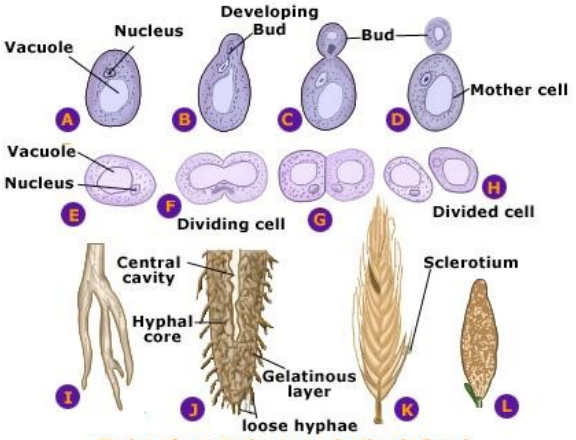


Andreaeidae

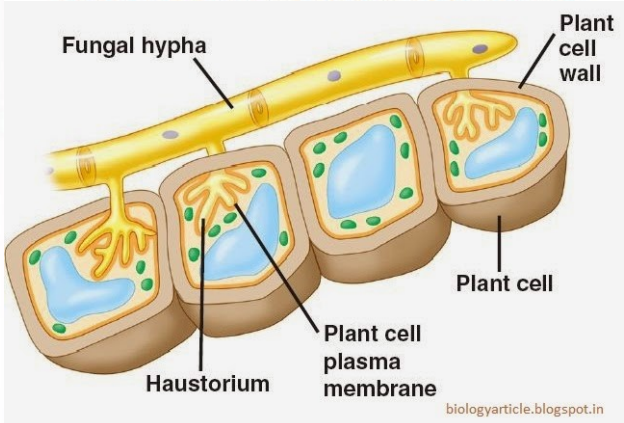
Granite Mosses

Protist Kingdom — Kingdom Protista

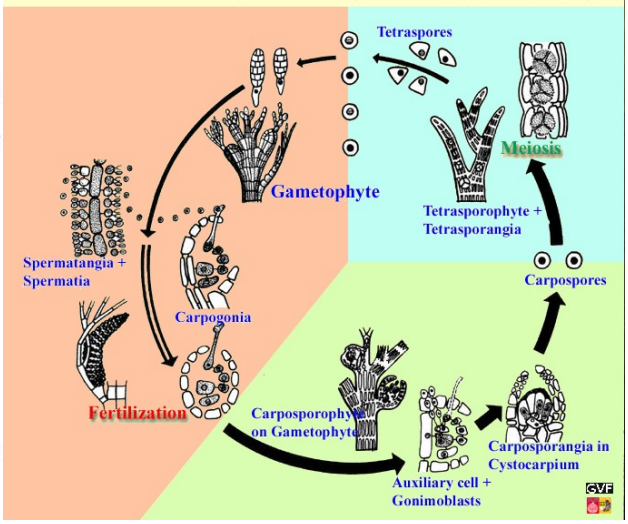
Phylum	Some characteristics	Examples
Euglenophyta (euglenoids)	one-celled make or take in food most have one flagellum	*Euglena*, *Phacus*
Chrysophyta (golden algae)	most are one-celled make own food yellow-brown color	*Synedra*, *Diatoma*
Pyrrophyta (dinoflagellates)	one-celled take in food have two flagella	*Gonyaulax*, *Peridinium*
Sarcodina (sarcodines)	one-celled take in food have pseudopods	*Amoeba*, *Globigerina*
Ciliophora (ciliates)	one-celled take in food have cilia	*Paramecium*, *Didinium*, *Vorticella*
Mastigophora (flagellates)	one-celled take in food have two or more flagella	*Trypanosoma*, *Trichomonas*
Sporozoa (sporozoans)	one-celled take in food no means of movement	*Plasmodium*, *Gregarina*
Myxomycetes (slime molds)	many- or one-celled absorb food change form during life cycle	*Physarum*, *Dictyostelium*

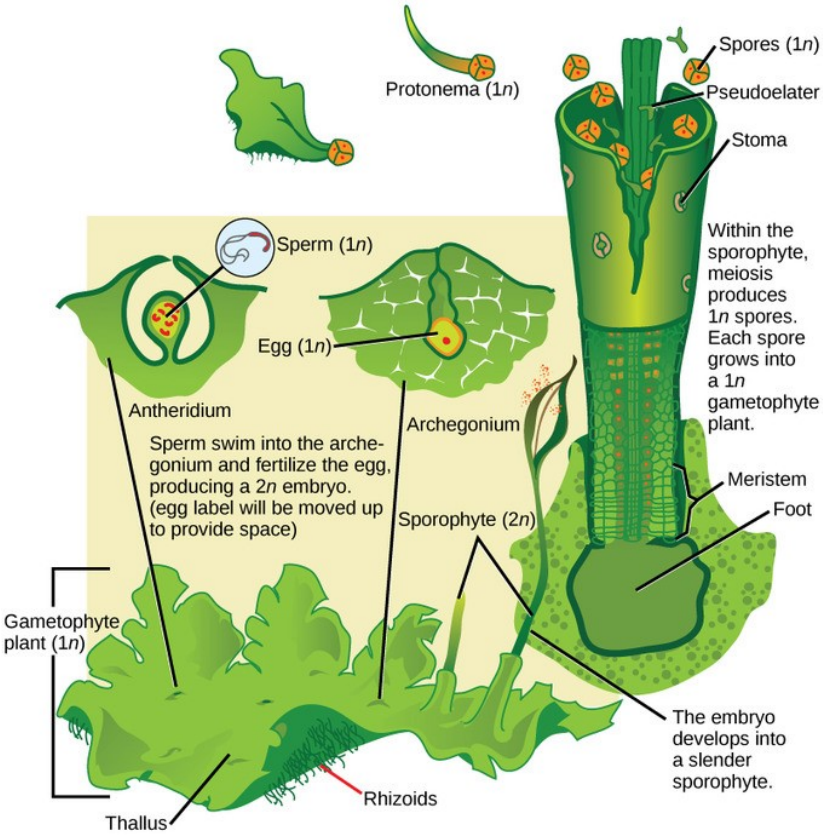


Modes of vegetative reproduction in fungi.
A-D. Budding. E-H. Fission. I-J. Rhizomorph; K-l. Sclerotia



LIFE CYCLE OF *POLYSIPHONIA FLEXICAULIS* (RED ALGA)





LAB EXAM I

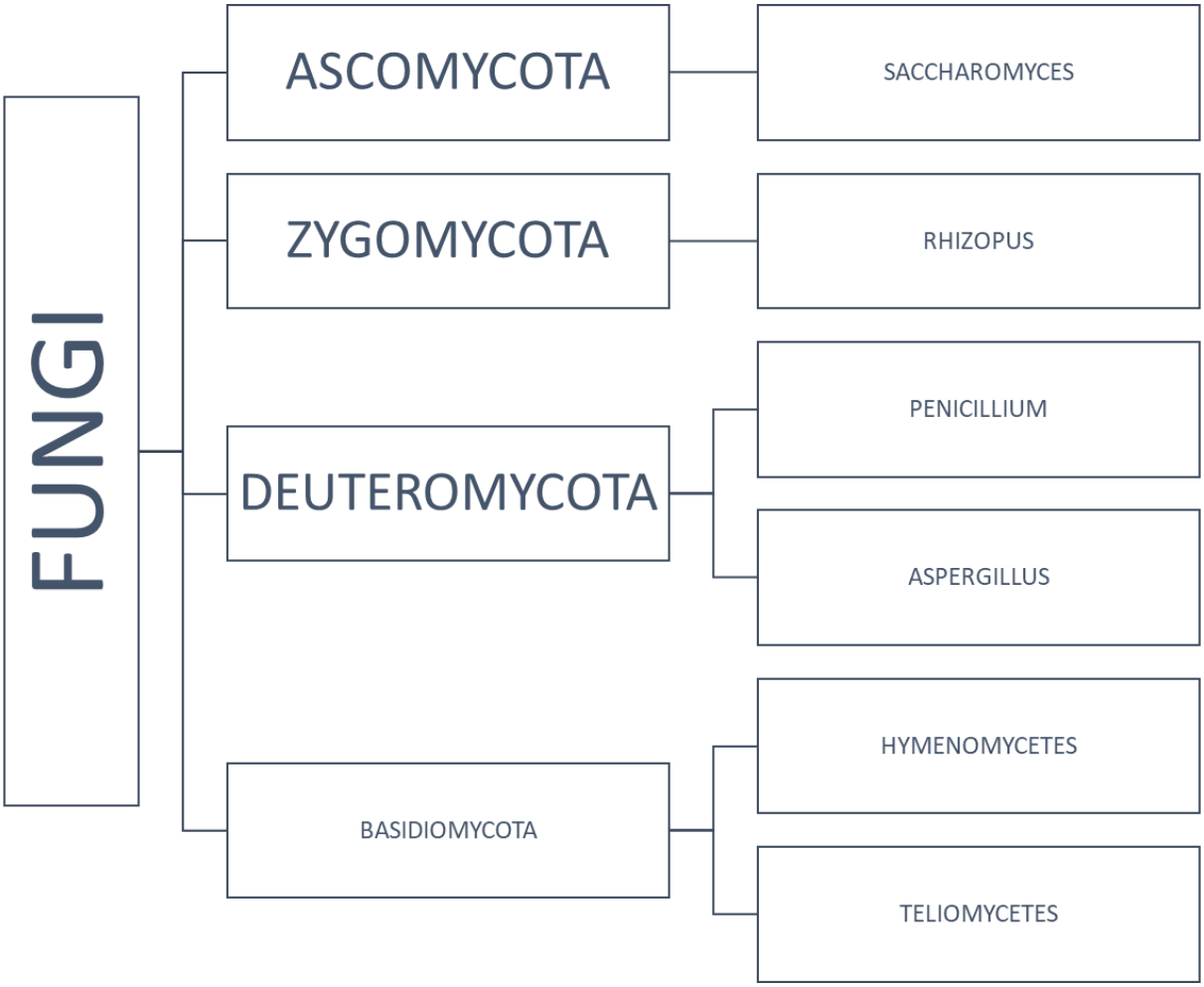
PROKARYOTES
Gleocapsa
Nostoc
Oscillatoria

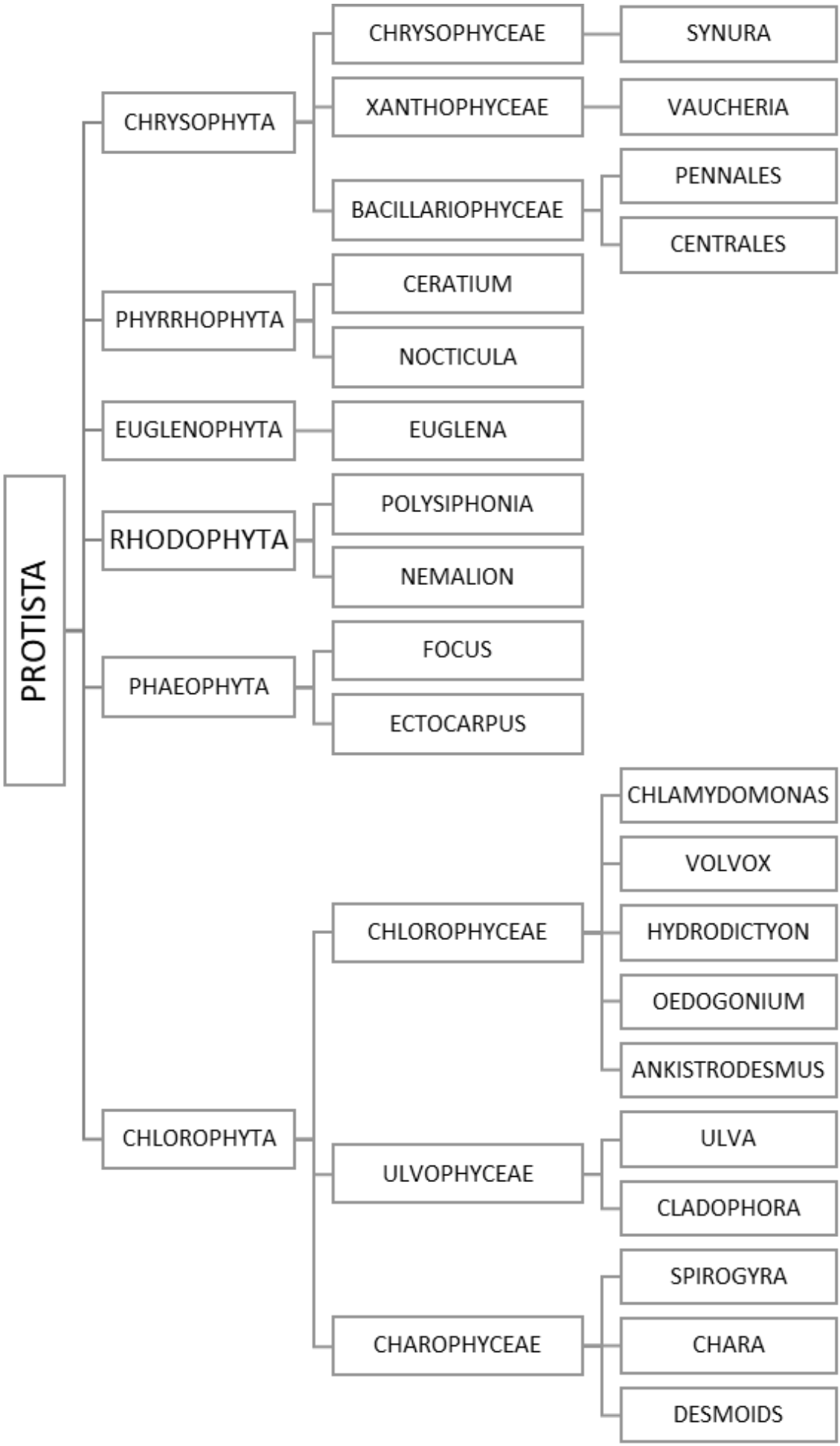
FUNGI
Aspergillus
Coprinus
Penicillum
Rhizopus
Saccharomyces

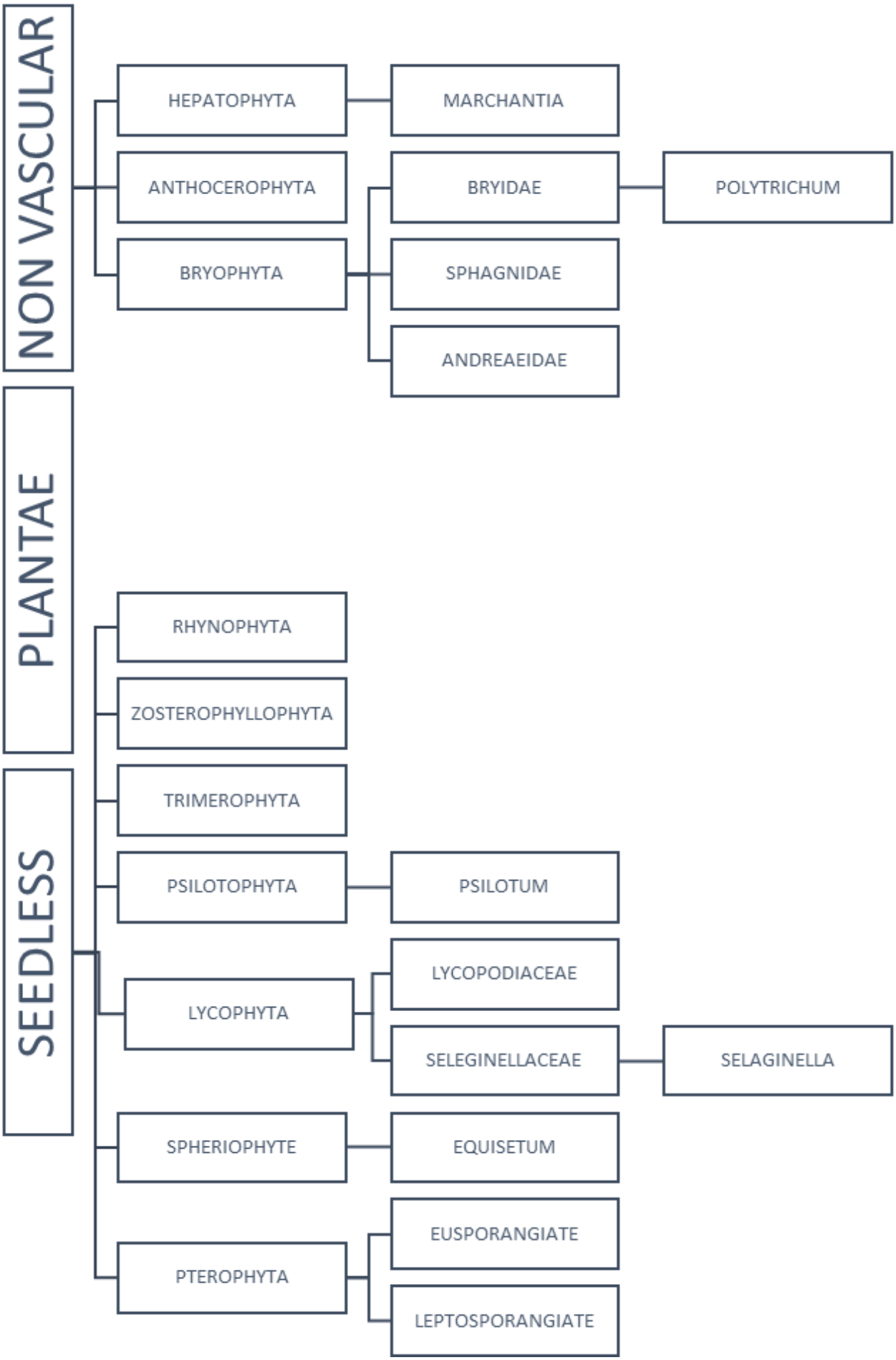
PROTISTA
Ankistrodesmus
Centrales
Ceratium
Chara
Chlamydomonas
Cladophora
Desmids
Ectocarpus
Euglena
Focus
Hydrodictyon
Nemalion
Nocticula
Oedognium
Pennales
Polysiphonia
Spirogyra
Synura
Ulva
Vaucheria
Volvox

