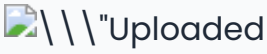
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Classification and Characteristics

- Multicellular, photosynthetic organisms; major producers in biosphere.
- Habitats: aquatic, terrestrial, and others.
- Classification systems evolved: artificial (Linnaeus), natural (Bentham & Hooker), phylogenetic (evolution-based).
- Artificial systems: based on few characters, separated related species, gave equal weight to vegetative and sexual traits.
- Natural systems: based on natural affinities, consider external and internal features (anatomy, embryology, phytochemistry).
- Phylogenetic systems: group organisms by common ancestry.
- Modern methods: numerical taxonomy (computer-based, all characters weighted equally), cytotaxonomy (chromosome data), chemotaxonomy (chemical constituents).
- Plant kingdom divided into Cryptogamae (non-seed plants) and Phanerogamae (seed plants).

Memory Aids

- Cryptogamae = \\"hidden seeds\\" (no seeds).
- Phanerogamae = \\"visible seeds\\" (seed plants).
- Phylogenetic = \\"family tree\\" classification.

Quick Checkpoints

- Difference between artificial and natural classification?
- What is basis of phylogenetic classification?
- Examples of modern taxonomy methods?

Algae

General Characteristics

- Simple, chlorophyll-containing, autotrophic, mostly aquatic organisms.
- Habitats: freshwater, marine, moist terrestrial, symbiotic (e.g., lichens with fungi, on animals).
- Unusual habitats include halophytic (saline), epiphytic (on plants), epizoic (on animals), endozoic (inside animals), parasitic, thermophytic (hot springs).
- Forms vary: unicellular (Chlamydomonas), colonial (Volvox), filamentous (Ulothrix), large kelps (brown algae).
- Vegetative body called thallus; cell wall has inner cellulose and outer pectin layers.
- Photosynthetic pigments: chlorophyll a (all), chlorophyll b, c, d; carotenoids (carotenes-orange, xanthophylls-yellow); phycobilins (phycocyanins, phycoerythrins).
- Food reserves: starch, laminarin, mannitol, floridean starch.
- Reproduction: vegetative (fragmentation), asexual (zoospores - flagellated, motile), sexual (isogamy, anisogamy, oogamy).

Memory Aids

- Thallus = simple plant body without true roots, stems, leaves.
- Isogamy = equal gametes; Anisogamy = unequal gametes; Oogamy = large non-motile egg + small motile sperm.
- Kelps = large brown algae, \\"trees of the sea\\".

Quick Checkpoints

- What pigments are common in all algae?
- Define thallus and its cell wall composition.
- Types of sexual reproduction in algae?

Classification of Algae

Major Classes

- Based on phylogeny and affinities, algae classified by Dr. F.E. Fritsch.
- Whittaker's system divides algae into three main classes: Chlorophyceae (green), Phaeophyceae (brown), Rhodophyceae (red).

Memory Aids

- Chlorophyceae = green algae; Phaeophyceae = brown algae; Rhodophyceae = red algae.

Quick Checkpoints

- Who classified algae based on phylogeny?
- What are the three main classes of algae?

Chlorophyceae

Characteristics

- Commonly called green algae; plant body unicellular, colonial, or filamentous.
- Photosynthetic pigments: chlorophyll a and b in definite chloroplasts (reticulate, cup-shaped, spiral, or ribbon-shaped).
- Pyrenoids in chloroplasts store protein and starch; some store oil droplets.
- Cell wall: inner cellulose layer, outer pectose layer.
- Reproduction: vegetative by fragmentation/spores; asexual by flagellated zoospores; sexual by isogamy, anisogamy, or oogamy.

Memory Aids

- Green algae = chlorophyll a + b, pyrenoids present.
- Reproduction types: all three sexual modes possible.

Quick Checkpoints

- What pigments are present in Chlorophyceae?
- Describe the cell wall layers.
- Modes of reproduction in Chlorophyceae?

