

Life Sciences, Grade 11, Biodiversity of Plants

Definitions

Vascular Tissue: Tissues (xylem and phloem) that transport water and nutrients in plants.

Thallus: A simple plant body structure, lacking true leaves, stems, or roots.

Rhizoids: Root-like structures in non-vascular plants (like mosses) that anchor the plant.

Gametophyte: The haploid (n) generation in a plant's life cycle that produces gametes. In mosses, it is the dominant generation.

Sporophyte: The diploid ($2n$) generation in a plant's life cycle that produces spores. In mosses, it is present for a short time and depends on the gametophyte.

Meiosis: A type of cell division that halves the chromosome number (e.g., producing spores from a sporophyte).

Mitosis: A type of cell division that produces genetically identical daughter cells.

Fragmentation: Asexual reproduction where a small part of a plant breaks off and grows into a new individual.

Antheridium: The structure in bryophytes where male gametes (sperm) are produced.

Archegonium: The structure in bryophytes where female gametes (eggs) are produced and where the embryo (sporophyte) develops.

Operculum: A small, lid-like structure on a moss capsule that degenerates to release spores.

Protonema: A branched, filamentous structure formed when a moss spore germinates, from which a leafy gametophyte develops.

Concepts

Plant Kingdom Overview

- **Classification of Plants (from primitive to more complex):**
 - **Bryophytes:** Mosses + Liverworts
 - **Pteridophytes:** Ferns
 - **Gymnosperms:** Yellowwood, Cycads
 - **Angiosperms:** Flowering plants (e.g., orchids)

Bryophytes (Mosses & Liverworts)

- **Structure:**
 - Small (< 20cm).
 - **No vascular tissue** (xylem + phloem), so they cannot grow tall.
 - Plant body is a **thallus** structure.
 - Water + nutrients are absorbed directly from the air and soil through osmosis, diffusion, and cytoplasmic streaming.
 - No true leaves, stems, or roots.
 - Root-like structures called **rhizoids** anchor the plant (not true roots).
 - Leaf-like structures are one cell layer thick and lack a cuticle, so they lose water quickly but can absorb water from any part of the thallus body.
 - Contain chlorophyll (photosynthesis).
- **Environment:** Need wet environments to grow.
- **Reproduction:**
 - Have sexual and asexual reproductive cycles.
 - **Asexual Reproduction:**
 1. Simple fragmentation: a small part breaks off and grows into a new plant (genetically identical clone).

o **Sexual Reproduction:**

1. **Gametophyte generation (haploid, n):** Dominant generation, always present. Produces gametes (eggs and sperm).
2. **Sporophyte generation (diploid, 2n):** Present for a short time, attached to the gametophyte by a seta, and depends on the gametophyte for food and water. Produces spores (n) in the sporangium (capsule) via meiosis.
3. Spores are spread by wind.
4. Male gamete (sperm, n) + female gamete (egg, n) fertilize to form a diploid zygote (2n).
5. The embryo (sporophyte) develops in the archegonium.

o **Life Cycle Sequence:** Gametophyte (n) → Gametes (n) → Fertilization (zygote, 2n) → Embryo (sporophyte, 2n) → Spores (n, via meiosis) → Mature Gametophyte (n) again.

o **Start of Life Cycle:**

1. Begins with the release of spores from a capsule, which opens when the operculum degenerates.
2. A single spore germinates to form a branched, filamentous **protonema**, from which a leafy gametophyte develops.
3. Gametophyte bears organs for sexual reproduction
 - Antheridium □ sperm
 - Archegonium □ egg
4. Sperm released by mature antheridium and is attracted to archegonium
5. Sperm fuses with the egg in the archegonium to produce zygote
6. After cell division, zygote becomes the sporophyte and at the same time the archegonium divides to form the protective calyptra
7. Sporophyte usually consists of a capsule and seta

8. Meiosis occurs within the capsule to produce haploid spores and the whole process begins again

Pteridophytes

- Ferns are largest seedless vascular plants and are the most successful and widespread
- Found in moist environments on the land, mountains, and deserts
- Most are tropical (adapted to warm, moist conditions)
- Many species in SA in most of biomes

- **Structure:**
 - Contain vascular tissue (xylem and phloem)
 - Therefore, able to grow taller than mosses
 - Xylem strengthened with lignin
 - Have true leaves, roots and stems
 - Leaves surrounded by cuticle (reduces water loss through transpiration)
 - Leaves and stems differentiated for strength and support
 - Roots anchor plant in soil (absorb water and mineral salts)
 - Roots grow off underground stem (Rhizome)
 - Spores produced by Sori (contain many sporangia) through meiosis
 - Spores develop into moisture-dependent gametophyte generation
 - Gametophyte generation = heart shaped thallus (prothallus □ produces gametes)