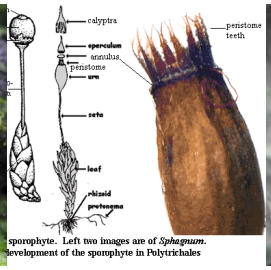
PLANTAE NV
Marchanta
Polytrichium
Protonema

PLANTAE
SEEDLESS
Equisetum
Psilotum
Selaguinella


FUNGI
ASCOMYCOTA
SACCHAROMYCES
ZYGOMYCOTA
RHIZOPUS
DEUTEROMYCOTA
PENICILLIUM
ASPERGILLUS
BASIDIOMYCOTA
HYMENOMYCETES
TELIOMYCETES


PROTISTA
CHRYSOPHYTA
CHRYSOPHYCEAE
SYNURA
XANTHOPHYCEAE
VAUCHERIA
BACILLARIOPHYCEAE
PENNALES
CENTRALES
PHYRRHOPHYTA
CERATIUM
NOCTICULA
EUGLENOPHYTA
EUGLENA
RHODOPHYTA
POLYSIPHONIA
NEMALION
PHAEOPHYTA
FOCUS
ECTOCARPUS
CHLOROPHYTA
CHLOROPHYCEAE
CHLAMYDOMONAS
VOLVOX
HYDRODICTYON
OEDOGONIUM
ANKISTRODESMUS
ULVOPHYCEAE
ULVA
CLADOPHORA
CHAROPHYCEAE
SPIROGYRA
CHARA
DESMOIDS


PLANTAE
NON VASCULAR
HEPATOPHYTA
MARCHANTIA
ANTHOCEROPHYTA
BRYIDAE
POLYTRICHUM
BRYOPHYTA
SPHAGNIDAE
ANDREAEIDAE
SEEDLESS
RHYNOPHYTA
ZOSTEROPHYLLOPHYTA
TRIMEROPHYTA
PSILOTOPHYTA
PSILOTUM
LYCOPHYTA
LYCOPODIACEAE
SELEGINELLACEAE
SELAGINELLA
SPHERIOPHYTE
EQUISETUM
PTEROPHYTA
EUSPORANGIATE
LEPTOSPORANGIATE



sporophyte. Left two images are of *Sphagnum*.
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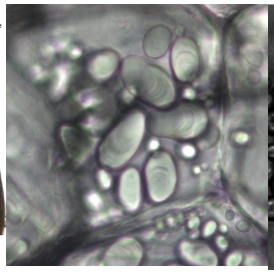
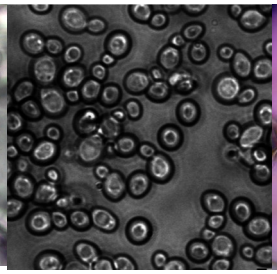
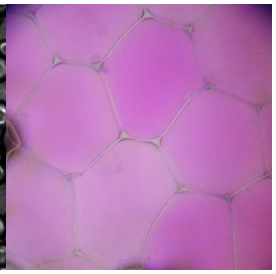

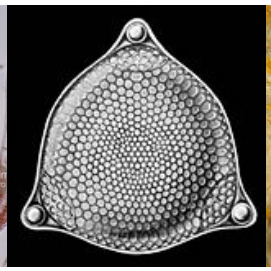
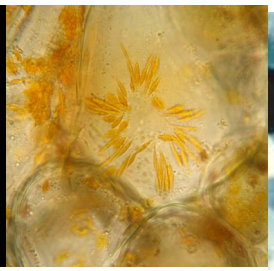
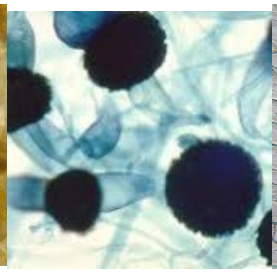
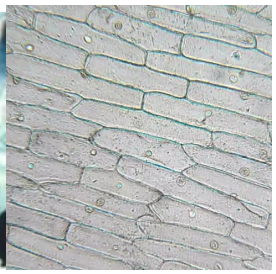

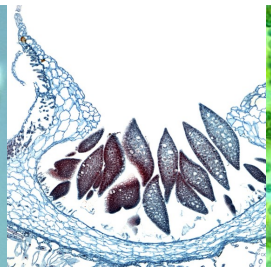
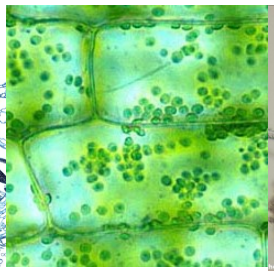
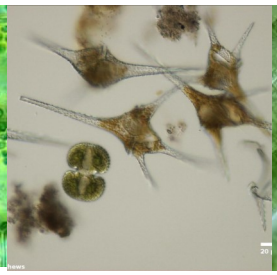

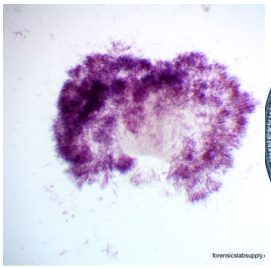
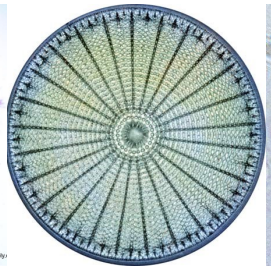
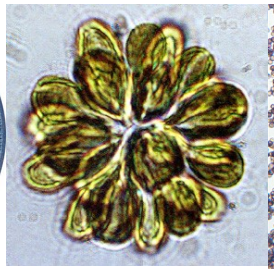
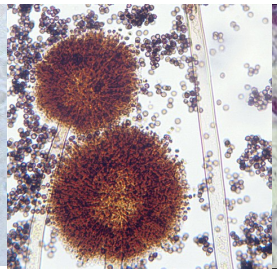
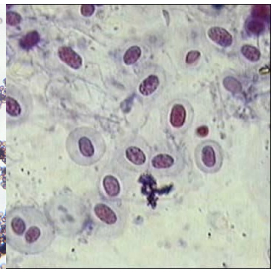

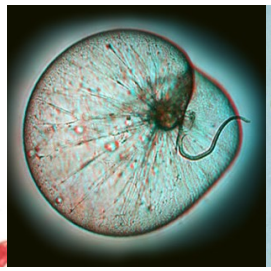
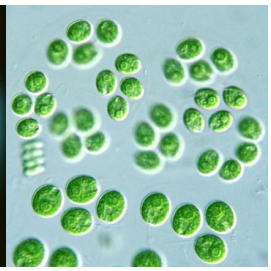
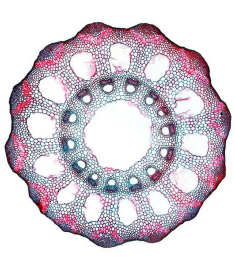

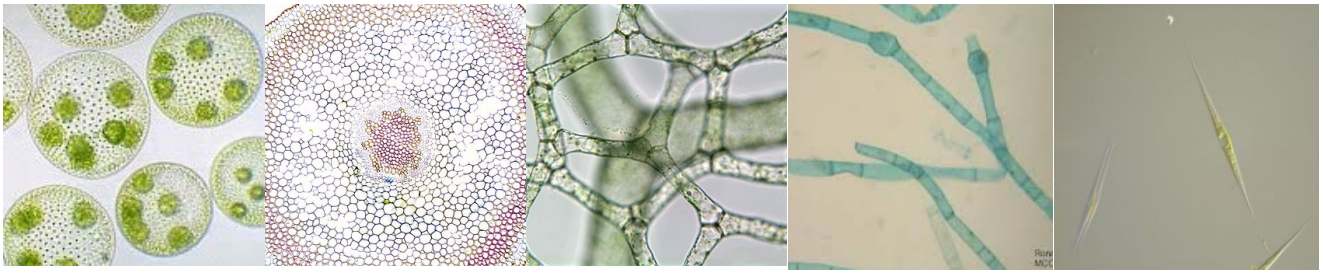

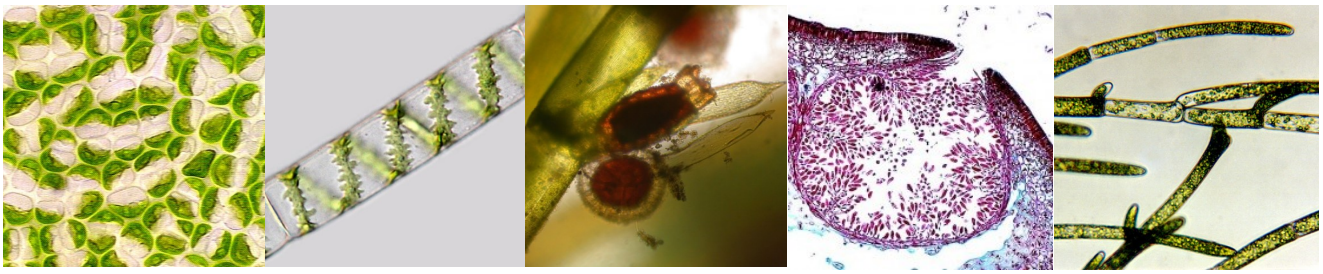

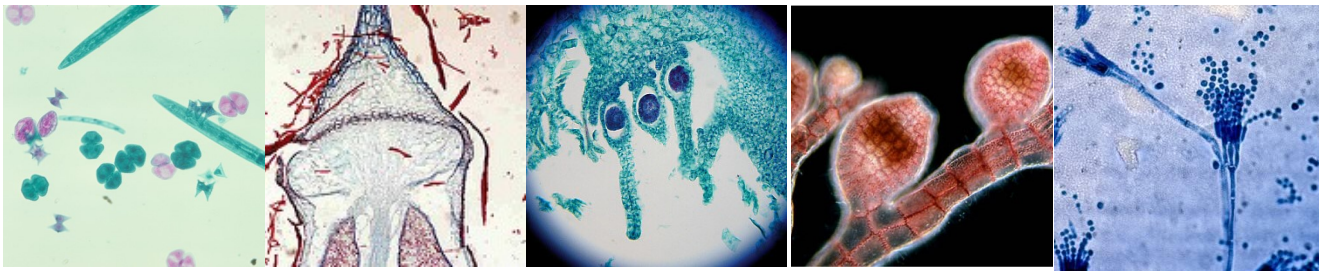

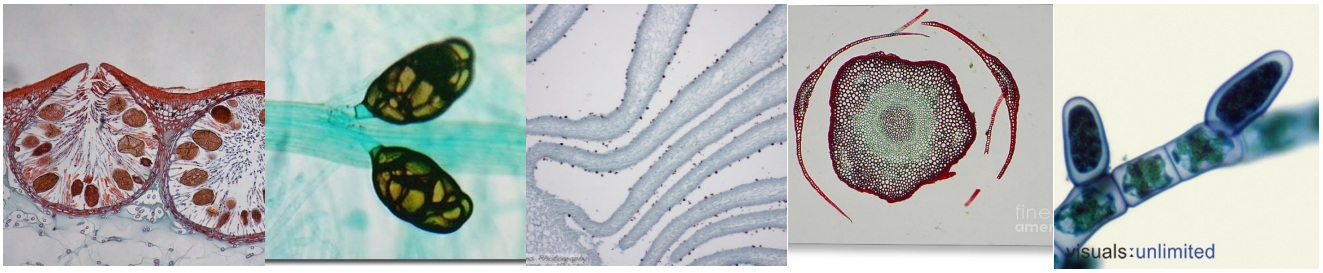
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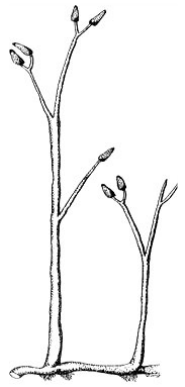


PLANTAE

SEEDLESS VASCULAR PLANTS

The same as plants:

- Cuticle
- Stroma (gas exchange)
- Archegonium protection for egg

Differ:

- Addition of vascular tissue to transport material inside the body.

Gametophyte gets smaller (progressively) becomes dependent on sporophyte.

EXAM III

Vascular plants have sporophytes that are more prominent than the gametophyes and are ultimately free -living.

The ability to synthesize lignin, which is incorporated into the cell walls of supporting and water-conducting was a pivotal step in the evolution of plants.

Tissue: group of cells that perform a function

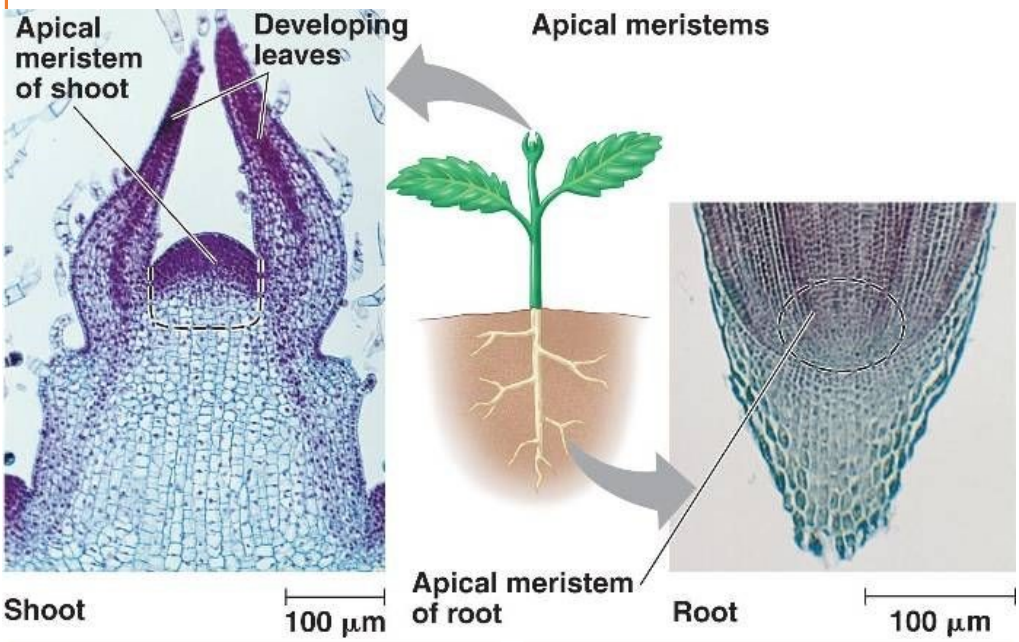
1. microphylls [1 vein serving them]. Only 1 vascular bundle. Are usually small—associated with protosteles
2. Megaphylls [have more than 1 vein. Can branch out, fill more space and get bigger. Associated with siphonosteles + eusteles (most leaves)
3. Reproduction: all plants are oogamous. Larger, non-motile egg. Smaller motile sperm.

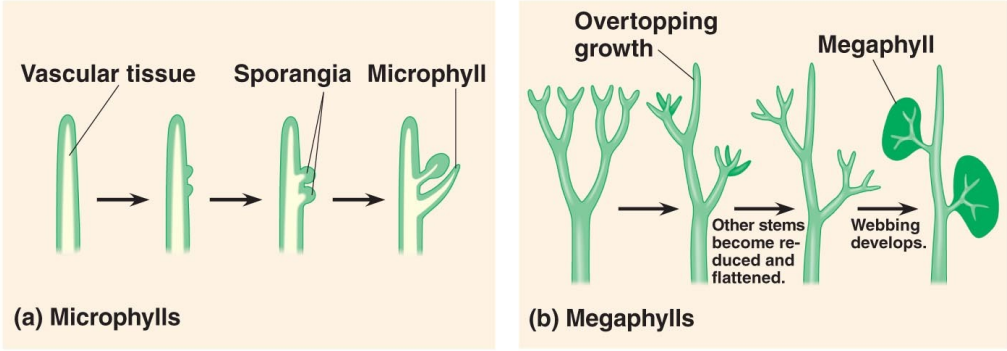
All seed plants are heterosporous—makes 2 kinds of spores.

Megaspores f. gametophyte

Microspore m. gametophyte

Separate male and female gametophytes like the liverworts we saw (which were all female).





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annulus [L. anus:ring] In ferns, a row of specialized cells in a sporangium; in gill fungi, the remnant of the inner veil forming a ring on the stalk.

apical meristem the meristem at the tip of the root or shoot in a vascular plant

carinal canal Equisetum and some of its fossil relatives, one of a number of longitudinal channels inside the metaxylem and formed by the disintegration of the protoxylem

compound leaves the blades are divided into leaflets. Each usually with its own small peritole.

cork cambium the lateral meristem that forms the periderm, producing cork (phellem) toward the surface (outside) of the plant and phelloderm toward the inside; common in stems and roots of gymnosperms and woody angiosperms. Also called phellogen.

dermal system The outer covering tissue of the plant; the epidermis or the periderm

eusporangiate (of ferns) having each sporangium formed from a single epidermal cell;

eustele [Gk. Eu: good + ste - le: pillar] A stele in which the primary vascular tissues are arranged in discrete strands around a pith; typical of gymnosperms and angiosperms.

frond The leaf of a fern; any large, divided leaf.

ground system (ground tissue system) All tissues other than the epidermis (or periderm) and the vascular tissues. Also called fundamental tissue system.

heterospory

homospory

lamina the blade of a leaf

lateral meristems Meristems that give rise to secondary tissue; the vascular cambium and cork cambium.

leaves organ where photosynthesis takes place.

leptosporangiate

ligule [L. ligula: small tongue] A minute outgrowth or appendage at the base of the leaves of grasses and those of certain lycophytes.

megaphyll [Gk. Megas: large + phyllon: leaf] A generally large leaf with several to many veins; its leaf trace (or traces0 is (are) associated with a leaf gap in ferns and with a leaf trace gap in seed plands; in contrast to a microphyll. Also called a macrophyll.