Phaeophyceae

Characteristics

- Commonly called brown algae; mostly marine.
- Range from simple filamentous (Ectocarpus) to large kelps (up to 100 m).
- Pigments: chlorophyll a, carotenoids, xanthophylls (fucoxanthin gives brown color).
- Plant body parts: holdfast (attachment), stipe (stalk), frond (leaf-like).
- Reproduction: vegetative by fragmentation; asexual by biflagellate zoospores (pear-shaped, two unequal flagella); sexual by isogamy, anisogamy, or oogamy.
- Gametes are pear-shaped with two lateral flagella; fusion in water or oogonium.

Memory Aids

- Brown algae = fucoxanthin pigment.
- Body parts: holdfast, stipe, frond.
- Zoospores have two unequal flagella.

Quick Checkpoints

- What pigment causes brown color in Phaeophyceae?
- Name the three main body parts of brown algae.
- Describe zoospore flagella in brown algae.

Rhodophyceae

Characteristics

- Commonly called red algae due to red pigment phycoerythrin.
- Found near surface and at great ocean depths (low light).
- Food stored as floridean starch (similar to glycogen and amylopectin).
- Mostly multicellular with complex body organization.
- Reproduction: vegetative by fragmentation; asexual by non-motile spores; sexual reproduction oogamous with complex post-fertilization development.

Memory Aids

- Red algae = phycoerythrin pigment.
- Floridean starch as food reserve.
- Sexual reproduction is oogamous with non-motile gametes.

Quick Checkpoints

- What pigment gives red algae their color?
- What is the food reserve in Rhodophyceae?
- Describe sexual reproduction in red algae.

Economic Importance of Algae

Uses

- Food: Edible algae include *Porphyra*, *Laminaria*, *Sargassum*; *Chlorella* is protein-rich supplement.
- Photosynthesis: Algae contribute ~50% of Earth's photosynthesis; vital for aquatic respiration.
- Phycocolloids:
    - Alginic acid (from brown algae) used in emulsions, flameproof plastics, security glass.
    - Agar-agar (from red algae) used as solidifying agent in culture media.
    - Carrageenan (from red algae) used in pharmaceuticals, cleaning, textile, leather, brewing.
- Medicines: Antibiotics from brown (*Laminaria*, *Ascophyllum*) and green algae (*Chlorella*, *Caulerpa*); vermifuge from *Durvillea*; worm infection cure from red algae *Corallina*.
- Sewage disposal: Green algae (*Chlamydomonas*, *Chlorella*, *Scenedesmus*) aid aerobic sewage treatment.

Memory Aids

- Alginic acid = brown algae; Agar = red algae.
- Algae = major oxygen producers in water.
- Medicinal algae: antibiotics and vermifuge sources.

Quick Checkpoints

- Name algae used as food supplements.

- What phycocolloids are derived from algae?
- Role of algae in sewage treatment?

Additional Facts

Key Points

- Study of algae is called phycology.
- Algae are non-embryophytes: no embryo, unicellular non-jacketed sex organs.
- *Batrachospermum*: freshwater filamentous red alga, called frog spawn alga.
- *Laminaria* species known as Devil's Apron.
- *Macrocystis pyrifera* is the largest alga.
- Brown algal cells may have fucosan vesicles containing phenolic fucosan.
- *Spirogyra* called pond silk due to mucilage shining like silk.

Memory Aids

- Phycology = algae study.
- Non-embryophytes = no embryo formation.
- Largest alga = *Macrocystis pyrifera*.

Quick Checkpoints

- What is phycology?
- Define non-embryophytes.

- Which is the largest alga?

General Characteristics

Overview

- Bryophytes are called amphibians of the plant kingdom; live on soil but need water for sexual reproduction.
- Found in damp, humid, shaded areas; important in succession on bare rocks/soil.
- Plant body is thallus-like, prostrate or erect, attached by unicellular/multicellular rhizoids.
- Lack true roots, stems, or leaves but may have similar structures.
- Main plant body is haploid gametophyte producing gametes.
- Male sex organ: antheridium producing biflagellate antherozoids.
- Female sex organ: flask-shaped archegonium producing a single egg.
- Antherozoids swim in water to fertilize egg forming zygote.
- Zygote forms sporophyte attached to gametophyte; sporophyte produces haploid spores by meiosis.
- Spores germinate into gametophytes, completing life cycle.

