Unit 8 · Pteridophyta

STUDY NOTES

WHAT NEB'S GRADE 11 EXAM ASKS

- **CDC's grid (2077):** Floral Diversity (Units 4–10 together): 18 of 75 marks; with Ecology and Vegetation a combined 26, at least 3 MCQs, 2 short and 1 long from them
- **The paper:** 11 MCQs × 1 · 8 short × 5 · 3 long × 8; 3 hours; 1 mark per expected point
- **CDC's model paper:** short (5): why gymnosperms are more advanced than **pteridophytes** (Unit 9 compares the two)
- **MCQ (1 mark)**
  - group from clues (spores, no seeds, xylem → pteridophyte)
  - haploid part of a fern (prothallus)
  - *Azolla* as biofertilizer; homosporous vs heterosporous
- **Short and long (in parts)**
  - define sorus, indusium, prothallus, ramenta, circinate…
  - bryophytes vs pteridophytes; alternation of generations
  - "vascular cryptogams"; characteristic features
  - label a fern; economic importance
  - prothallus: structure and function with diagram
  - reproduction in *Dryopteris* with diagrams

Key terms

Pteridophyta (*pteron*, feather): seedless **vascular** plants: ferns, horsetails, clubmosses; study: **pteridology**.

Cryptogams: "hidden" reproduction; no flowers, seeds.

Vascular cryptogams: pteridophytes: xylem, phloem, true roots, stems, leaves, but no seeds.

Frond: a fern leaf.

Ramenta: brown papery scales on rhizome, petiole, rachis.

Circinate: young leaf rolled from the tip down (fiddlehead, niuro).

Sporophyll: fertile leaf with sori; **trophophyll**: sterile, food only.

Sorus (pl. sori): group of sporangia; **indusium**: its kidney-shaped cover; **placenta** (receptacle): its cushion.

Annulus: row of thick-walled cells on the capsule; **stomium**: thin-walled cells where it tears.

Homosporous: one kind of spore; **heterosporous**: microspores + megaspores.

Prothallus: haploid, heart-shaped, independent gametophyte of a fern.

Chemotaxis: antherozoids swim towards malic acid.

General

- first **vascular plants**; most advanced seedless plants
- main body **sporophyte**; herbs; tree ferns 9–12 m (tallest ~20 m)
- **ferns**: *Dryopteris*, *Pteris*, *Cyathea* (tree fern), *Marsilea*, *Azolla* (water ferns)
- **horsetails**: *Equisetum*: jointed, ribbed stems, leaves in rings, cones at tips
- **clubmosses**: *Lycopodium*, *Selaginella*: small spiral leaves
- Nepal: ~534 kinds (5 %); tree fern *Cyathea spinulosa* (Kaski, Lamjung, Panchase); rare; CITES Appendix II
- **Carboniferous** (300–360 million years ago): *Lepidodendron* (30 m), *Calamites* (10 m), tree ferns → **coal**

Characteristic features

1. **cool, moist, shady** land; some **aquatic** (*Marsilea*, *Azolla*)
2. adult = **sporophyte** (2n): true **roots, stem, leaves**
3. **vascular**: xylem, phloem
4. leaves small, sessile (*Selaginella*, *Equisetum*) or large, petiolate (ferns)
5. primary root short-lived → **adventitious roots**

6. stem herbaceous, often a **rhizome**; monopodial or dichotomous
7. **spores** in **sporangia**: in **sori** (ferns), **strobili** (*Equisetum*, *Lycopodium*, *Selaginella*), **sporocarps** (*Marsilea*, *Azolla*)
8. **homosporous** (most ferns, *Lycopodium*, *Equisetum*) or **heterosporous** (*Selaginella*, *Marsilea*, *Azolla*)
9. spore → **prothallus**: small, green, **independent** gametophyte
10. antheridia and archegonia on the prothallus
11. antherozoid swims through **water** → zygote (oospore) → sporophyte
12. **alternation of generations**, **sporophyte dominant**

Bryophytes	Pteridophytes
plant body **gametophyte** (n)	plant body **sporophyte** (2n)
no true roots, stems, leaves; rhizoids	true roots, stem, leaves
no xylem, phloem	**xylem, phloem**
sporophyte dependent on gametophyte	sporophyte independent; gametophyte (prothallus) also independent
antherozoids biflagellate	ferns' antherozoids **multiflagellate**
Marchantia, *Funaria*	*Dryopteris*, *Equisetum*, *Selaginella*

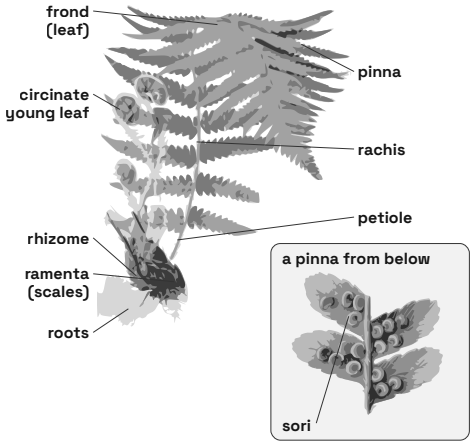
- both: spores, no seeds; archegonia; water for fertilization

Dryopteris

- *drys* oak + *pteris* fern; male fern *D. filix-mas*
- Plantae → Tracheophyta → Pteridophyta → Pteridopsida → Filicales → Polypodiaceae → *Dryopteris* (today Dryopteridaceae, Polypodiales)
- **moist, shady**: forests, stream banks; worldwide; Nepal's hill forests