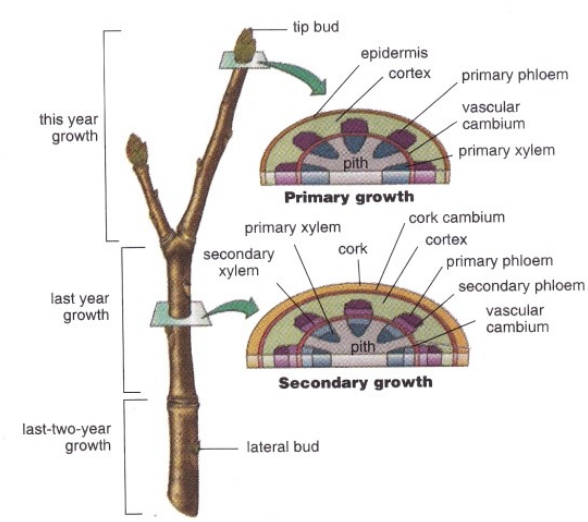
megaspores in heterosporous plants, a haploid [n] spore that develops into a female gametophyte; in most groups, megaspores are larger than microspores.

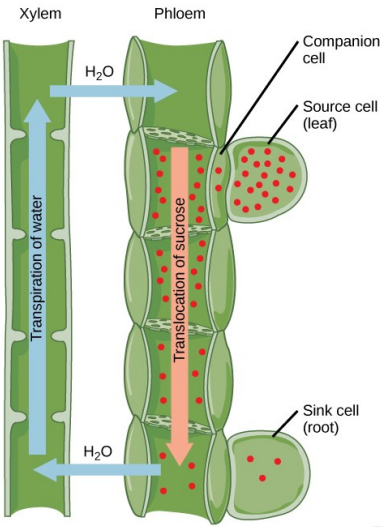
microphyll [Gk. Mikros: small + phyllon: leaf] A small leaf with one vein and one leaf trace, not associated with either a leaf gap or a leaf trace gap; in contrast to a megaphyll. Microphylls are characteristic of the lycophytes.

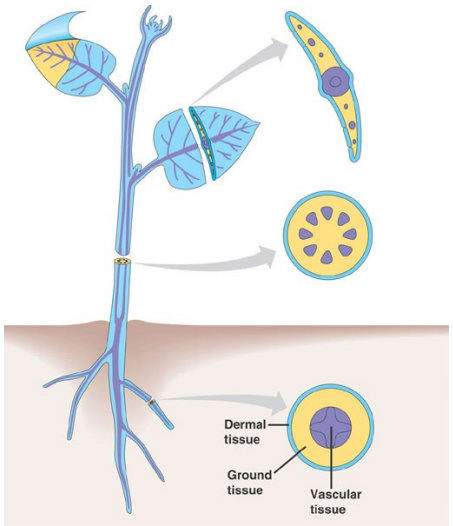
microspore in heterosporous plants, a spore that develops into a male gametophyte.

oogamous large nonmotile eggs and small sperm that seim to, or are conveyed to, the egg (all vascular plants).

periderm [Gk. Peri: around + derma: skink] Outer protective tissue that replaces epidermis when it is destroyed during secondary growth; includes cork, cork cambium, and phelloderm.







phloem transports the products of photosynthesis to all parts of the plant.

pinnae A leaflet or primary division of a pinnately compound leaf, especially of a fern frond.

pith the ground tissue occupying the center of the stem or root within the vascular cylinder; usually consists of parenchyma.

primary growth growth originating in the apical meristems of shoots and roots. Increases plant's length.

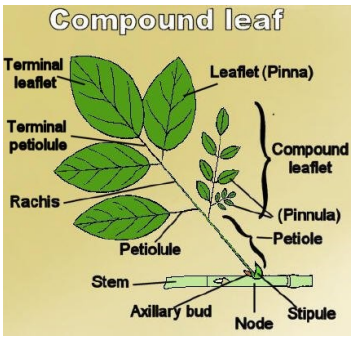
primary tissue Cells derived from the apical meristems and primary meristematic tissues of root and shoot; as opposed to secondary tissues derived from a cambium; primary growth results in an increase in length.

protostele [Gk. Protos: first + ste - le : pillar] The simplest type of stele, consisting of a solid column of vascular tissue

rachis a stem of a plant, especially a grass, bearing flower stalks at short intervals.

root The usually descending axis of a plant, normally below ground, which serves to anchor the plant and to absorb and conduct water and minerals to it.

secondary growth growth derived from secondary or lateral meristems, the vascular cambium and cork cambium, that results in an increase in girth; in contrast to primary growth, which results in an increase in length.



shoot the aboveground portions, such as the stem and leaves, of a vascular plant.

siphonostele a stele consisting of a core of pith surrounded by concentric layers of xylem and phloem.

sporophyll the upper surface of fertile microphylls. A modified leaf or leaflike organ that bears sporangia; a term applied to the stamens and carpels

stele central cylinder of a pith

strobilus pl. strobili [Gk. Strobilos: cone] A reproductive structure consisting of a number of modified leaves (sporophylls) or ovulebearing scales grouped terminally on a stem; a cone. Strobili occur in many kinds of gymnosperms, lycophytes, and sphenophytes.

tapetum adds a lipid-rich coat to the surface layer of pollen grain and the spaces within it. / [Gk. Tapes: carpet] Nutritive tissue in the sporangium, particularly an anther.

tissue system

tracheid a type of water-conducting cell in the xylem that lacks perforations in the cell wall.

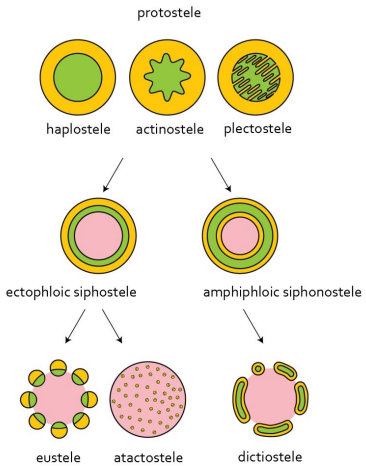
vascular cambium a cylindrical sheath of meristematic cells that dives to produce secondary phloe and secondary xylem.

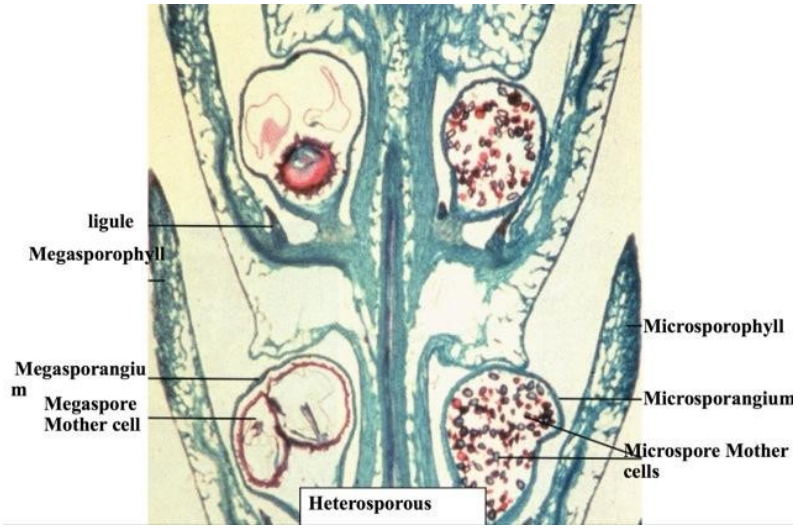
vascular system All the vascular tissues in their specific arrangement in a plant or plant organ.

vessel member

whorled leaves

xylem [Gk. Xylong: wood] A complex vascular tissue through which most of the water and minerals of a plant are conducted; characterized by the presence of tracheary elements.





RHYNIOPHYTA

Oldest known vascular plant

No leaves or roots (just stems. (cuticle & stromata)
All are extinct.

Simple dichotomous branching
Terminal sporangia

Hommosporous.
Cooksonia: oldest known vascular plant.

ZOSTEROPHYLLOPHYA

All extinct. Larger than Rhyniophita.

Homosporous. Lateral sporangia allowed stems to grow taller.

TRIMEROPHYTA

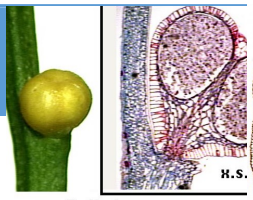
All extinct. Look like tumbleweed.

More complex homosporous. Dichotomous branching.

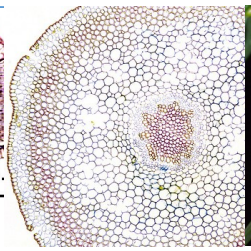
PSILOTOPHYTA

Whisk ferns

Only 2 species. Exist.



Psilotum
Sporangium



Alchotomous branching. Lateral sporangia.
Homosporous, milliflagellated sperm swim to egg.
ONLY vascular plant with NO roots or leaves.

<u>Plants small; true roots and leaves absent; rhizome and rhizoids present; homosporouos.</u>

LYCOPHYTA

Club mosses

1000 spp

Used to be big.

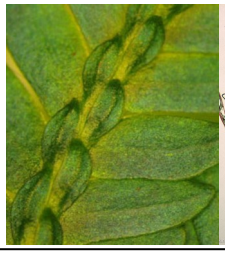
Family: Lycopodiaceae

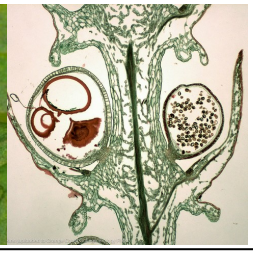
Microphylls spirally arranged, have leaves.

Spores (sporangia) are formed by centralaxes

Family: Seleginellaceae

heterosporous

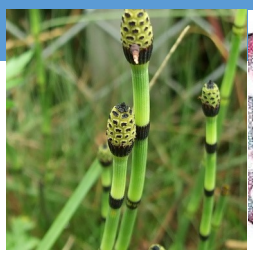


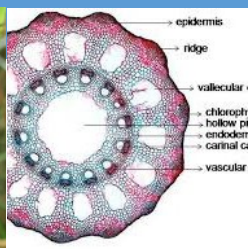


SPHENOPHYTA

Horsetails

Oldest genus > 300MYO





Were about 40' tall, now much smaller, but some still grow at 6' tall. Homosporous

Has leaves.

Stems do the photosynthesis

"leaves" are megaphylls

Grow near or around water

Fast rooting.

Epidermis embedded with silica; tips of stems bear cone-like structures containing sporangia; homosporous.

PTERIDOPHYTA

Ferns

11000 spp—plants often large and conspicuous; leaves complex. Rhizome common; mostly homosporous.

Largest group of non-flowring plants.

Carboniferous area 360 MYO (coal & oil froming on earth—made of organic stuff

Homosporous.

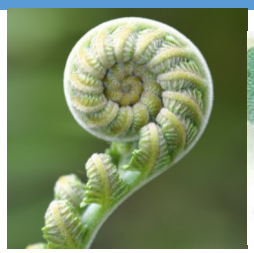
Fern leaves are called fronds.

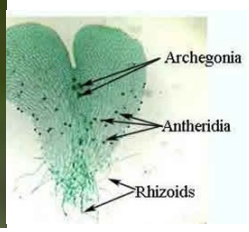
DISTINGUISHING CHARC: Sori: (Sorus) clusters of sporangia borne on underside of leaves

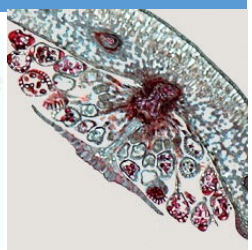
Fiddlehead. Some are edible.

A. Eusporangiate ferns: Ophioglossum (1260 chromosomes). 1 leaf per year—slow growth

B. Leptosporangiate ferns. Order: filicales(?)







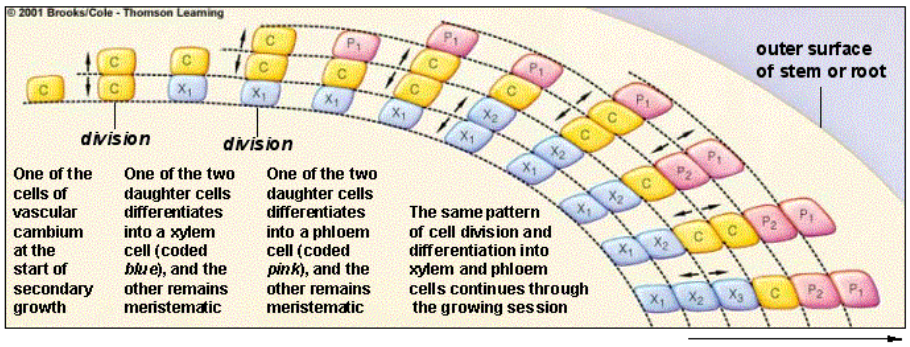
Eusporangiate Ferns

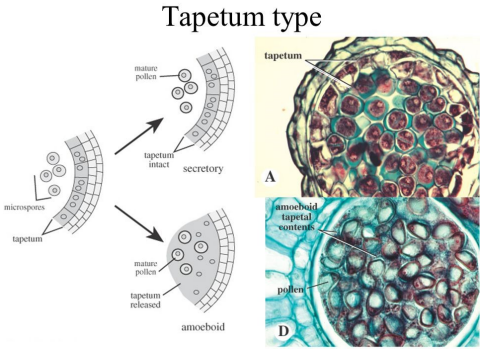
Ophioglossum (1260 Chromosomes.

Slow growth—I leaf per year

Leptosporangiate ferns

Order: Filicales





PLANTAE

GYMNOSPERMS EXPOSED SEED PLANTS

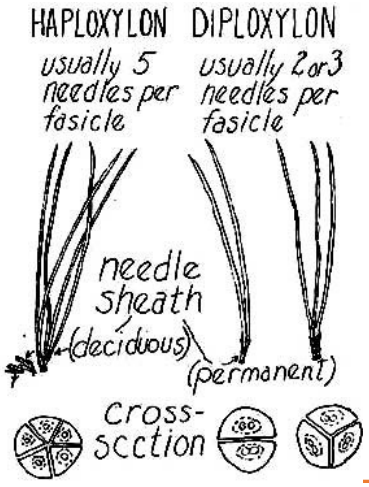
Seeds are one of the most important innovations of plants.

Inside the seeds:

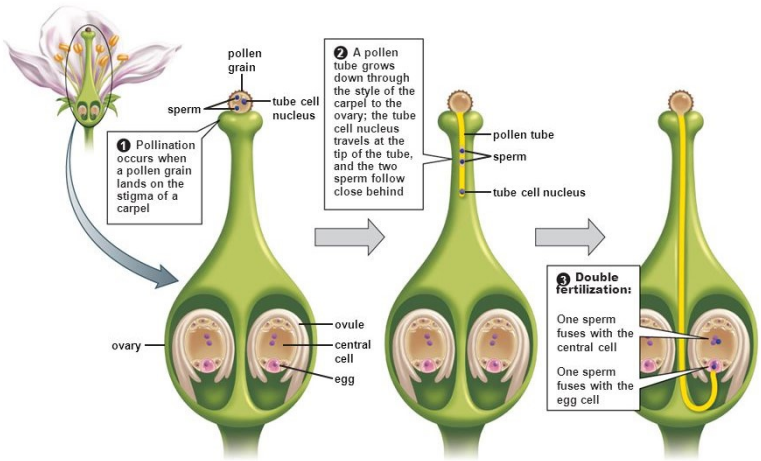
1. Embryo plant
2. Nourishment for seedling at germination.

Temperate seeds: seed remains dormant until conditions improve.

Oldest seed: 360 MYO Devonian.



Pollination and Fertilization of a Flower



Coniferophyta:

Cycadophyta:

Fascicle: Bundle of leaves

Generative cell: In many gymnosperms, the cell of the male gametophyte that divides to form the sterile and spermatogenous cells; in angiosperms, the cell of the male gametophyte that divides to form two sperm.

Ginkgophyta:

Gnetophyta:

Heterosporous: Having two kinds of spores, designated as microspores and megaspores

Integuments: the outermost layer or layers of tissue enveloping the cucellus of an ovule; develops into the seed coat.

Integuments: The outermost layer or layers of tissue enveloping the nucellus of an ovule; develops into the seed coat.

Megagametophyte: [Gk. Megas: large + gamos: marriage + phyton: plant] In heterosporous plants, the female gametophyte; located in the ovule of seed plants.

Micropyle: in the ovules of seed plants, the opening in the integumetns through which the pollen tube usually enters.

Nucellus: fleshy megasporangium, contains a megagametophyte composed of nutritive tissue and archegonia.

Ovulate cone: megasporangiate, larger and more complex in structure than pollen baring cones.

Pollen tube: A tube formed after germination of the pollen grain; carries the male gametes into the ovule.

Pollination: In angiosperms, the transfer of pollen from an anther to a stigma. In gymnosperms, the transfer of pollen from a pollen-producing cone directly to an ovule.

Polyembryony: Having more than one embryo within the developing seed.

Prothallial cell: [Gk. Pro: before + thallos: sprout] The sterile cell or cells found in the male gametophytes or microgametophytes, of vascular plants other than angiosperms; believed to be remnants of the vegetative tissue of the male gametophyte.

Seed coat: the outer layer of the seed, developed from the integuments of the ovule.

CYCADOPHYTA

Produce cones.