Memory Aids

- \\"Amphibians\\" = need water for reproduction.
- Gametophyte is dominant and haploid.
- Antheridium = male; Archegonium = female.
- Sporophyte depends on gametophyte.

Quick Checkpoints

- Why are bryophytes called amphibians of plant kingdom?
- What is the dominant phase in bryophytes?
- Structure and function of antheridium and archegonium?
- Relationship between sporophyte and gametophyte?

Types of Bryophytes

Liverworts

- Also called Hepaticopsida or Hepaticae.
- Grow in moist, shady habitats: banks, marshy ground, damp soil, tree bark.
- Plant body is thalloid (e.g., *Marchantia*), dorsiventral, closely attached to substratum.
- Leafy liverworts have tiny leaf-like appendages in two rows on stem-like structures.
- Asexual reproduction by fragmentation or gemmae (multicellular buds) in gemma cups.
- Sexual reproduction: male and female sex organs on same or different thalli.
- Sporophyte has foot, seta, and capsule; spores formed after meiosis germinate into gametophytes.
- Examples: *Riccia*, *Marchantia*.

Mosses

- Dominant gametophyte stage with two phases: protonema and leafy stage.

- Protonema: creeping, green, branched, filamentous stage from spore.
- Leafy stage develops from lateral buds on secondary protonema; upright axes with spirally arranged leaves.
- Attached to soil by multicellular, branched rhizoids.
- Vegetative reproduction by fragmentation and budding in secondary protonema.
- Sex organs (antheridia and archegonia) at apex of leafy shoots.
- After fertilization, zygote forms sporophyte with foot, seta, capsule containing spores.
- Examples: *Funaria*, *Polytrichum*, *Sphagnum*.

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Memory Aids

- Liverworts = Hepaticae, thalloid, gemma cups for asexual reproduction.
- Mosses = protonema + leafy gametophyte, sporophyte with capsule.
- *Funaria* and *Sphagnum* are common moss examples.

Quick Checkpoints

- What are gemmae and their role in liverworts?
- Describe protonema and leafy stages in mosses.
- Structure of sporophyte in bryophytes?
- Examples of liverworts and mosses?

Economic Importance of Bryophytes

Key Roles

- **Prevention of soil erosion:** Mosses form dense mats reducing soil loss by water and rain impact.
- **Soil formation:** Bryophytes aid ecological succession on rocks; e.g., *Sphagnum* fills ponds with soil.
- **Water retention:** *Sphagnum* absorbs 18-26 times its weight in water; used in gardening and plant transport.
- **Peat formation:** Dead mosses in acidic marshes form peat, used as manure, fuel, and soil conditioner.
- **Ecological importance:** First colonizers of rocks along with lichens.

Memory Aids

- *Sphagnum* = water retention and peat formation.
- Moss mats = soil erosion control.
- Peat = fuel and manure.

Quick Checkpoints

- How do bryophytes prevent soil erosion?
- Role of *Sphagnum* in water retention and peat formation?
- Ecological significance of bryophytes in succession?

Additional Facts

Notable Points

- Study of bryophytes is called Bryology.
- Tallest bryophytes reach up to 70 cm, e.g., *Dawsonia*.
- *Polytrichum* is known as hair cap moss.
- *Sphagnum* is also called famine food.

Memory Aids

- Bryology = study of bryophytes.
- *Dawsonia* = tallest bryophyte.
- *Polytrichum* = hair cap moss.
- *Sphagnum* = famine food.

Quick Checkpoints

- What is Bryology?
- Name the tallest bryophyte.
- Common names of *Polytrichum* and *Sphagnum*.

