Unit 7 · Bryophyta

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
- **MCQ (1 mark)**
  - diploid part of a moss (stalk and capsule)
  - class from clues (scales, no columella → liverwort)
  - why mosses monitor heavy metals
  - gemma, elaters, father of bryology
- **Short and long (in parts)**
  - define gemma, archegonium, antheridium, alternation of generations
  - algae vs bryophytes; features of bryophytes
  - "amphibians of the plant kingdom"
  - *Marchantia*: dominant body; alternation of generations; thallus drawing
  - economic importance; bryophytes as indicators of environmental health

Key terms

Bryophytes (*bryon*, moss): small green, non-vascular **embryophytes**: liverworts, hornworts, mosses.

Embryophyte: embryo grows inside the female organ, fed by the parent.

Bryology: study of bryophytes; **Johann Hedwig** (1730–1799): father of bryology.

Gametophyte: haploid generation that makes gametes; the bryophyte's plant body.

Sporophyte: diploid generation from the zygote; makes spores by meiosis.

Alternation of generations: haploid gametophyte and diploid sporophyte follow each other.

Gemma: green many-celled disc on a one-celled stalk, notch on each side; made in **gemma cups**; vegetative reproduction.

Antheridium: male sex organ; jacket one cell thick; androcytes → biflagellate **antherozoids**.

Archegonium: flask-shaped female organ: **venter** (egg + venter canal cell), **neck** (neck canal cells), **cover cells**.

Protonema: green branched thread from a moss spore; leafy shoots grow from it.

Columella: central column of sterile tissue in a capsule.

Elaters: spindle-shaped cells with spiral thickening; flick spores out.

Peat: dead *Sphagnum* pressed in waterlogged, acidic bogs.

General

- a few mm to a few cm; photosynthetic; **no xylem, phloem**; embryophytes → land plants, not algae
- everywhere, tropics to Antarctica; tiny light spores survive drying
- **amphibians of the plant kingdom**: land body (rhizoids, many cells thick, tough wind-borne spores), but male gametes **swim**: **fertilization needs water**
- Nepal: ~1,150 kinds (8 % of world's, NBSAP 2014); 1,318 by 2023 (766 mosses, 541 liverworts, 11 hornworts); most at ~2,500–2,800 m
- *Sphagnum* dressings in the First World War: absorbent, acidic

Characteristic features

1. **damp, moist, shady** places: soil, rocks, walls, bark
2. **no true roots, stems, leaves**: **thallus** (liverworts, hornworts) or **leafy shoot** (mosses, leafy liverworts)
3. plant body = **gametophyte**: **haploid**, **independent**, **autotrophic**
4. **rhizoids**: unicellular (liverworts, hornworts), multicellular (mosses)
5. simple **parenchyma**; **no vascular tissue**
6. vegetative and sexual reproduction
7. vegetative: fragmentation, adventitious buds, **gemmae**, tubers
8. sexual **oogamous**
9. **antheridium** → biflagellate **antherozoids**; flask-shaped **archegonium** → one **egg** (oosphere)
10. antherozoids swim in water → **diploid zygote** (oospore)
11. zygote → many-celled **sporophyte**, attached to and **dependent** on gametophyte (water, food, support): "parasitic"; partly in mosses, hornworts (green)
12. **meiosis** in sporophyte → haploid **spores** → gametophyte
13. **alternation of generations**; **gametophyte dominant**

Algae	Bryophytes
mostly water	land, damp places
unicellular to thallus; no rhizoids (most)	thallus or leafy shoot; **rhizoids**
sex organs one-celled, no jacket	many-celled, **jacket** of sterile cells
no embryo	**embryophytes**
iso-, aniso- or oogamous	always **oogamous**
zygote often meiosis at once	multicellular **sporophyte**
spores often motile	non-motile, tough, wind-borne
Chlamydomonas, *Spirogyra*	*Marchantia*, *Funaria*

Classification

- three classes (today often three divisions: Marchantiophyta, Anthocerotophyta, Bryophyta)

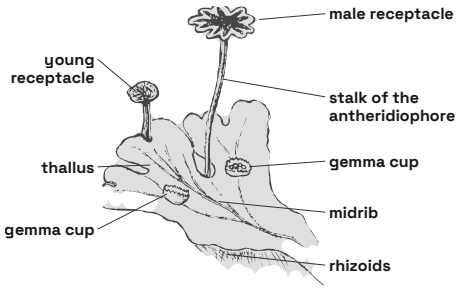
Feature	Hepaticopsida (liverworts)	Anthocerotopsida (hornworts)	Bryopsida (mosses)
name	*hepaticus*, liver-like	*anthos* flower + *keras* horn	*bryon*, moss
gametophyte	**dorsoventral**; thalloid or foliose; leaves **no midrib**	dorsoventral flat thallus	**upright, radial**; spiral leaves
rhizoids	**unicellular**, unbranched	unicellular, smooth	**multicellular**, branched, **oblique** walls
ventral scales	present (thalloid)	**absent**	absent
sex organs	upper side, sunk or on stalks	sunk in upper side	at **tips** of shoots
sporophyte	capsule (*Riccia*); or **foot, seta, capsule** (*Marchantia*)	foot + long **horn-like** capsule; keeps growing from its base	foot, seta, capsule
dependence	**completely** dependent	**partly** (green)	partly (young capsule green)
columella	**absent**	present	present; **peristome** teeth
protonema	**none**	short, simple	**well developed**
other		mucilage cavities with *Nostoc* (N_2-fixing); stomata	stomata on capsule
e.g.	*Marchantia*, *Riccia*, *Porella*	*Anthoceros*, *Notothylas*, *Megaceros*	*Polytrichum*, *Funaria*, *Sphagnum*