200 spp. Tropical—subtropical. Cutting ties away from water—it isnow delievered cia pollen. Sometimes via wind or animals.

Pollen: male gametophyte.

Habitat destruction & overcolletion is threatening their existence.

How to succeed 0 slow growing "sago palms (sold at ikea):

1. Be toxic.
2. 2. Be armed.

Dioecious: separate male & female plants.

GINKGOPHYTA

1 sspp ginko bilboba

Cultivated plant saved It from ice-gae (china)

Deciduous: drop leaves in autumn.

Also **Dioecious:** separate male & female plants.

Good street tree– resistant to pollution.

Female tree stinks. Mayb be good at blood circulation of bfrain if you're over 70 YO

<u>Deciduous, fan-shaped leaves; motile sperm; large tree</u>

CONIFEROPHYTA

630 SPP 70 genera—90 of these are pines. Woody

Largest non-flowering seed plant group.

Oldest known organism = Pinus longaera, these have a lot of extremes. 4600 YO!

Common name: **bristlecone pine.**

Largest organism: sequoia (tallest [380ft] & broadest). Oldest is 290 MYO .

Arboniferous _ Permian , earth becomes cooler and drier, seed plants winning, -dicersification of conifers. Needles instead of leaves so to not loose water.

<u>motile sperm absent; stomata sunken</u>

Drought: cannot bring water down to the roots –such as the water being frozen.

Pinus: 90 spp. Quirky—Native to No. Hem-isphere.

Stomata get plugged up from air-pollution, not good as a street plant.

Male **gametophyte** is pollen: 4 cells:

2—prothallial cells

1—tube cell

1—generative cell (makes sperm).

Micropyle: where pollen enters.

After fertilization = Seed.

Nucellus: makes nutrients

It takes a year for pollen to find it's way in.

Pinus pinea—italian to make pesto—edible. "slash pine".

Turpentine (paint thinner solvent) rosin gum white powder or ends of bows for violins.

Spruce = desired wood for musical instrumetns , news-papers. 123 acres of trees = 1 day's paper.

Redwood is not good in humid weather.

Juniper = used to flavor gin.

GNETOPHYTA

600 spp—only 3 genera, and each one is very different.

Contain vessel elements; motile sperm absent; mostly shrublike.

Ephedra

35 spp

Desert/ avrid 9dry) lands.

Monecious or diaecious. Stems photosynthetic, leaves are tiny & short lived. Speed up your heartrate—used as weight-loss .

Gnetum

34spp

Tropical, broad-leaf vines (lianasMale **gametophyte** is pollen:

4 cells:

2—prothallial cells

1—tube cell

Welwitschia

Nambian desert (the cones branch).

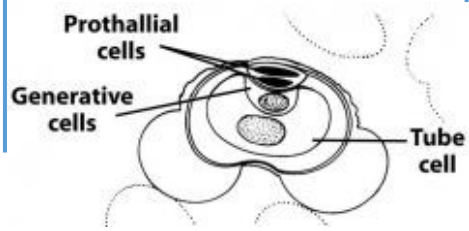
Cone-bearing, mostly dioecious. Rare & endengared. Has only 2 (shredded) leaves.

Male

2—prothallial cells

1—tube cell

1—generative cell (makes sperm).



Anthopyta-like characteristics:

1. branched cones in Welwitschia resemble inflorescences
2. Presence of vessels in xylem
3. No archegonia in gnetum or Welwitschia
4. Ephedra has double fertilization.

Xylem: transports H2O

Tracheids: in all vascular plants

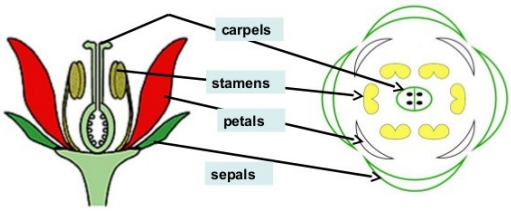
Vessels = only in Anthophyta + Gnetophyta.

These plants don't belong anywhere else.

1. Naked Seeds
2. All have cones
3. Close to flowering plants

- Not all of them have all the structures mentioned before
  - A. ***Complete flowers*** have all the major parts: stamens, pistils, sepals & petals
  - B. ***Incomplete flowers*** are missing one or more of these major parts
  - C. ***Perfect flowers*** have both stamens and pistils on the same flower
  - D. ***Imperfect flowers*** are missing either the stamens or pistils

Flower parts are organised in circles called whorls



ANTHOPHYTA

250000 spp

ANGIOSPERM (Flowers [& fruit])

Inflorescence = flowering stalk

Peduncle = single flower (like tulip)

Dedicel = multiple flowers inaninflo-rescence

Receptacle = where floral segments attach

Pollination: transfer of pollen from anther to stigma.

Pollen is the male gametophyte and consists of three cells.

Double fertilization—1 sperm fertilizes eggs, the other joins the polar nuclei. [exept for ephedra, only flowering plants]

Antipodals go away after fertilization & synergids

Central cell produces endosperm that nourishes germinating seedlings.

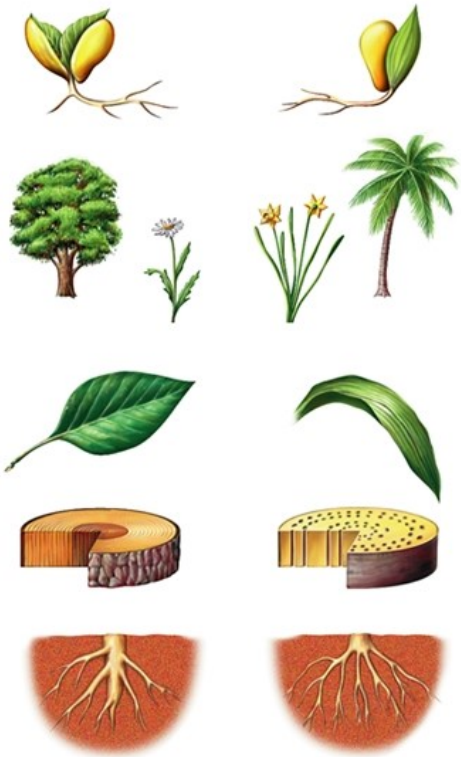
Calux = all sepals together

Corolla = all petals together

Perianth (sterile whorls)

Stamin & pistil = fertile

Tepals—segments that aren't clearly de-lineated as sepals or petals.



Monocotyledones

Parallel venation

Fibrous roots

Flowr segments of 3s

Dicotyledones

2 cotyledons "seed leaves"

Reticulate venation

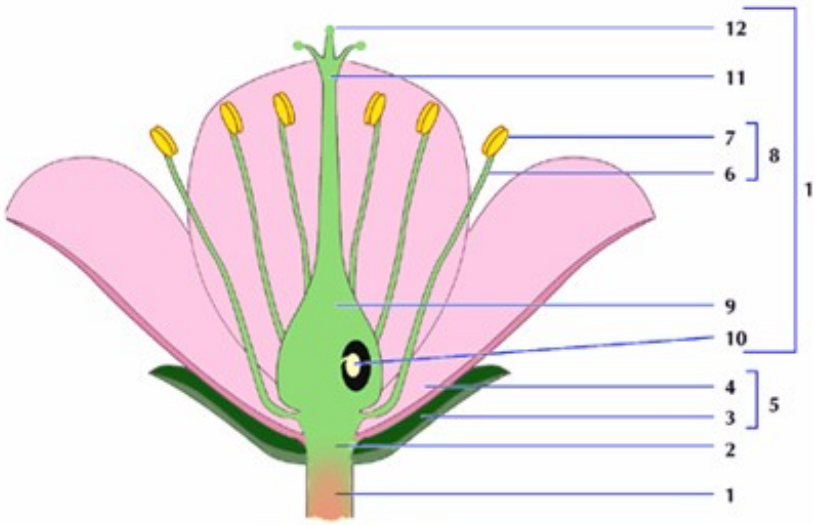
Flower segments of 2s or 5d.

Pollen Cells (3)

1. tube Cell x1
2. Sperm x2

Floral Whorts

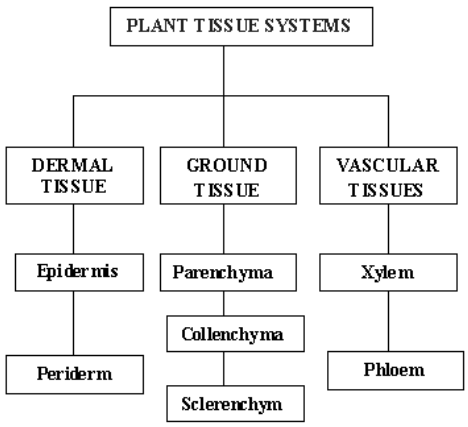
1. Sepals—protect the bud
2. Petals—attraction
3. **Stamens**—pollen (fertile)
4. **Pistil**—carpellgunoecium (fertile)

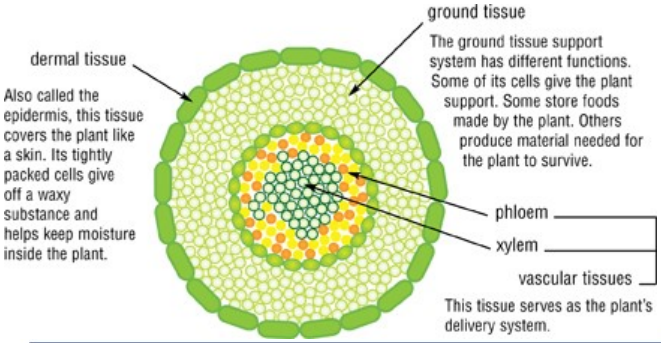


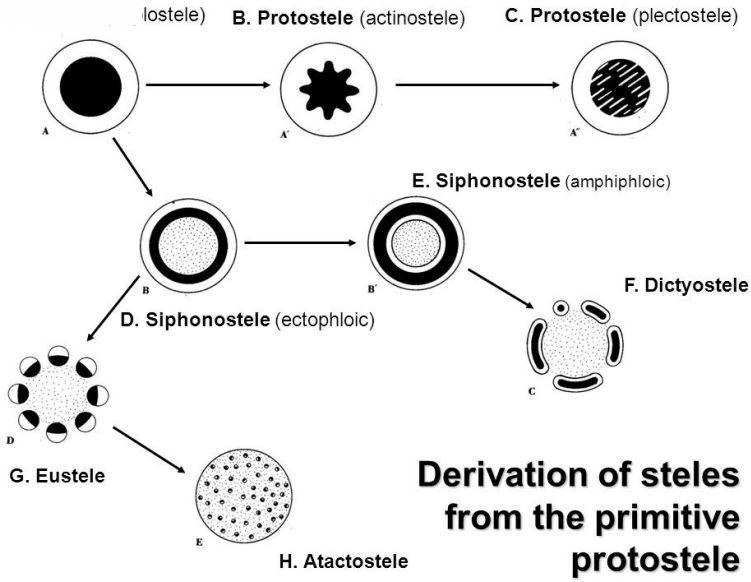
Generalized Flower

1 = pedicel (or peducle)
2 = receptacle
3 = sepal (calyx)
4 = petal (corolla)
5 = perianth
6 = filament
7 = anther
8 = stame (androecium)
9 = ovary
10 = ovule (seed)
11 = style
12 = stigma

13 = pistil (gynoecium)







- The body of a dicot

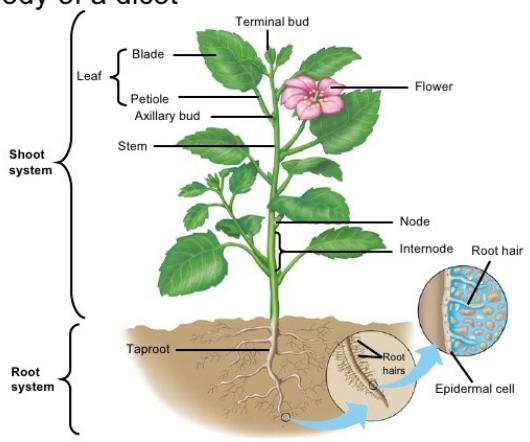


Figure 31.3

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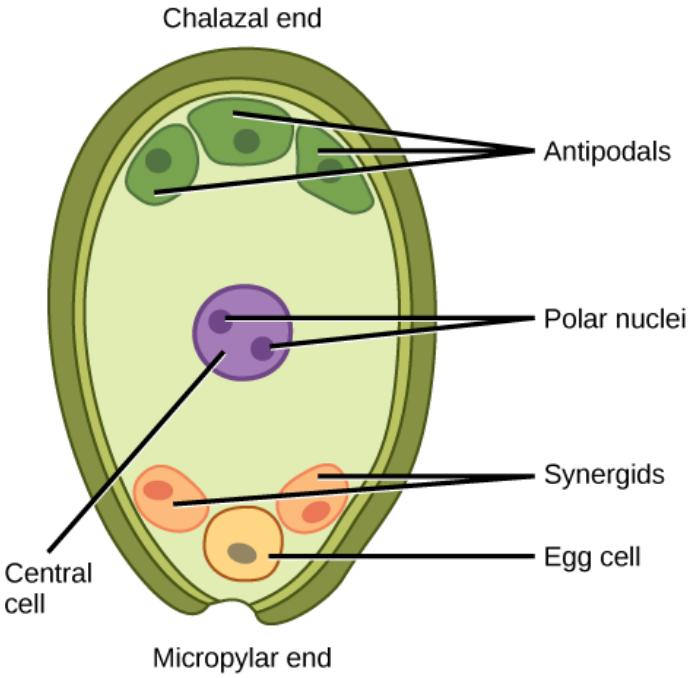
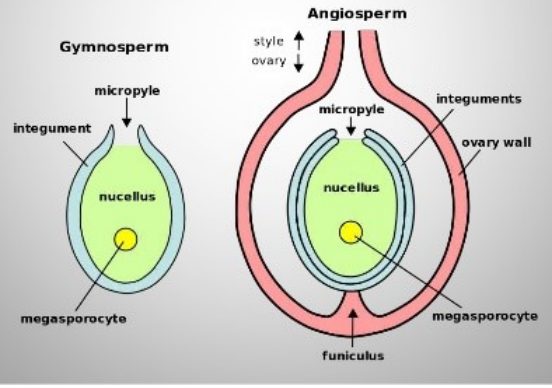


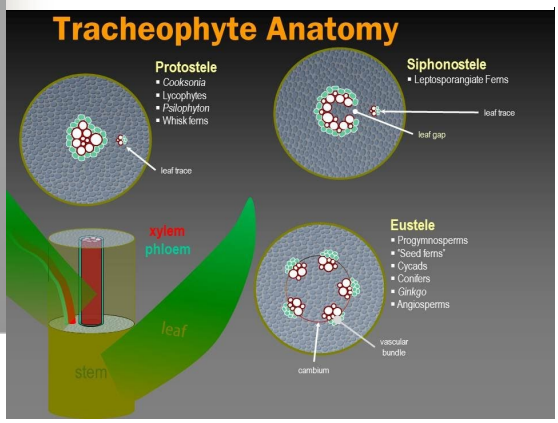
Seed plant spores

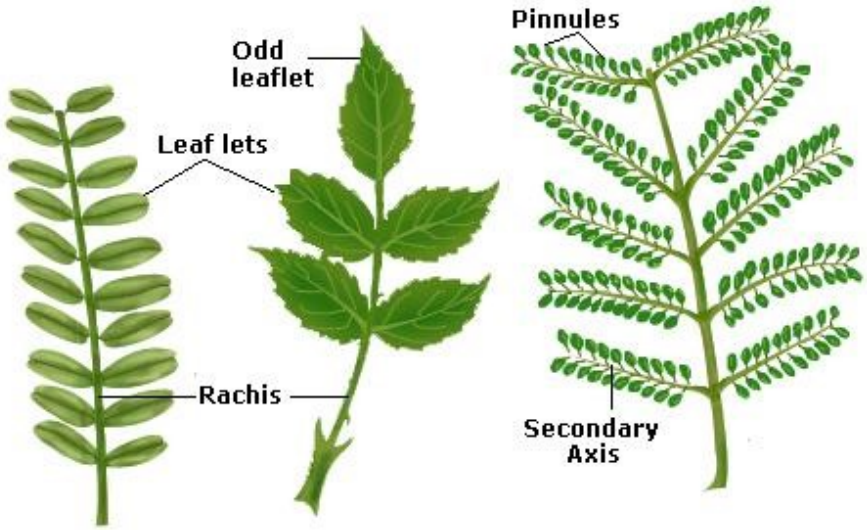
- Microspores (male) undergo mitosis to create pollen
- Megaspores (female) undergo mitosis to create egg

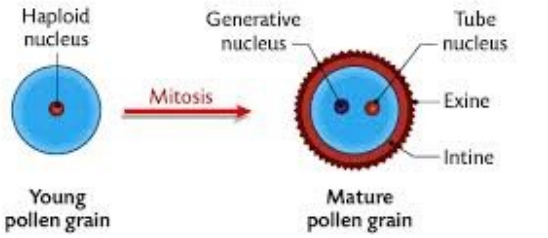


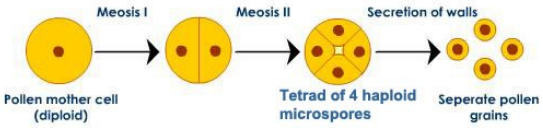
Homospory versus Heterospory

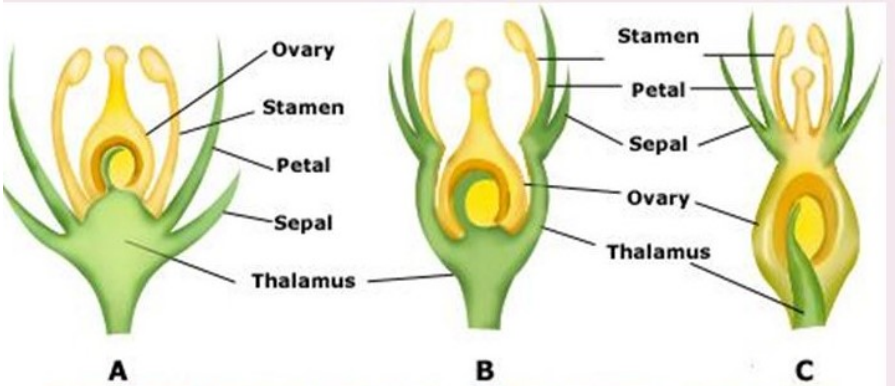
- Mosses and ferns are homosporous
  - Produce only one type of spore
- All seed plants, spike mosses, and quillworts as well as a few fern species are heterosporous
  - Produce two types of spores
    - Male microspores
    - Female megaspores