Pteridophytes

General Characteristics

Features

- Pteridophytes include horsetails and ferns; first terrestrial plants with vascular tissues (xylem, phloem).
- Found in cool, damp, shady places; some grow in sandy soils.
- Main plant body is sporophyte with true roots, stems, and leaves (microphylls or macrophylls).
- Sporophytes bear sporangia on leaf-like structures called sporophylls; may form strobili or cones (e.g., *Selaginella*, *Equisetum*).
- Spores produced by meiosis germinate into free-living, photosynthetic gametophytes called prothallus.
- Gametophytes bear male (antheridia) and female (archegonia) sex organs; require water for fertilization.
- Fertilization forms zygote, which develops into dominant sporophyte.
- Most pteridophytes are homosporous; some (e.g., *Selaginella*, *Salvinia*) are heterosporous producing microspores and megaspores.
- Heterosporous gametophytes develop on parent sporophyte; embryo development within female gametophyte is precursor to seed habit.

Memory Aids

- Pteridophytes = first vascular plants without seeds.
- Sporophyte dominant; gametophyte = prothallus.
- Homosporous = one spore type; heterosporous = two spore types.

Quick Checkpoints

- What is the dominant phase in pteridophytes?
- Define sporophyll and strobili.
- Difference between homosporous and heterosporous plants.
- Role of water in pteridophyte reproduction.

Classification of Pteridophytes

Classes and Features

- **Psilopsida**: Oldest vascular plants; no roots, have rhizoids; all extinct; e.g., *Psilotum*.
- **Lycopsida**: Club/spike mosses; have roots, stems, leaves; homosporous or heterosporous; e.g., *Lycopodium*, *Selaginella*.
- **Sphenopsida**: Stems with ridges/grooves; small leaves in whorls; always homosporous; spores in stalked sporangia; e.g., *Equisetum*.
- **Pteropsida**: Largest, most advanced; mostly no aerial stem except tree ferns; spores in sori on leaves; homosporous or heterosporous; e.g., *Dryopteris*, *Marsilea*.

Memory Aids

- PLSP = Psilopsida, Lycopsida, Sphenopsida, Pteropsida (classification order).
- Psilopsida = simplest, no roots.
- Lycopsida = club mosses, roots present.
- Sphenopsida = horsetails, ridged stems.
- Pteropsida = true ferns, sori on leaves.

Quick Checkpoints

- Identify features of each pteridophyte class.
- Which class includes *Equisetum*?
- Examples of homosporous and heterosporous genera.

Economic Importance of Pteridophytes

Uses

- Food: Sporocarps of *Marsilea* eaten by some tribes.
- Soil binding: Prevent soil erosion on slopes.
- Scouring: Stems of *Equisetum* used for cleaning utensils and polishing metals.
- Nitrogen fixation: *Azolla* forms symbiosis with *Anabaena azollae*, used as biofertilizer in paddy fields.
- Medicines: Rhizomes of *Dryopteris* yield anti-helminthic drugs; *Equisetum* used for diuretic, haemostatic, haemopoietic drugs.
- Ornamental: Ferns grown for attractive foliage, used in bouquets and decorations.

Memory Aids

- Azolla = biofertilizer via nitrogen fixation.
- Equisetum = scouring and medicinal uses.
- Marsilea = edible sporocarps.
- Ferns = ornamental plants.

Quick Checkpoints

- Which pteridophyte is used as biofertilizer?
- Medicinal uses of *Dryopteris* and *Equisetum*.
- Role of pteridophytes in soil conservation.

Additional Facts

Key Points

- Term 'Pteridophyta' proposed by Haeckel in 1866.
- Study of pteridophytes is called Pteridology.
- *Adiantum* is called walking fern due to adventitious roots at leaf tips forming new plants.
- *Salvinia* is rootless pteridophyte, known as "Sorrow of Kashmir".
- *Alsophila* is tallest pteridophyte; *Azolla* is smallest aquatic fern.
- *Selaginella* species can roll into brown balls in dry season and revive with water; called resurrection plants (e.g., *S. bryopteris*).

Memory Aids

- Walking fern = *Adiantum*.
- Resurrection plant = *Selaginella*.
- Rootless pteridophyte = *Salvinia*.

Quick Checkpoints

- Who proposed the term Pteridophyta?
- Why is *Adiantum* called walking fern?
- Identify the smallest and tallest pteridophytes.