Sporophyte

- perennial, evergreen, vascular
- **roots**: adventitious, from the rhizome; root hairs, root cap
- **stem**: short, thick, underground **rhizome**, covered by **ramenta**
- **leaves** (**fronds**): large, stalked, **pinnately compound**, in a crown
  - **petiole** → **rachis** → **pinnae** → **pinnules**
  - **sporophyll** and **trophophyll** look alike
  - young leaf **circinate**: protects the tip, unrolls

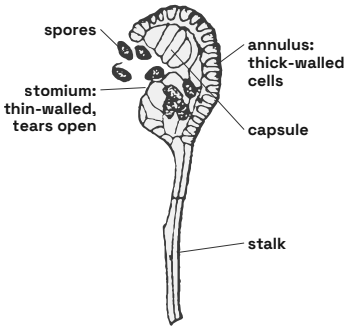


Dryopteris: fronds (petiole, rachis, pinnae), circinate leaf, rhizome with ramenta, roots; inset: sori under a pinna.

Vegetative: **fragmentation** of the branching rhizome

Asexual: spores

- **sori** on the **lower** surface of sporophylls: two rows per pinna, one each side of its midrib
- each over a vein on a **placenta**, covered by a **kidney-shaped indusium**; shrivels when ripe
- **sporangium**: long many-celled **stalk**; flat oval **capsule**, wall one cell thick
  - **annulus**: ~12 cells, thick inner and side walls, ¾ round
  - **stomium**: thin-walled, broad cells; tears here
- **12–16** spore mother cells → **meiosis** → **48–64** haploid spores; all alike: **homosporous**



Sporangium opening: annulus, stomium, spores.

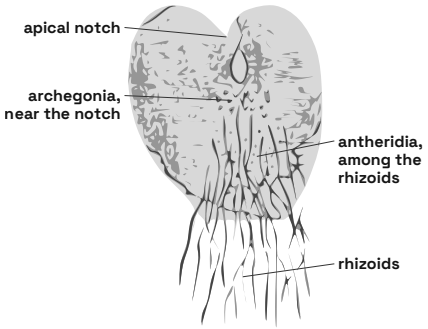
Dehiscence (catapult)

1. dry air: water evaporates from annulus cells
2. annulus straightens, tears capsule at **stomium**, bends back with the spores
3. remaining water turns to vapor → annulus **snaps back** → spores flung out

- fastest plant movement; water only, no muscle (Noblin, 2012)

Sexual: prothallus (gametophyte)

- **haploid**, flat, many-celled, green, **heart-shaped**, ~5 mm
- **apical notch** with growing point at the broad front
- **rhizoids** on the lower side, near the pointed back
- **independent**, **autotrophic**
- **monoecious**: archegonia near the notch, antheridia among the rhizoids, on the lower side



Prothallus from below: apical notch, archegonia, antheridia, rhizoids.

Antheridium	Archegonium
rounded, **no stalk**, bulges out	**flask**-shaped
androcytes → **antherozoids**, coiled, **multiflagellate**	**venter** sunk in prothallus: **egg** + venter canal cell
bursts in water	short **neck** outside: one **binucleate neck canal cell**

Fertilization

- canal cells → **mucilage** with **malic acid**; opens neck
- **water** (dew, rain) needed; antherozoids swim to malic acid (**chemotaxis**)
- **one** fuses with the egg → zygote (oospore); usually one archegonium per prothallus
- antheridia ripen first → egg usually fertilized from a **neighboring** prothallus

New sporophyte

- zygote = first cell of sporophyte → **embryo**: **foot**, first **root**, first **leaf**, stem tip
- first dependent on prothallus; then independent; prothallus dies

Life cycle

- sporophyte (2n) → meiosis → spores (n) → prothallus (n) → gametes → fertilization → zygote (2n) → sporophyte
- **sporophyte**: large, long-lived, independent, **dominant**; **gametophyte**: small, short-lived, also independent
- reverse of bryophytes

Economic importance

1. **ornamental**: Boston fern, maidenhair (*Adiantum*), *Selaginella*; garlands
2. **food**: **niuro** (*Diplazium esculentum*); starchy rhizomes in hard times; fodder; raw or much bracken (*Pteridium*) harmful (stomach cancer)
3. **soil binding**: rhizomes, roots on slopes; first cover on landslide scars
4. **medicine**: *Lycopodium* spores as dusting powder; tinctures (stomachic, diuretic); asthma, fever, wounds; *D. filix-mas* rhizome once against **tapeworms** (poisonous; no longer used)
5. **coal**: Carboniferous clubmosses, horsetails, tree ferns
6. **lycopodium powder**: **fingerprints**; **flash powder** (photography, theaters)
7. **shelter**: millipedes, insects, spiders; bacteria, cyanobacteria; fish, frogs' eggs
8. **nitrogen fixation**: *Azolla* + *Anabaena azollae* in leaf cavities → **biofertilizer** in rice fields; fed to ducks, fish, cattle

COMMON MISTAKES

✗ The fern plant is the gametophyte
✓ it is the **sporophyte** (2n); the prothallus is the gametophyte.

✗ Pteridophytes make seeds
✓ **spores** only; no seeds, flowers.

✗ The prothallus depends on the fern
✓ it is **independent** and autotrophic.

✗ Sori are on the upper surface
✓ on the **lower** surface of sporophylls.

✗ *Dryopteris* is heterosporous
✓ **homosporous**; *Selaginella*, *Marsilea*, *Azolla* are heterosporous.

✗ Fern antherozoids are biflagellate
✓ **multiflagellate** (bryophytes' are biflagellate).

✗ *Lycopodium* is a moss
✓ a clubmoss, a **pteridophyte**.