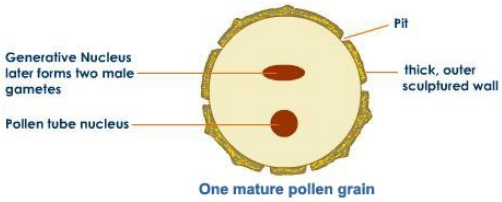


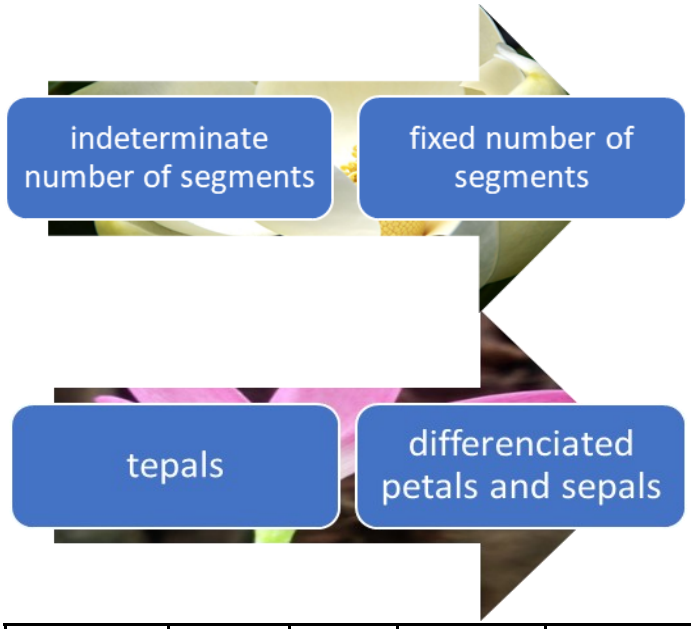


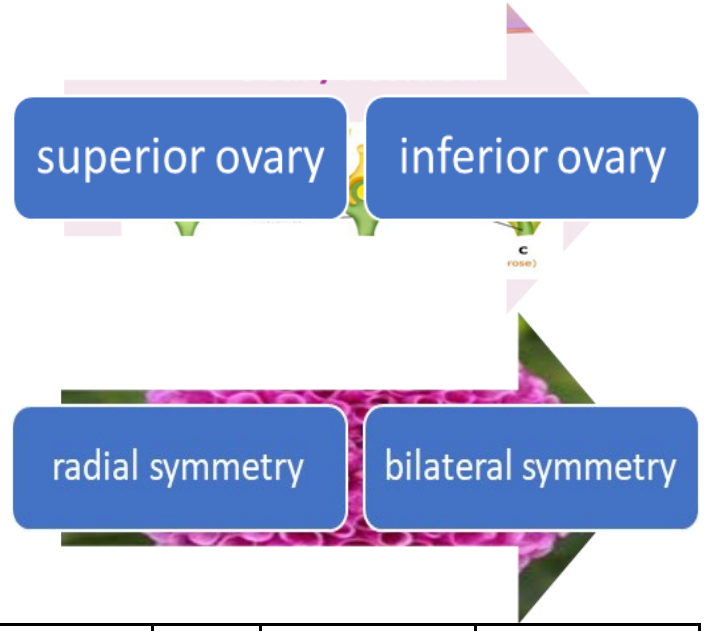




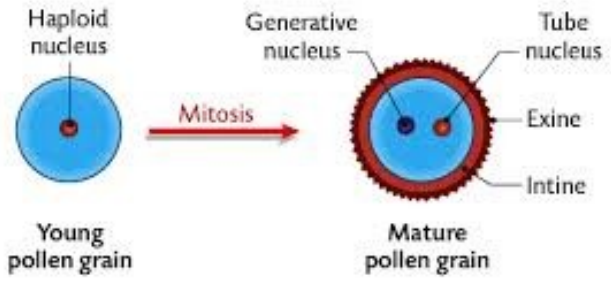
Insertion of floral parts on thalamus, A. Hypogynous (China rose) B. Perigynous (Rose), C. Epigynous (strawberry).



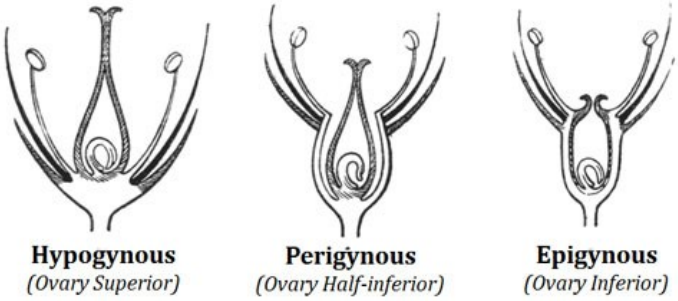


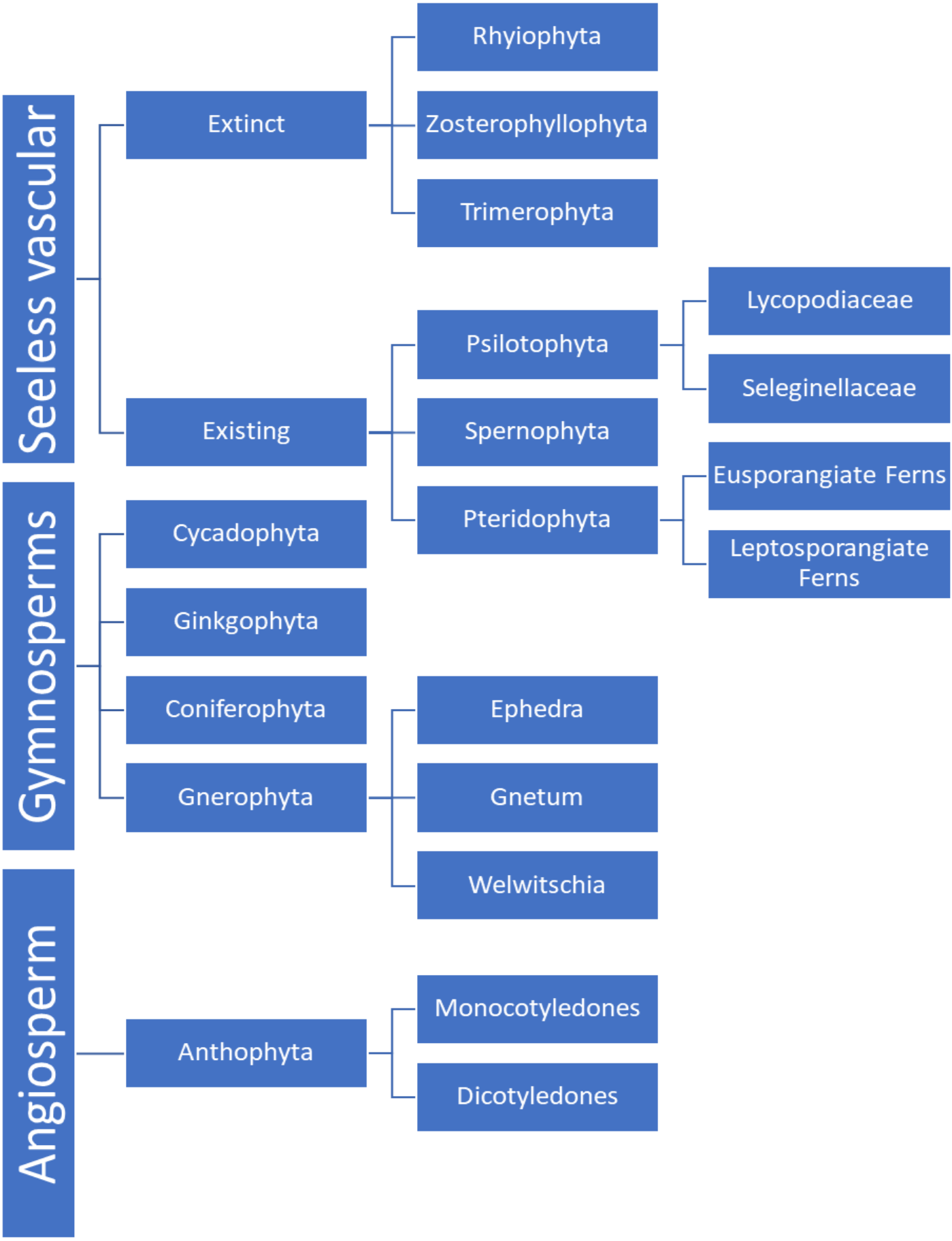


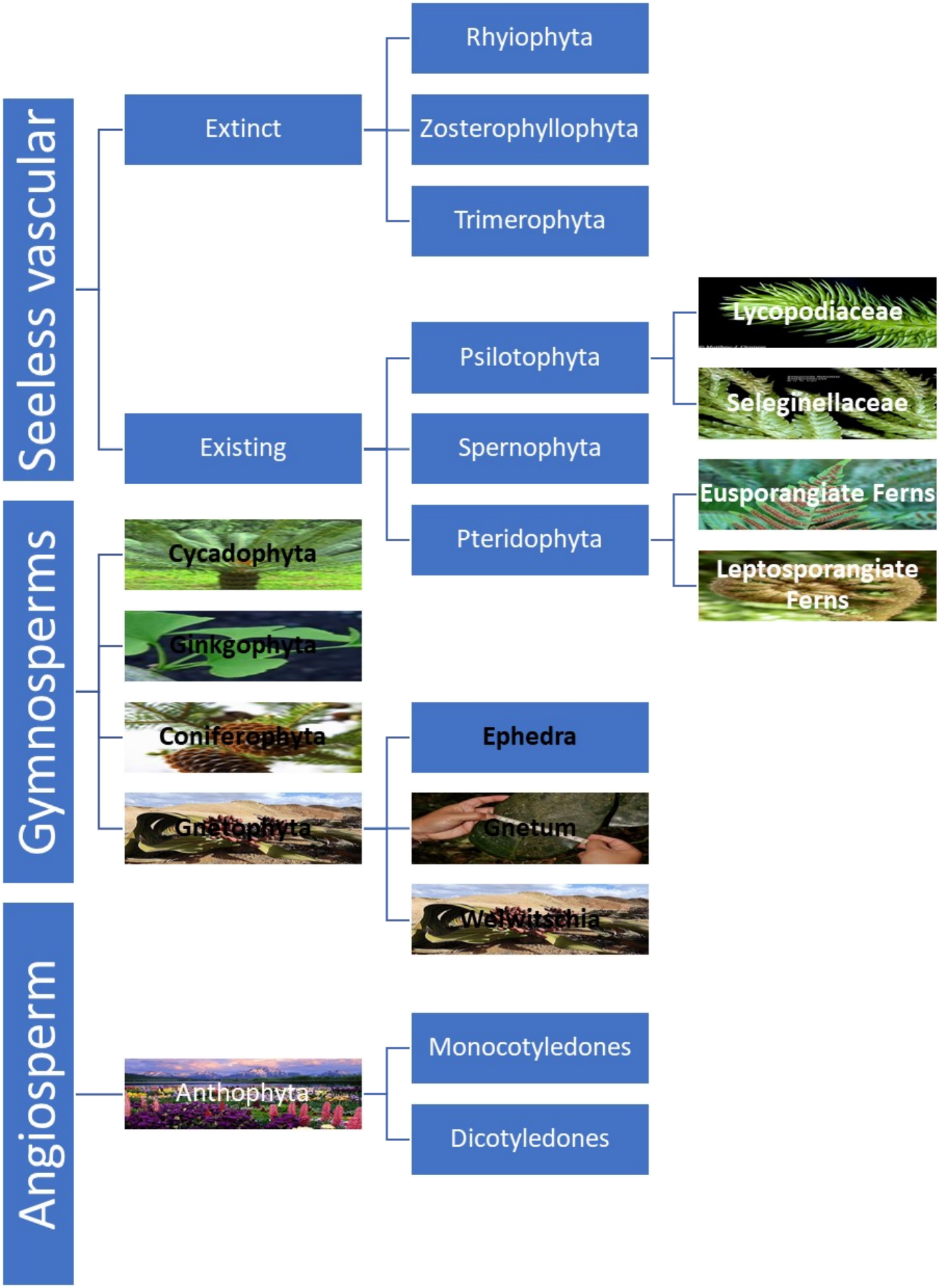
Animal	Eyesight	Smell	shape	Scent	Color/s	Time	Reward	Examples
Beetles	Poor	Good	(bowl shaped)	Fermented	White/ Dull/ Green	Day		Magnolia/ dog-wood/ lilies
Bees	Good	Good	Need landing platform	Fresh / Mild	Blue/ Yel-low / UV	Day	Nectar – bees Pollen – larvae	Rosemary
Flies	Good	Good	Landing platform	Death or Poop	Yellow w/ Red or Brown veins	Day		
Butterflies	Good	Good	Tubular corolla	Faint but Fresh	Reds	Day	Nectar	
Moths	Good	Good		Sweet	White	Night		
Birds	Good	Poor	Tubular corolla	None	Red/ Yellow	Day	A Lot of Nectar	
Bats	None	Good	Bowl Shaped	Fruity/ Mus-ty / Fer-mented	White / Green	Night		Mangos & Bana-nas
Secondary Wind	-	-	small	-	-	-		Grass, Oak Trees



Classification of Flower Based on Position of Ovary




Seeless vascular
Extinct
Rhyiophyta
Zosterophyllophyta
Trimerophyta
Existing
Psilotophyta
Lycopodiaceae
Seleginellaceae
Spernophyta
Pteridophyta
Eusporangiate Ferns
Leptosporangiate Ferns
Gymnosperms
Cycadophyta
Ginkgophyta
Coniferophyta
Gnerophyta
Ephedra
Gnetum
Welwitschia
Angiosperm
Anthophyta
Monocotyledones
Dicotyledones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Leptosporangiate Ferns
Gymnosperms
Cycadophyta
Ginkgophyta
Coniferophyta
Gnetophyta
Ephedra
Gnetum
Welwitschia
Angiosperm
Anthophyta
Monocotyledones
Dicotyledones

hardwood
Ranunculus—buttercup
Dicot root
Helianthus—Sun Flower
dicot stem eustele
Quorcus Monocot Wood radial
Quorcus Monocot Wood Tangential
Smilax—green briar
monocot root
Coleus
Shoot tip
Quorcus Monocot Wood transverse
Zea—Corn
monocot root
monocot stem
200.00 µm
Pinus Wood Radial
Medicago- Alfalfa
dicot stem eustele
Nymphaea—Water Lily
watergardenplants.co.uk
monocot stem
Leptosporangia
Cycad
Pinus
Cedrus Deodara
Ginkgo
Juniperus
Hemerocallis—day lily
Sambucus lenticel
Pinus Wood Transverse
Image Library
Leaf Mesophyte dicot
Leaf Mesophyte Monocot
Leaf Hydrophyte
Leaf Xenophyte

100x magnification
200.00 µm
Image Library
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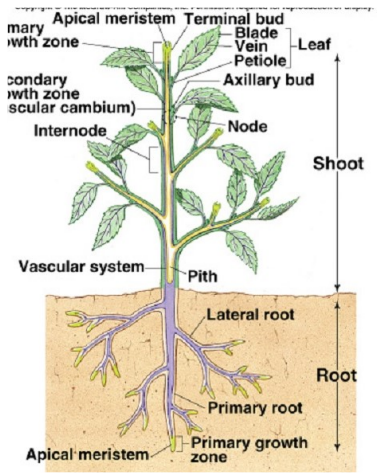


ANATOMY

Plantae

INITIAL: A cell that remains within the meristem indefinitely and, at the same time, divides and adds cells to the plant body.

EXAM IV

stoma (also *stomate*; plural **stomata**) is a tiny opening or pore that is used for gas exchange. They are mostly found on the under-surface of plant leaves.[1] In a stoma, there is the chloroplast, a cell wall, a vacuole and a cell nucleus.

PRIMARY ROOT: the first root of the plant, developing as a continuation of the root tip or radicle of the embryo, the taproot.

Mucigel is a slimy substance that covers the root cap of the roots of plants. It is a highly hydrated polysaccharide, most likely a pectin, which is secreted from the outermost (epidermal) cells of the rootcap. **Mucigel** is formed in the Golgi bodies of such cells, and is secreted through the process of exocytosis.

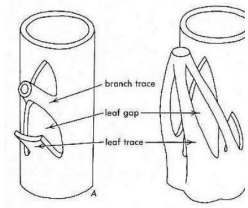
PERICYCLE:a thin layer of plant tissue between the endodermis and the phloem.

GROWTH REGIONS: A) Cell division. B) Elongation. C) Maturation (differentiation.

apical meristem the meristem at the tip of the root or shoot in a vascular plant

A ***leaf* gap** is a space in the stem of a plant through which the *leaf* grows.

The *leaf* is connected to the stem by the ***leaf trace***, which grows through the *leaf* gap. The *leaf* gap is a break in the vascular tissue of a stem above the point of attachment of a *leaf trace*.