Gymnosperms

General Characteristics

Features of Gymnosperms

- Ovules are exposed, not enclosed by ovary wall; seeds are naked.
- Include medium to tall trees and shrubs; e.g., *Sequoia* (giant redwood) is very tall.
- Roots usually tap roots; some have mycorrhizal association (*Pinus*), others have coralloid roots with nitrogen-fixing cyanobacteria (*Cycas*).
- Stems may be unbranched (*Cycas*) or branched (*Pinus*, *Cedrus*).
- Leaves simple or compound; *Cycas* has persistent pinnate leaves.
- Leaves adapted to extreme conditions: needle-like in conifers, thick cuticle, sunken stomata reduce water loss.

Memory Aids

- Gymnosperms = \\"naked seeds\\" (no ovary).
- *Sequoia* = tallest tree.
- *Pinus* roots + mycorrhiza; *Cycas* roots + cyanobacteria.
- Needle leaves = water conservation.

Quick Checkpoints

- What type of roots do gymnosperms have?
- How are gymnosperm leaves adapted to dry conditions?
- Which gymnosperm is known as the tallest tree?

Reproductive Structures

Key Points on Gymnosperm Reproduction

- Gymnosperms are heterosporous: produce microspores (male) and megaspores (female).
- Spores develop in sporangia on sporophylls arranged spirally to form cones (strobili).
- Male cones (microsporangiate strobili) bear microsporophylls and microsporangia; microspores develop into pollen grains (male gametophyte).
- Female cones (megasporangiate strobili) bear megasporophylls with ovules; ovule = nucellus + protective envelopes.
- Megaspore mother cell in nucellus undergoes meiosis to form four megaspores; one develops into multicellular female gametophyte with archegonia.
- Male and female gametophytes remain within sporangia on sporophyte; no free-living gametophyte stage.

- Pollen grains released, carried by wind to ovule opening; pollen tube delivers male gametes to archegonia for fertilization.
- Post-fertilization: zygote forms embryo; ovule develops into seed.
- Gymnosperms classified into four groups: Cycadopsida, Ginkgopsida, Coniferopsida, Gnetopsida.

Memory Aids

- Heterosporous = two spore types: micro (male), mega (female).
- Cones = strobili; male = microsporangiate, female = megasporangiate.
- Pollen grain = reduced male gametophyte.
- Female gametophyte retained inside ovule.
- Fertilization via pollen tube.

Quick Checkpoints

- Define heterospory in gymnosperms.
- Where does pollen grain develop?
- What is the structure of an ovule?
- How is fertilization achieved in gymnosperms?
- Name the four gymnosperm groups.

Economic Importance

Uses of Gymnosperms

- Edible seeds: *Pinus gerardiana* seeds eaten after roasting.
- Timber: wood used for light furniture, plywood, railway sleepers.
- Paper: wood from *Picea*, *Pinus*, *Larix*, *Abies* used in paper manufacture.
- Linoleum: sawdust used in linoleum and plastics production.
- Ephedrine: drug from *Ephedra* used to treat respiratory ailments.
- Resin: extracted commercially; distilled to turpentine (solvent) and rosin (waterproofing, writing paper).

Memory Aids

- Pinus seeds = edible.
- Gymnosperm wood = timber and paper.
- Ephedra = source of ephedrine drug.
- Resin products = turpentine and rosin.

Quick Checkpoints

- Which gymnosperm seeds are edible?
- List major uses of gymnosperm wood.
- What is ephedrine used for?
- What products are obtained from resin?

Special Adaptations

Adaptations and Features

- Gymnosperms grow on mountain slopes in cold regions; show xerophytic adaptations.
- All are vascular plants with xylem and phloem; xylem lacks vessels, phloem lacks companion cells.
- Exceptions: *Gnetum*, *Ephedra*, *Welwitschia* have true vessels in xylem.
- Secondary growth occurs; stems are woody.
- Wood is called softwood due to absence of vessels.
- Endosperm is haploid, formed before fertilization.
- *Ginkgo biloba* known as Maidenhair tree.
- *Sequoia* known as redwood tree.
- *Cycas* has largest egg, sperm, and ovule among gymnosperms.