- **Reproduction:**
 - Ferns reproduce sexually
 - Diploid sporophyte = dominant generation
 - Fertilization depends on water- new or rain drops for sperm to swim
 - Spore capsule under the leaf (sporangial are grouped in clusters called sori (sing . Sorus)

 - The mature sporangia explodes, and spores are dispersed by air currents

- o When the spore germinates, it grows into a tiny heart-shaped green thallus, called a prothallus
- o The prothallus produces male and female gametes and after fertilization, the fern plant sprouts and the prothallus withers away

- o spores (n) germinate into a prothallus (n) which will produce eggs (n) in the archegonium and sperm (n) in the antheridium; they combine to form a zygote (2n); the zygote grows into a young sporophyte (2n) which then produces spores through meiosis-halving division (n)

- **Life cycle of a fern**
 1. The sporophyte generation is photosynthetic and is independent of the gametophyte
 2. meiosis of the tissue within the sporangia yields a haploid spore that divides to produce
 3. A heart-shaped gametophyte that differentiates both
 4. Archegonia and
 5. Antheridia on one individual. The gametophyte is photosynthetic and independent, although it is reduced in size relative to the sporophyte
 6. Fertilization takes place when water is available when water is available for sperm to swim to the archegonia and fertilize the egg
 7. Diploid sporophyte develops in the archegonium
 8. Gametophyte withers away

Tracheophytes

- Land plants with a well-adapted vascular system
- Includes ferns, gymnosperms + angiosperms
- Always have a dominant sporophyte generation (mosses are the only plants that have a dominant gametophyte)

Spermatophytes

- Gametophyte generation is small and well-protected
- Structure of pollen grains allows plants to survive on land

- Gymnosperms
 - seeds are exposed or on scales of cones
- Angiosperms
 - seeds are inside a fruit

Gymnosperms

- seed-bearing plants
- seeds are naked, exposed-not protected inside a Fruit (ovary)
- true roots, stems and leaves
- better developed conducting and strengthening tissue
- e.g. Conifers (pine trees, cycads, yellowwood, Welwitschia (Namib desert))
- **sporophyte dominant generation**
 - large trees with an erect stem, branches and well-developed taproot system-> obtain water and anchor plant
 - tracheophytes land plants with a well developed vascular system (xylem +phloem)
- **Gametes in cones**
 - female cones produce ovules (bigger than male cones)
 - male cones produce pollen (independent of water-wind pollination)
 - pollen and seeds are produced in protective cones made up of tightly packed woody scales
 - leaves (tough, needle-like with a waxy cuticle layer)
 - prevent water loss, can survive droughts
- **Dependence on Water**
 - less dependent on water as it is not required for fertilisation due to the development of a pollen tube
 - pollen grain also protects sperm from drying out
- **Gymnosperm trees produce "soft wood"** which is composed entirely of xylem tracheids, they do not have xylem vessels
 - These woods are of huge NR for lumbar + paper industry

Angiosperms

- Flowering, seed producing plants
- Dominant sporophyte generation
- Most are autotrophic, bt some re parasitic or saprophytes

- **Vascular tissue**
 - Well-developed specialized tissues such as phloem and xylem
 - Helps to transport substances and support plants
 - Allow the plant to live on land
- **Leaves and roots**
 - Leaves have cuticles and stomata (true leaves)
 - True roots and stems
- **Parts of the flower**
 - Reproductive organs = flowers
 - Made up of
 - Calyx (ring of sepals)
 - Corolla (ring of petals)
 - Male reproductive part = androecium (stamens)
 - Anther
 - Filament
 - Female reproductive part = gynoecium (carpel)
 - Stigma
 - Style
 - ovary
- **Seeds and spores**
 - Heterosporous: flowers produce 2 different types of spores
 - Pollen sacs (microsporangia)
 - Inside anther
 - Produces by microspore mother cells by meiosis
 - Pollen contains sperm
 - Megaspores
 - Develop into ovules inside the ovary
 - Each ovule produces an egg
 - During pollination, pollen grains are transferred from anthers to the stigma of the same or a different flower
 - A pollen tube grows from the pollen grain, down the style and towards the egg cell.
 - It delivers the sperm to the egg in order for fertilisation to occur
 - Fertilized ovules become seeds, while the zygote becomes the embryo inside
 - Seed grows into an adult flowering plant

- **Fruit**
 - Seeds protected in fruit
 - Large, swollen, enlarged ovary
 - Animals eat fruit to disperse seeds