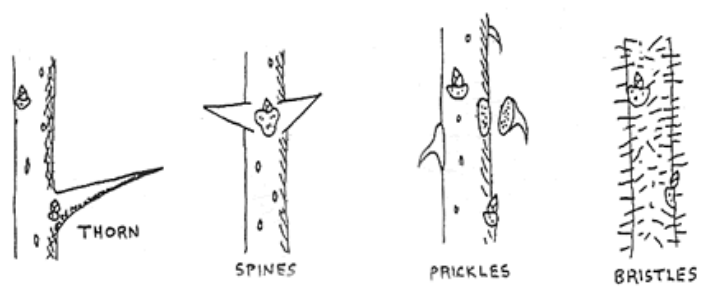


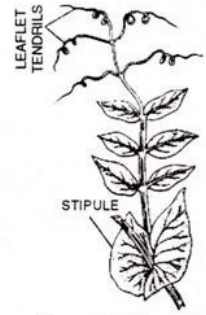
Diagrams of vascular system from stems with a unilacuna node (*B*). In *A*, a single leaf trace diverges into a leaf and tw

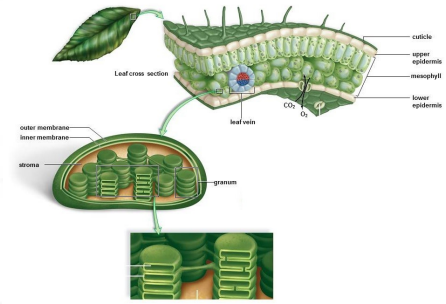
radial sheets or ribbons extending vertically through the tree across and perpendicular to the growth rings. Also called **pith rays**or wood **rays**, these formations of primarily parenchyma cells allow the radial transport of sap and are essential in the process of tylosis.

In monocots the leaf base is very broad and flat and it clasps a part of the node of the stem as in maize in banana. It is called sheathing leaf base.

PALISADES PARENCHYMA: in leaves, right below the epidermis and cuticle. They are vertically elongated, a different shape from the spongy mesophyll cells beneath them in the leaf. Their chloro-







plasts absorb a major portion of the light energy used by the leaf.

BIENNIAL: A Plant that normally requires two growing seasons to complete its life cycle, flowering and fruiting in second year.

FUSIFORM: The vertically elongated cells in the vascular cambium tht give rise to the cells of the axial system in secondary xylem and secondary phloem.

RAY INITIALS: An initial in the vascular cambium that gives rise to the ray cells of secondary xylem and secondary phloem

HARDWOOD: A name commonly applied to the wood of a (angiosperms) magnoliid or eudicot tree.

MORPHOLOGY: [Gk. Morphe—from + logos—discourse] Study of form and its development.

The **ground tissue of** plants includes all tissues that are neither dermal nor vascular. It can be divided into three types based on the nature of the cell walls. 1) Parenchymacells have thin primary walls and usually remain alive after they become mature. **Parenchyma** forms the "filler" tissue in the soft parts of plants.usually present in cortex, pericycle, pith,and medullary rays in primary stem and root.2) **Collenchyma** cells have thin primary walls with some areas of secondary thickening. Collenchyma provides extra structural support, particularly in regions of new growth. 3**)Sclerenchyma** cells have thick lignified secondary walls and often die when mature. Sclerenchyma provides the main structural support to a plant.[1]

FIBER: An elongated, tapering, generally thick-walled sclerenchyma cell of vascular plants; its walls may or may not be lignigied; it may or may not have a living protoplast at maturity.

SIMPLE TISSUE: Parenchyma, Collenchyma, Sclerenchyma.

WOODY PERENNIALS: woody perennials are plants with stems that do not die back and instead grow with each passing season. Trees and shrubs are woody perennials as well as various species of vines and fruit.

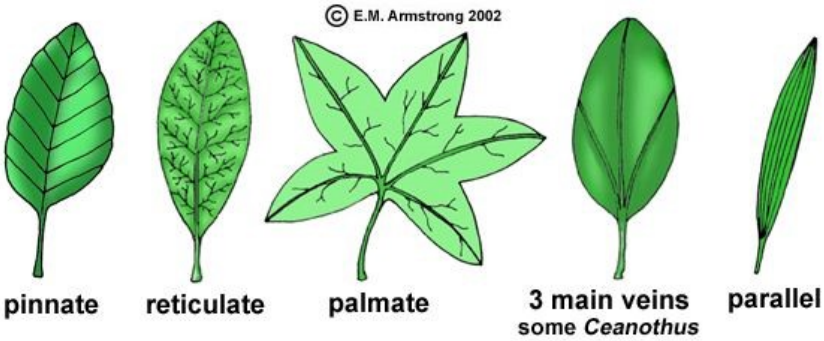
PERENNIAL: lasting or existing for a long or apparently infinite time; enduring or continually recurring.

PRICKLES: Prickles are comparable to hairs but can be quite coarse (for example, rose prickles). They are extensions of thecortex and epidermis.[8][9] Technically speaking, many plants commonly thought of as having thorns or spines actually have prickles. Roses, for instance, have prickles.

BUNDLE SHEATH: A layer or region of compactly arranged cells surrounding a vascular bundle in a plant. The bundle sheaths regulate the movement of substances between the vascular tissue and the parenchyma and, in leaves, protect the vascular tissue from exposure to air.

Plant Growth

- Zone of Cell Division: the zone of primary growth in roots consisting of the root apical meristem and its derivatives. New root cells are produced in this region.
- Zone of Elongation: the zone of primary growth in roots where new cells elongate, sometimes up to ten times their original length
- Cell elongation is mainly responsible for pushing the root tip farther into the soil
- Zone of Maturation: the zone of primary growth in roots where cells complete their differentiation and become functionally mature



Wood

Early wood or Spring wood

1. Formed during spring season.

2. Formed early in a year.

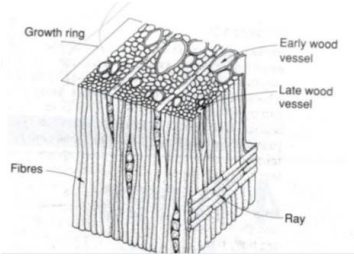
3. Consists of xylem tissues with wider vessels.

4. Produced more in amount.

5. Less dense.

6. A broad zone of wood.

7. Not as strong as late wood.



Late wood or Autumn wood

1. Formed during winter season.

2. Formed after the early wood.

3. Consists of xylem elements with narrow vessels.

4. Produced less in amount.

5. More dense.

6. A narrow zone of wood.

7. Stronger than early wood due to larger volume of wall materials.

VASCULAR CAMBIUM: The vascular cambium (also called main cambium, wood cambium, bifacial cambium; plural cambia) is a plant tissue located between the xylem and the phloem in the stems and roots of vascular plants. It is a cylinder of unspecialized meristem cells that divide to form secondary vascular tissues.

RETICULAR VENATION: Reticulate venation-veins are interconnected and form a web like network. Parrallel venation-A pattern in the veins of a leaf where the secondary veins run parallel to each other off of a central, perpendicular primary vein.

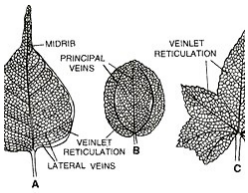
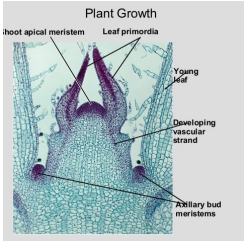
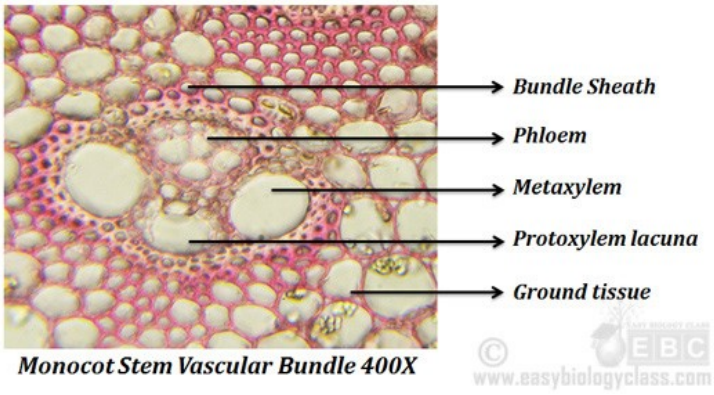


Fig. 5.54. Types of reticulate venation. A, unicostate; B, multicostate convergent of *Zizyphus* (**Ber**); C, divergent of *Luffa*.

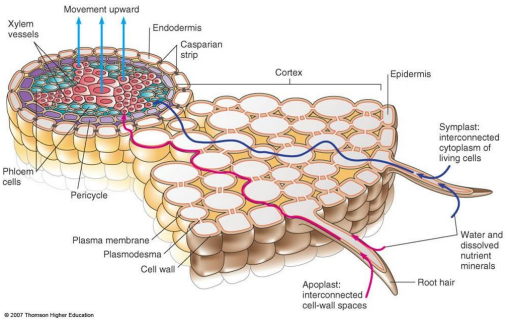
LEAF PRIMORDIA: a group of cells that will develop into a leaf, seen as small bulges just below the shoot apex.



METAXYLEM: the part of the primary xylem that differentiates after the protoxylem and that is distinguished typically by broader tracheids and vessels with pitted or reticulate walls



CASPARIAN STRIPS: a band of cell wall material deposited in the radial and transverse walls of the endodermis, and is chemically different from the rest of the cell wall - the cell wall being made of lignin and without suberin - whereas the Casparian strip is made of suberin and sometimes lignin



ROOT CAP: The root cap is a section of tissue at the tip of a plantroot. It is also called calyptra. Root caps contain statocytes which are involved in gravity perception in plants. If the cap is carefully removed the root will grow randomly. The root cap protects the growing tip in plants.

EPIDERMIS: a single layer of cells that covers the leaves, flowers, roots and stems of **plants**. It forms a boundary between the **plant** and the external environment.

PHLOEM: the living tissue that transports the soluble organic compounds made during photosynthesis and known as photosynthates, in particular the sugar sucrose, to parts of the plant where needed.

XYLEM: one of the two types of transport tissue in vascular plants, phloem being the other. The basic function of xylem is to transport water from roots to shoots and leaves, but it also transports some nutrients. The word "xylem" is derived from the Greek word ξύλον (xylon), meaning "wood";

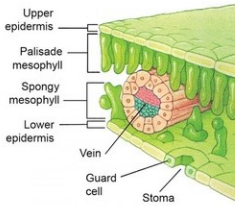
COLLENCHYMA: Parenchyma forms the "filler" tissue in the soft parts of plants.usually present in cortex, pericycle, pith,and medullary rays in primary stem and root.2) Collenchyma cells have thin primary walls with some areas of secondary thickening. Collenchyma provides extra structural support, particularly in regions of new growth.

COMPLEX TIXXUE: The complex tissue consists of more than one type of cells which work together as a unit. Complex tissueshelp in the transportation of organic material, water and minerals up and down the plants. That is why it is also known as conducting and vascular tissue.

GROWTH RINGS: a cross section of the stem of a woody plant, the increment of wood added during a single growth period. In temperate regions the growth period is usually one year, in which case the growth ringmay be called an “annual ring.” In tropical regions, growth rings may not be discernible or are not annual.

LENTICELS: one of many raised pores in the stem of a woody plant that allows gas exchange between the atmosphere and the internal tissues.

VEINS: Veins are composed of xylem and phloem cells embedded in parenchyma, sometimes sclerenchyma, and surrounded by bundle sheath cells. The vein xylem transports water from the petiole throughout the lamina mesophyll, and the phloem transports sugars out of the leaf to the rest of the plant.



MESOPHYLL: In dicotyledonous leaves there are two types of mesophyll cell; palisade mesophyll and spongy mesophyll.Palisade mesophyll cells are elongate and form a layer beneath the upper epidermis, whereas spongymesophyll cells are internal to the lower epidermis

PETIOLE: the stalk that joins a leaf to a stem; leafstalk.

LAMINA: a broad expanded blade

INTERCALARY MERISTEMS: classified by their location in the plant as apical (located at root and shoot tips), lateral (in the vascular and cork cambia), and intercalary (at internodes, or stem regions between the places at which leaves attach, and leaf bases, especially of certain monocotyledons— e.g., grasses).

PROTOXYLEM: As a young vascular plant grows, one or more strands of primary xylem form in its stems and roots. The first xylem to develop is called 'protoxylem'. In appearance protoxylem is usually distinguished by narrower vessels formed of smaller cells

ENDODERMIS: an inner layer of cells in the cortex of a root and of some stems, surrounding a vascular bundle.

FIBROUS ROOTS: usually formed by thin, moderately branching roots growing from the stem. A fibrous rootsystem is universal in monocotyledonous plants and ferns. The fibrous root systems look like a mat made out of roots when the tree has reached full maturity.

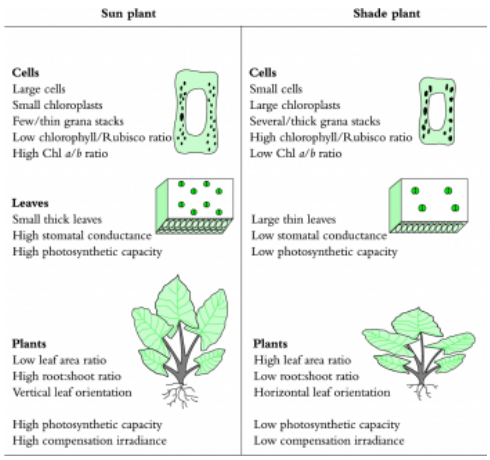
PERIDERM: comprises phellem, phellogen, and phelloderm. periderm. initially located beneath epidermis, however in roots and stems of woody plants eventually replaces epidermis as outer protective tissue.

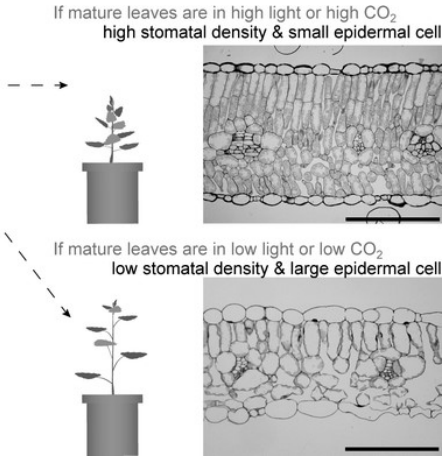
CORK CAMBIUM: a tissue found in many vascular plants as part of the epidermis. The cork cambium is a lateral meristem and is responsible for secondary growth that replaces the epidermis in roots and stems.

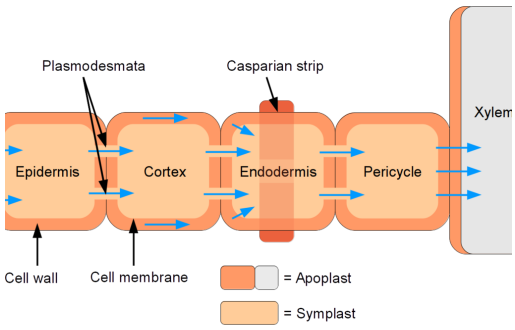
LIGNIN: Lignin is a class of complex organic polymers that form important structural materials in the support tissues of vascular plants and some algae. Lignins are particularly important in the formation of cell walls, especially in wood and bark, because they lend rigidity and do not rot easily.

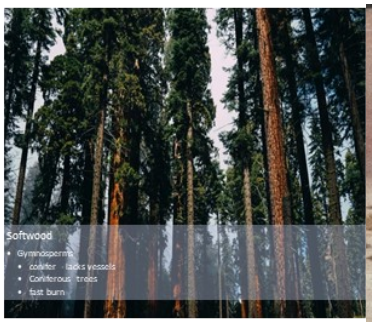
SCLEREIDS: a reduced form of sclerenchyma cells with highly thickened, lignified cellular walls that form small bundles of durable layers of tissue in most plants.

PARENCHYMA: the cellular tissue, typically soft and succulent, found chiefly in the softer parts of leaves, pulp of fruits, bark and pith of stems, etc.









SPONGY MESOPHYLL: the site of gaseous exchange for photosynthesis and respiration. See also PALISADEMESOPHYLL. "spongy mesophyll."

SESSIL: (meaning "sitting", used in the sense of "resting on the surface") is a characteristic of plant parts which have no stalk. Flowers or leaves are borne directly from the stem or peduncle, and thus lack a petiole or pedicel. The leaves of the vast majority of monocotyledons lack petioles.

Wood Structure

Hardwood

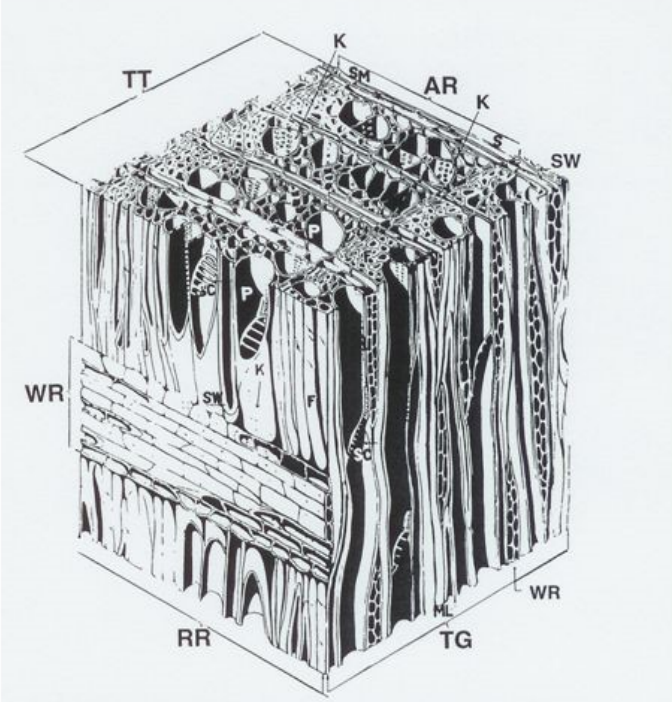


FIGURE 2.23. Anatomy of angiosperm wood. TT, Transection; RR, radial section; TG, tangential section; P, vessel; SC, perforation plate at end of vessel; F, fibers; K, pit; WR, wood ray; AR, annual ring; S, earlywood; SM or SW, latewood; ML, middle lamella. Courtesy of the U.S. Forest Service.