Memory Aids

- Softwood = gymnosperm wood without vessels.
- Xerophytic = adapted to dry, cold habitats.
- Endosperm = haploid, pre-fertilization.
- Maidenhair = *Ginkgo biloba*.
- Redwood = *Sequoia*.

Quick Checkpoints

- What type of vascular tissues do gymnosperms have?
- Which gymnosperms have vessels in xylem?
- Why is gymnosperm wood called softwood?

- What is unique about endosperm in gymnosperms?
- Name common names of *Ginkgo biloba* and *Sequoia*.

Angiosperms

Overview

- Seed plants with sporophylls arranged into flowers.
- Seeds develop inside fruits.
- Most evolved and dominant plants on Earth.
- Range from tiny *Wolffia* to tall *Eucalyptus* trees.
- Provide food, fodder, fuel, medicines, and commercial products.
- Divided into two classes: dicotyledons and monocotyledons.

Memory Aids

- Dicots: Two cotyledons, broad leaves, flower parts in 4s or 5s.
- Monocots: One cotyledon, narrow parallel-veined leaves, flower parts in 3s.

Quick Checkpoints

- What defines angiosperms?
- Difference between dicots and monocots?
- Role of flowers and fruits in angiosperms?

Plant Life Cycles and Alternation of Generations

Overview

- Life cycles follow rigid phase sequences called alternation of generations.
- Three types: haplontic, diplontic, haplodiplontic.

Memory Aids

- Alternation of generations means alternating haploid and diploid phases.
- Haplontic: dominant haploid phase.
- Diplontic: dominant diploid phase.
- Haplodiplontic: both phases multicellular and distinct.

Quick Checkpoints

- What is alternation of generations?
- Identify the three life cycle types.

Haplontic Life Cycle

Characteristics

- Single haploid vegetative phase (gametophyte).

- Gametophyte produces haploid gametes.
- Gametes fuse to form diploid zygote (single-celled).
- Zygote does not form multicellular diploid phase.
- Meiosis occurs during zygote germination producing haploid spores.
- No alternation of generations; sporophyte is only the zygote.
- Examples: algae like *Volvox*, *Spirogyra*, *Chlamydomonas*.

Memory Aids

- Haploid dominant, diploid stage brief and unicellular.
- Think: \\"Haploid life, zygote brief\\".

Quick Checkpoints

- Which phase is dominant in haplontic cycle?
- What happens to the zygote?
- Examples of organisms with haplontic cycle?

Diplontic Life Cycle

Characteristics

- Single diploid vegetative phase (sporophyte).
- Sporophyte produces haploid gametes via meiosis in sex organs.

- Gametes are the only haploid stage.
- Gametes fuse to form diploid zygote, which grows into sporophyte.
- Occurs in *Fucus*, *Cladophora*, gymnosperms, and angiosperms (with reduced gametophyte).

Memory Aids

- Diploid dominant, haploid stage only gametes.
- Think: \\"Diploid life, gametes brief\\".

Quick Checkpoints

- Which phase is dominant in diplontic cycle?
- When does meiosis occur?
- Examples of diplontic organisms?

Haplodiplontic Life Cycle

Characteristics

- Two multicellular somatic phases: haploid gametophyte and diploid sporophyte.
- Sporophyte (2n) undergoes meiosis to produce haploid spores.
- Haploid spores germinate into gametophytes (n).
- Gametophytes produce gametes; gametes fuse to form diploid zygote.

- Clear alternation of generations between gametophyte and sporophyte.
- Occurs in bryophytes, pteridophytes, and some algae like *Dictyota*, *Ectocarpus*, *Polysiphonia*, kelps.

Memory Aids

- Both haploid and diploid phases multicellular and distinct.
- Think: \\"Alternation of generations\\".

Quick Checkpoints

- What are the two phases in haplodiplontic cycle?
- Where does meiosis occur?
- Examples of haplodiplontic organisms?

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