Water dependence

- **Bryophytes**
 - not yet suited for terrestrial environment:
 - No cuticle, support + strengthening tissue, neither vascular nor conducting tissue - dominant gametophyte essentially tiny to reduce desiccation
 - sporophyte totally dependent on gametophyte for food support
 - sperm dependent on a film of water to swim to egg
- **Pteridophytes:**
 - more evolved than bryophytes but still not totally terrestrial, because
 - leaves have a cuticle to protect them desiccation
 - have vascular tissue to conduct water + minerals (xylem) and food (phloem)
 - still dependent on moist conditions for gamete transfer
- **Spermatophytes:**
 - evolved for a true terrestrial environment:
 - have all the above terrestrial adaptations,
 - plus, embryos are now protected from desiccation by being enclosed in a seed
 - pollen grains protect potential sperm from drying out

Ecological importance of plants

- **Mosses**
 - pioneer plant-> first to grow in new area
 - economic value: source of peat (marshland with carbonized plant material)
 - Soil richer in organic matter
 - mosses trap dust + organic material (organic material rots → produces acids → acids break down rock to form soil particles → seed of large tree falls on mossy carpet → it will germinate)

- o Blind soil, prevent erosion
- Gymnosperms
 - o Produce 'soft wood' (made up entirely of xylem tracheids) these woods are of huge economic importance for the lumbar and paper industry

Pollination

- Self-pollination
 - o Transfer of pollen from anthers to stigma of same flower
- Cross pollination
 - o Transfer of pollen from anther of one plant to stigma of flower of another plant of the same species
 - o Why is this NB?
 - causes greater genetic variety of the seeds + the population
- **Mechanisms that help cross-pollination**
 - o **PROTANDRY**
 - Pollen in the anther (androecium) ripens + is released before the stigma matures
 - stigmas are not ready to receive pollen and self-pollination can't take place
 - o **PROTOGYNY**
 - Stigma (gynoecium) ripens before the anther matures + releases pollen grains
 - Stigma will receive pollen from another plant that does have a ripened anther
 - o **INCOMPATIBILITY**
 - pollen and stigma in a single plant are incompatible.
 - When pollen lands on the stigma of the same plant, no pollen tube develops, thus preventing self-fertilization
 - o **DIOECY**
 - some plants will only have male/female flowers, not both
 - these are called dioecus plants
 - e.g. cycad, holly, Welwitschia, Cannabis, willow

Adaptations of flowers for pollination

Pollination: the transfer of pollen from the anthers to the stigma of the same or a different flower of the same species

- Wind pollinated flowers
 - Usually very small
 - To produce large amounts of pollen
 - Large anthers
 - more exposure to wind
 - Long and flexible filaments/hanging anthers
 - To catch more pollen
 - Long and feathery stigmas
 - There is no need to attract pollinators
 - Reduced scent and nectar
 - There is no need to attract pollinators
 - Dull colours
 - Help catch the pollen and direct it towards the stigma
 - Papery bracts
 - Allows them to float on the air currents
- Insect pollinated flowers
 - Usually quite large
 - Large, broad petals
 - To provide a landing platform for insects
 - Highly scented with bright-coloured petals
 - Attracts the insect to the flowers
 - Offer a sugary reward in the form of nectar
 - Attracts the insects
 - Legs brush up against anthers as they suck the pollen
 - Pollen grains are usually very sticky
 - Pollen is easily transferred from insect's body to the flower's sticky stigma
- Bird pollinated flowers
 - Have similar structures to insect pollinated flowers
 - Usually red or pink
 - Often tube-shaped to accommodate beak of birds
 - Large, broad petals/ strong flower structures

- A large and strong landing platform required for the weight of the bird
- Highly scented with brightly coloured petals
 - Attracts the birds to the flowers
- Offer a sugary reward in the form of nectar
 - Attracts the birds to the flowers
- Pollen grains are usually very sticky
 - Essential for the pollen grains to stick to the bird beak for it to be transferred to another flower

Asexual and sexual reproduction

- Asexual: A new organism is formed from one parent only-mitosis!
 - new organism identical to the parent (a clone)
 - Advantages
 - Only one parent needed
 - Offspring is a clone so if parent is well adapted, the offspring will also be
 - Many offspring produced in short period of time
 - allows them to crowd out competition
 - No need to rely on pollination or dispersal agents
 - Can occur in any season
 - Disadvantages
 - All offspring genetically identical so offspring may not survive if the environment changes
 - Weakness in parent is transmitted to offspring
 - Overcrowding due to rapid growth
 - Leads to increased competition for space, water, sunlight etc.
- Sexual: haploid male gamete (sperm) fuses with haploid female gamete (ovum/egg) to form a diploid zygote
 - zygote undergoes mitosis to develop into new organism
 - Advantages
 - Offspring are genetically different
 - increased variance and chances of survival
 - farmer can cross organisms with desirable characteristics
 - produce offspring with a better yield

o Disadvantages

- Requires 2 parents (one male and one female)
- Offspring are born helpless and vulnerable and may take long to mature
 - Vulnerable to predators or disease
 - Dependent on parents for food and protection
- Depend on pollinating and dispersal agents