Softwood

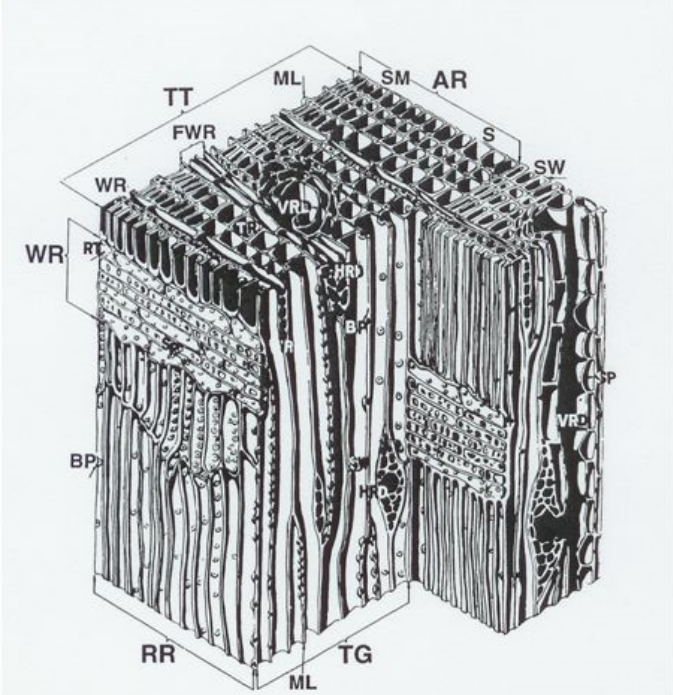
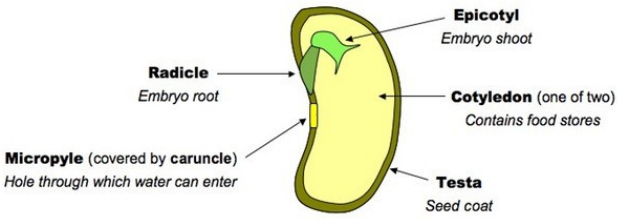
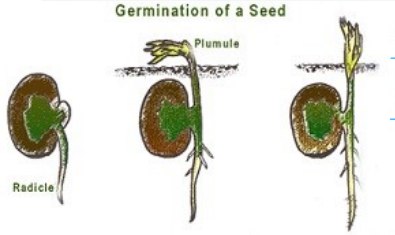
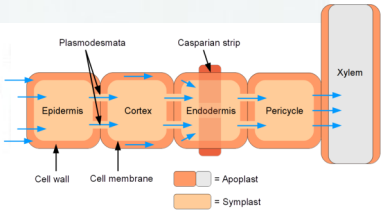
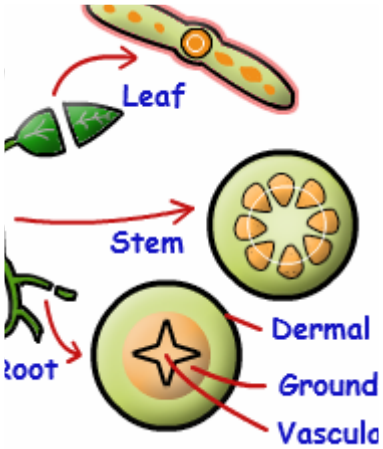


FIGURE 2.19. Anatomy of gymnosperm wood. TT, Transection; RR, radial section; TG, tangential section; TR, tracheids; ML, middle lamella; S, earlywood; SM or SW, latewood; AR, annual ring; WR, wood ray; RT, ray tracheid; FWR, fusiform wood ray; SP, simple pit; BP, bordered pit; HRD, horizontal resin duct; VRD, vertical resin duct. Courtesy of the U.S. Forest Service.









DIFFERENTIATION: How genetically identical cells become different.

MORPHOGENESIS: acquisition of a particular shape apperiance

SIMPLE TISSUE: Only have 1 kind of cell.

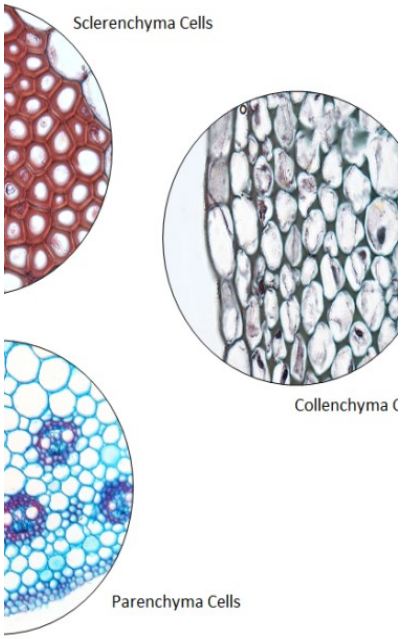
COMPLEX TISSUE: more than 1 kind of cells

GROWTH (In plants): Will have Cell Division and Cell Enlargement

- Some tissues are dead at maturity—When they are functional, they are actually dead.

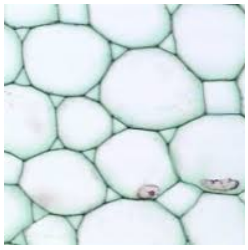
TISSUE SYSTEMS

Plantae



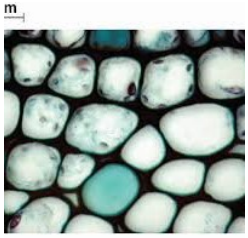
GROUND

Parenchyma



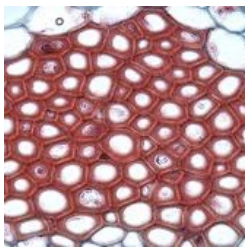
- Simple Tissue
- Alive at maturity
- Most abundant ground tissue
- Photosynthesis, secretion, storage
- Advantage: retains ability to divide.

Collenchyma



- Simple tissue
- Alive at maturity
- Extra reinforcing cellulose (especially in corners)
- Support in elongating plant organs
- Along veins
- Like celery strings
- Mainly in things that are still growing.

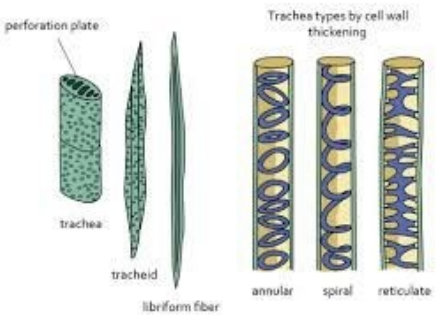
Sclerenchyma



- Complex tissue
- Dead at maturity
- Hard
- 1. fibers (pointy at ends, hemp, bundles, flax (linen) Jutecrope) SUPPORT
- 2. Sclereids, irregular in shape. (grit in pears) walnut, pecan shells) PROTECTION

VASCULAR

Xylem



- Transports H2O and minerals
- Complex tissue
- Dead at maturity

Contains:

1) **Tracheary element** (Pipes/Tubes)

    A. Tracheids (found in all vascular plants.

    B. Vessels (found only in Gnetophyta and Anthophyta)

2) Fibers for additional strength.

3) Parenchyma (It can still divide, can repair and regenerate.

PICTURED: 1. puts down lignen formed in rings 2. helical thickening, rings start to joing, stretch eventually goes away and elongation is over (like a coiled spring). 3. Pits don't have lingdin, full length and now dead and fully functional.

Phloem

- Trnasports nutrients, larger molecules, hormones
- Complex tissues
- Alive at maturity
- Contains:

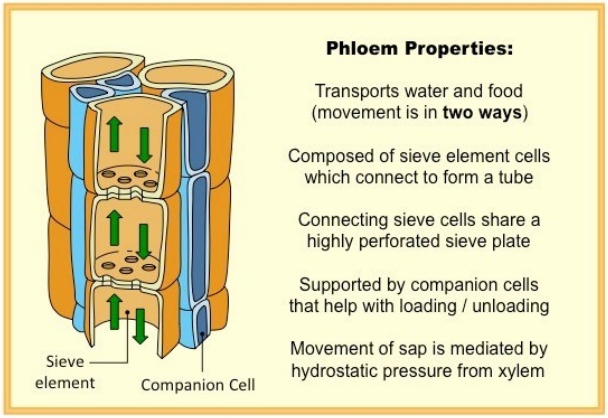
1) Sieve elements

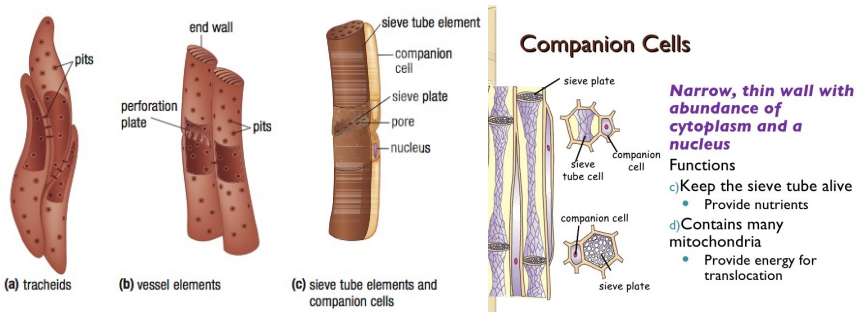
    A. sieve cells—all vascular plants except flowers/Anthopyta

    B. Sieve tube members—only Anthophyta. No nucleus, companion cells maintain STM2

2) Fibers

3) Parenchyma





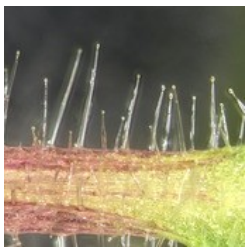
DERMAL

Epidermis

- The epidermis is the outermost layer of cells/ primary growth
- One layer of cells covered by cuticle

CUTICLE: waxy layer that prevents water loss

TRICHOMES: Hairs:



root hairs that absorb H2O

Anywhere else: defense (most animals don't like hairy stuff—deters predators

Dessert plants: gray or silver leaves—cool leaves (reflect solar radiation)

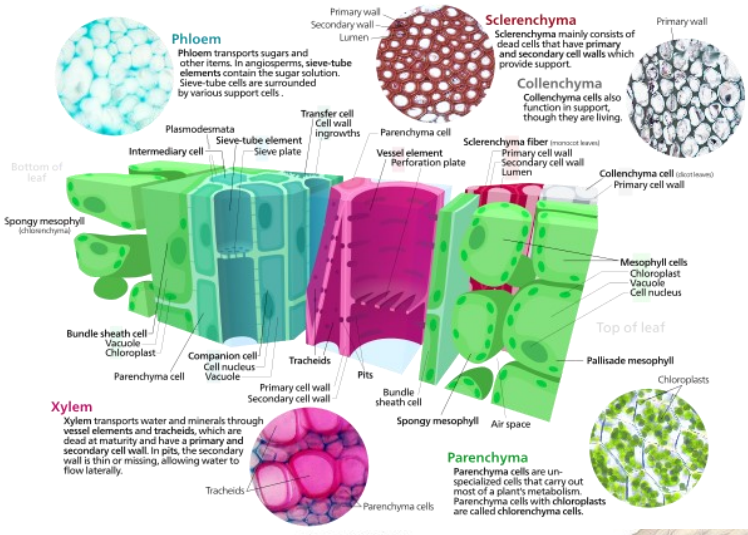
Periderm

- Replaces epidermis in woody plants: bark

PHELLOGEN: cork cambium

PHELLEM: cork to the outside

PHELLODERM: parenchyma to inside



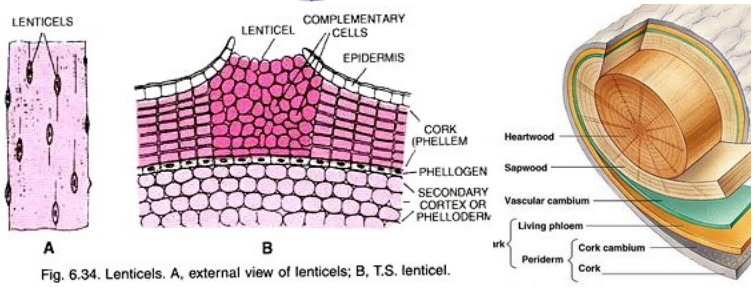
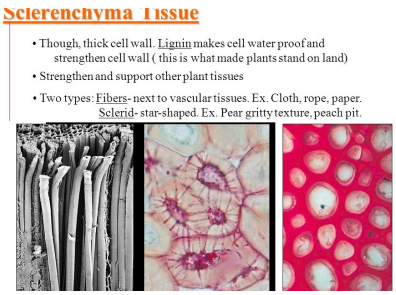
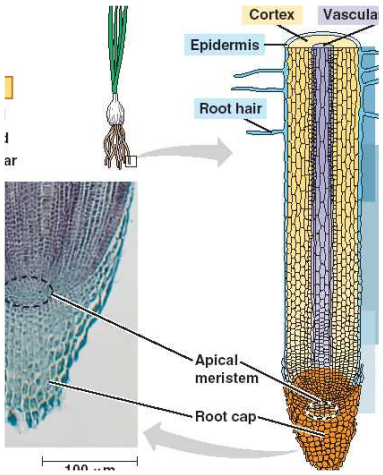


Fig. 6.34. Lenticels. A, external view of lenticels; B, T.S. lenticel.



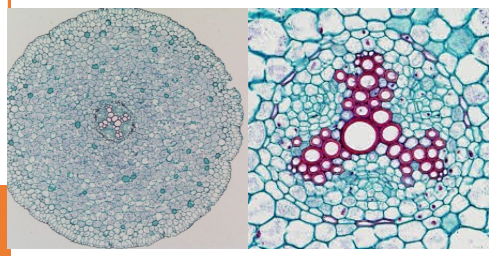


ROOTS

Taproot

Taproots; good for reaching deep water—Dicots

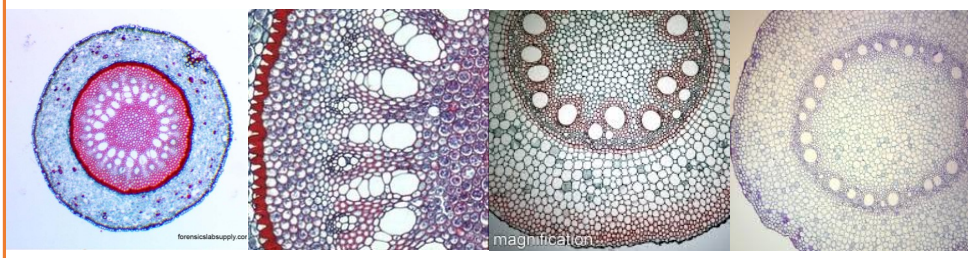
Ranunculus



BODY

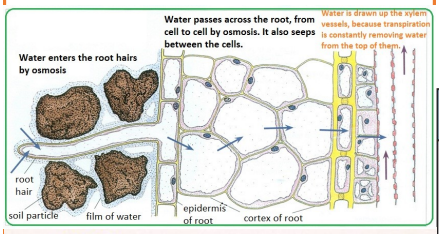
Fibrous

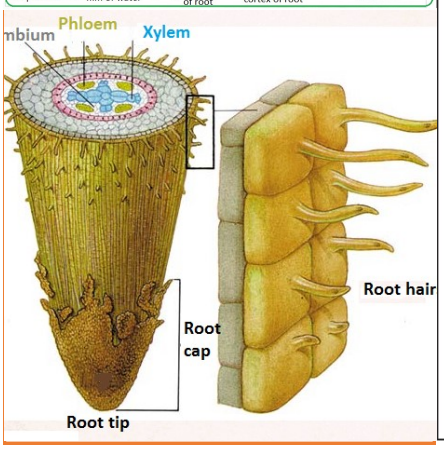
Good for erosion prevention and easy to remove.

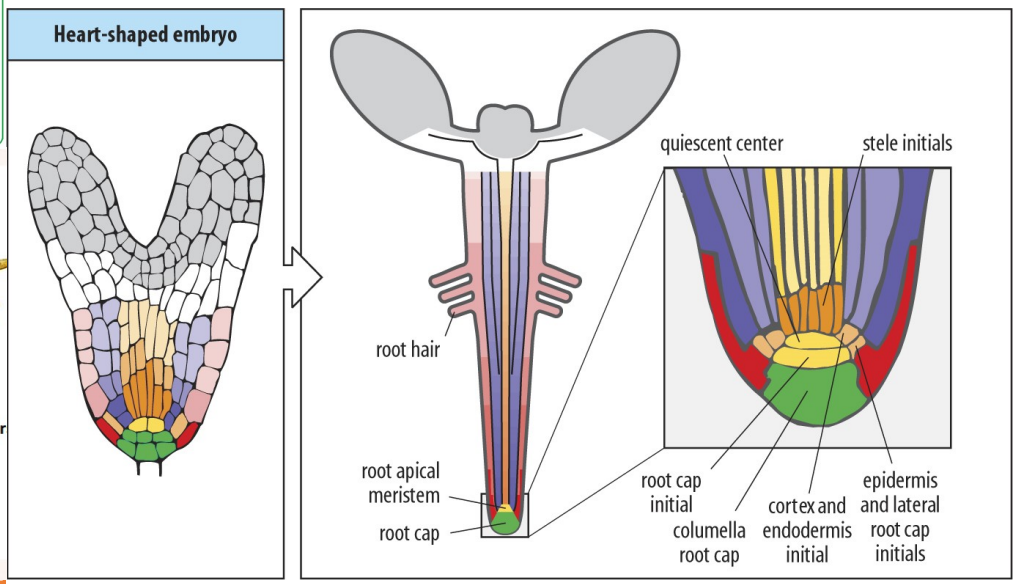


Plantae

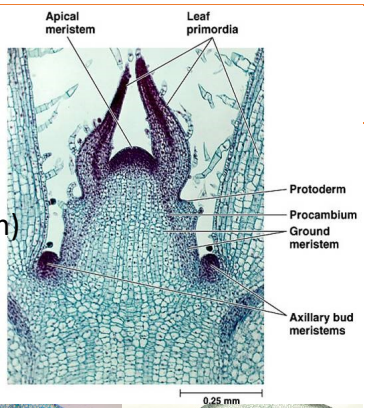
- Absorption
- Anchoring
- Storage







SHOOTS

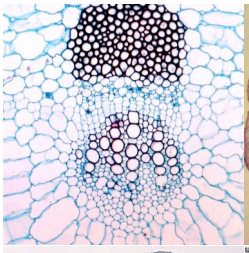
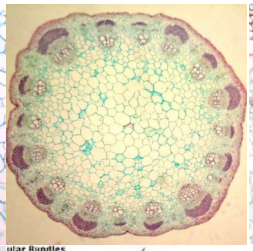
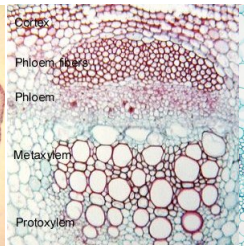


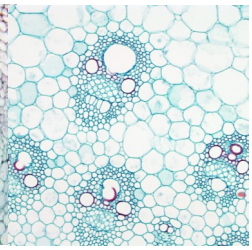
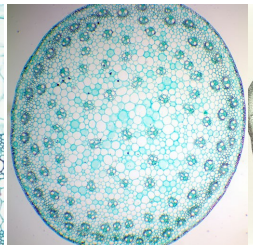
Stems

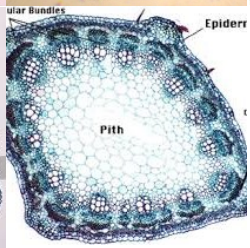
- Conduction
- Support
- Photosynthesis (if green)

Dicot

Monocot

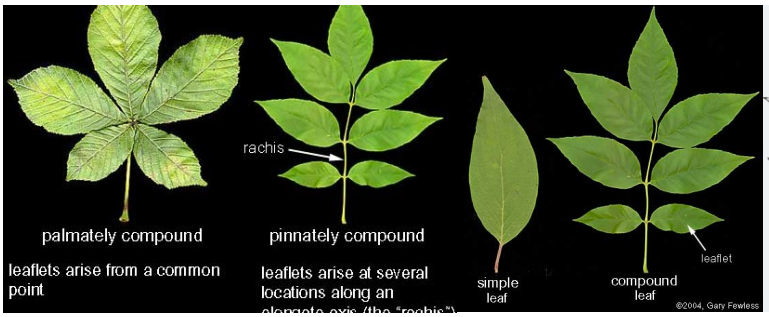



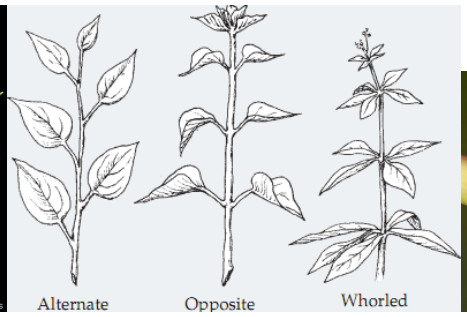


Leaves

- Photosynthesis
- RADICLE: 1. Embryonic root
- Plumule—epicotul –embryonic shoot (epical meristem)

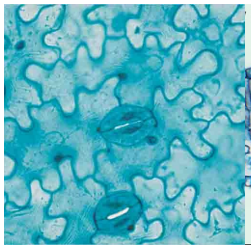
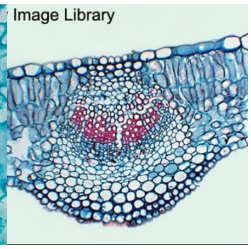
SESSILE: No petiore sheathing leaf base (like corn)

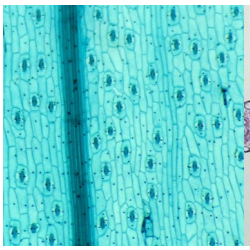
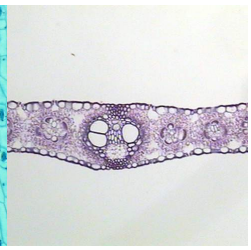




Mesophyte—Dicot

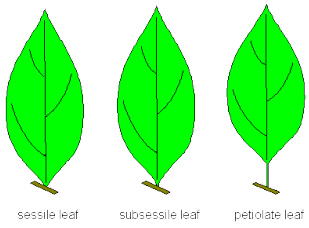
Mesophyte—Monocot

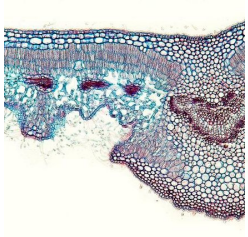
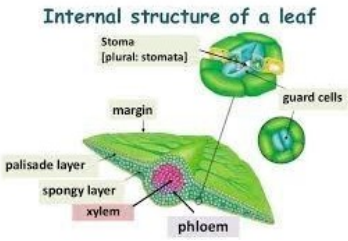



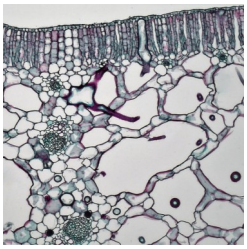
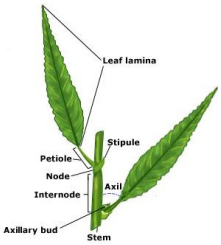



Xerophyte

Hydrophyte



WOOD

Not every plant produces wood.

VASCULAR CAMBIUM: Lateral meristem—makes things get fatter (girth)

- Produces secondary xylem and secondary phloem
- First forms in middle of vascular bundle
- Ray initials: secondary paranchyma

Xylem pushes into pith—lingdin fills in with secondary xylem. Phloem pushes in to cortex—cork cambium makes bark.

Phelloderm is secondary parenchyma

Wood is secondary xylem

Density = mass/volume

Density is predictor of strength.

Oak > pine

Hardwood

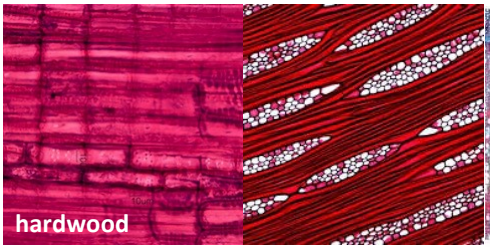
- Dicot trees
- Vessels and tracheids
- Multiseriate rays (more than 1 cell)

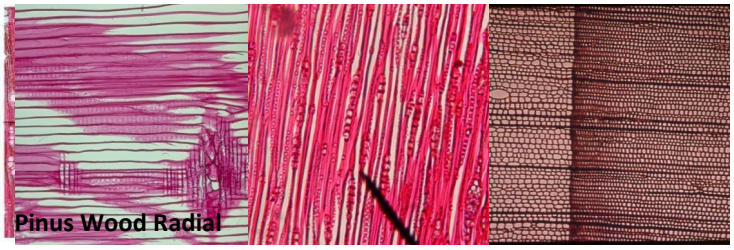
Softwood

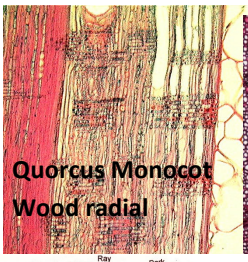
Gymnosperm trees

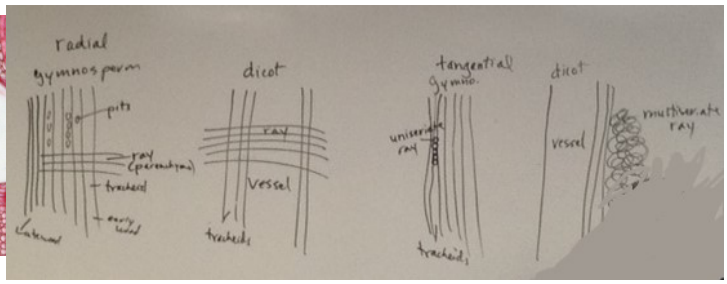
Tracheids only

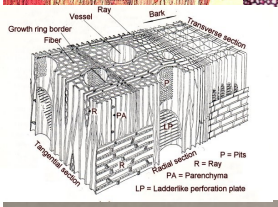
Uniseriate rays (only one cell)

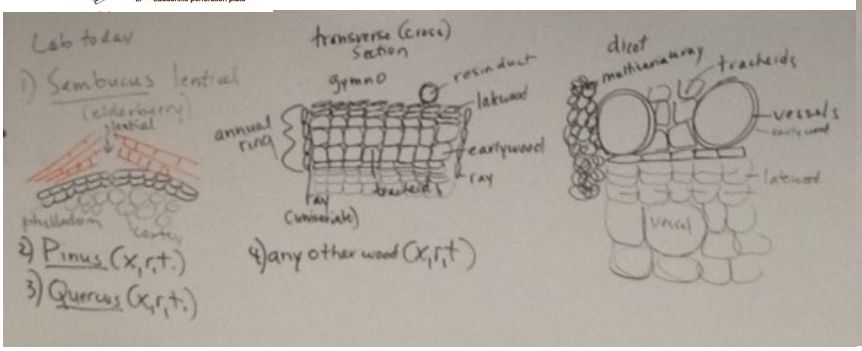


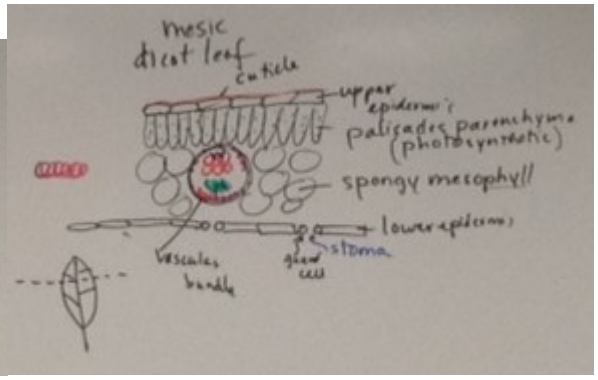


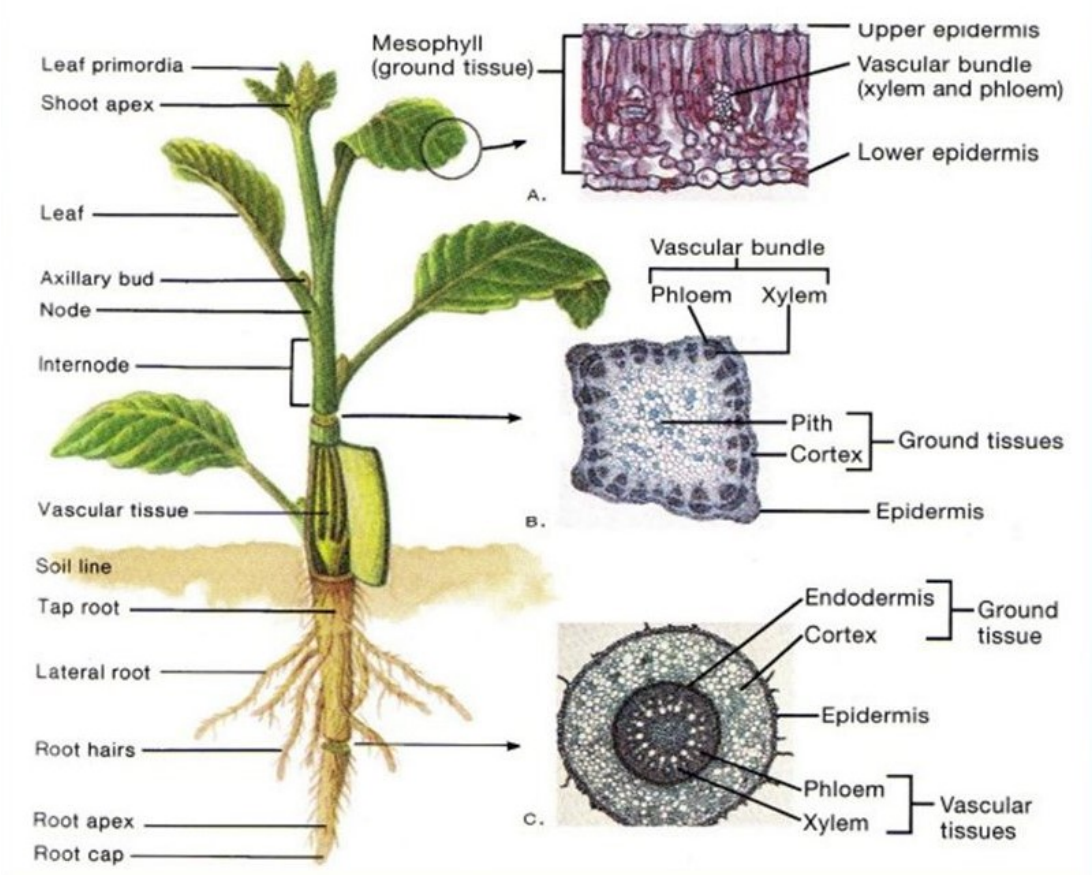


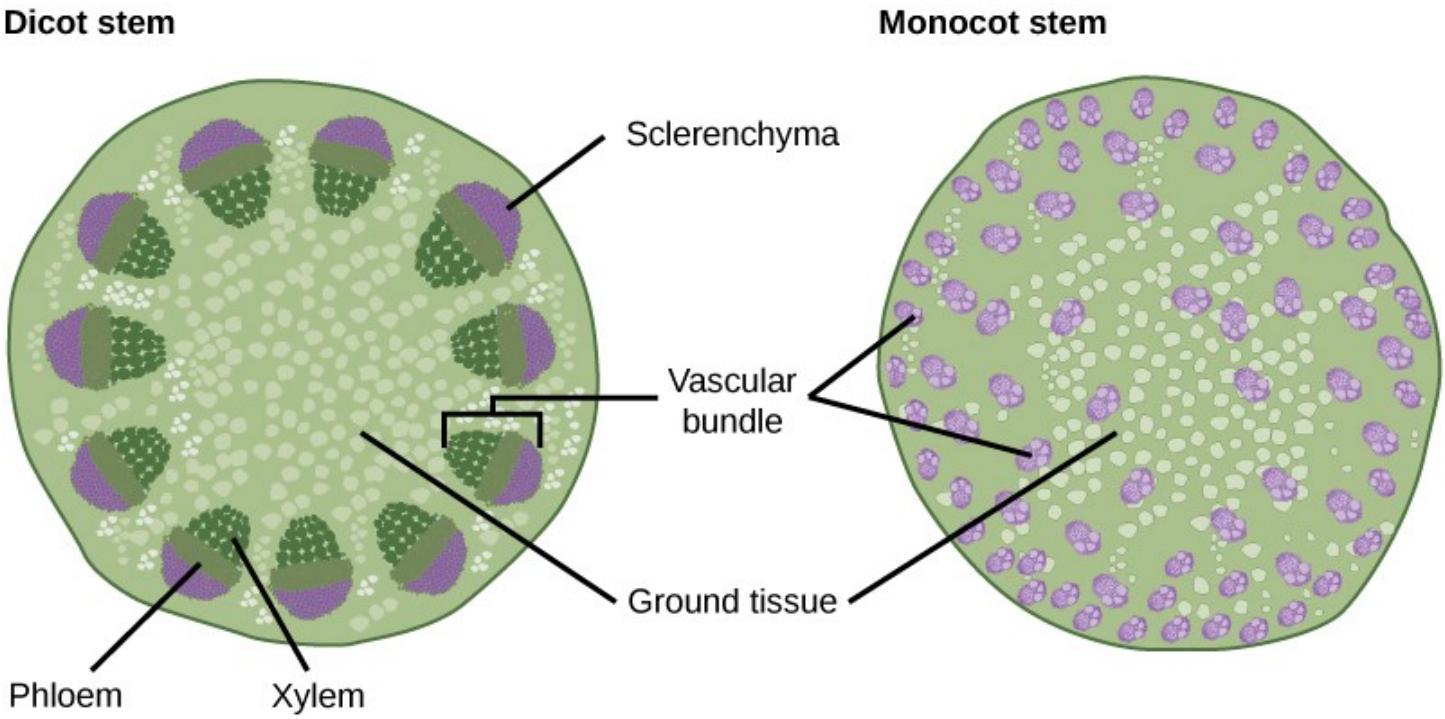









Leaf primordia
Shoot apex
Leaf
Axillary bud
Node
Internode
Vascular tissue
Soil line
Tap root
Lateral root
Root hairs
Root apex
Root cap
Mesophyll (ground tissue)
Upper epidermis
Vascular bundle (xylem and phloem)
Lower epidermis
A.
Vascular bundle
Phloem
Xylem
Pith
Cortex
Ground tissues
Epidermis
B.
Endodermis
Cortex
Ground tissue
Epidermis
Phloem
Xylem
Vascular tissues
C.


Dicot stem
Monocot stem
Sclerenchyma
Vascular bundle
Ground tissue
Phloem
Xylem