Marchantia

- Plantae → Bryophyta → Hepaticopsida → Marchantiales → Marchantiaceae → *Marchantia*
- **moist, cool, shady**: damp soil, rocks, walls, logs, stream banks; by a dhara; burnt ground (*M. polymorpha*)

Thallus (gametophyte)

- flat dark green ribbon, **prostrate**, **dorsoventral**, **dichotomously branched**
- **midrib**; **apical notch** with **growing point**
- upper side: **gemma cups** on midrib; diamond **air chambers**, each with an **air pore**
- lower side
  - **scales**: multicellular, purple, in rows; protect growing point, hold water
  - **rhizoids**: unicellular, colorless; **smooth** and **tuberculate** (peg-like ingrowths, wick water)
- **dioecious**: male or female thallus

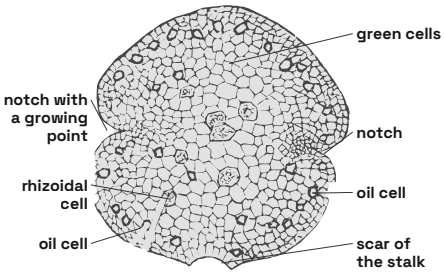


Male *Marchantia*: thallus, midrib, gemma cups, rhizoids, antheridiophores with male receptacles.

- the umbrella stalks are **gametophyte branches**, not sporophytes or flowers

Vegetative

- **fragmentation**: old parts rot back to a fork → two plants
- **gemmae** (commonest): disc of many cells, thick middle, **one-celled stalk**, **notch on each side**; green cells + **oil cells**, **rhizoidal cells**, **mucilage cells** (swell, push gemmae out)
  - raindrop splashes them up to ~1 m; **each notch** → **new thallus** (one gemma, two plants)
  - same sex as parent

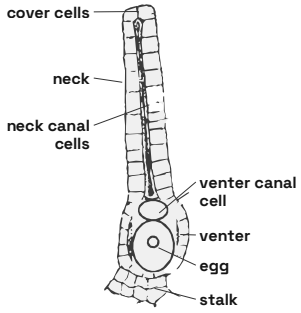


Gemma: disc of green cells, two notches with growing points, oil and rhizoidal cells, stalk scar.

Sexual on **gametophores**: **antheridiophore**, **archegoniophore**

	Male	Female
stalk	2–3 cm	longer
receptacle	flat disc, **8 lobes**	umbrella head, usually **9 rays**; **8 rows** of archegonia ("eight-lobed")
organs	**antheridia** in flask-shaped chambers opening by pores, among air chambers	**archegonia** hang **neck-down** under the head, 12–16 a row; **perichaetium** (involucre)

- **antheridium**: oval, **stalked**, **jacket one cell thick**, **androcytes** → **antherozoids** (curved, **two flagella**); bursts in water
- **archegonium**: stalked flask
  - **venter**: **egg** + **venter canal cell**
  - **neck**: **4–6 neck canal cells**
  - **four cover cells**



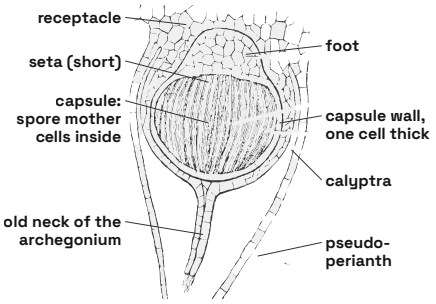
Archegonium: cover cells, neck with neck canal cells, venter with venter canal cell and egg.

Fertilization

- canal cells → **mucilage**; swells, pushes cover cells apart
- needs **water**: antherozoids swim, or **splash** from male onto female heads (stalks lift receptacles)
- chemicals in mucilage attract them; **one** fuses with egg → **zygote** (2n)

Sporophyte

- zygote = **first cell of the sporophyte** → embryo inside the venter
- hangs under the female receptacle; **completely dependent** (parasitic)
- **foot**: in the receptacle, absorbs food, water
- **seta**: short; lengthens to push capsule out
- **capsule**: jacket one cell thick; **spore mother cells** (fertile) + **elater mother cells** (sterile)
- coverings: **calyptra** (old venter), **pseudoperianth**, perichaetium
- spore mother cells → **meiosis** → 4 haploid spores; elater mother cells feed them, then → **elaters** (spiral thickening)
- capsule splits into teeth curling back; elaters twist, flick spores out → spore → gametophyte



Young sporophyte under the receptacle: foot, seta, capsule, calyptra, old neck, pseudoperianth.

Life cycle: alternation of generations

- gametophyte (n) → gametes → zygote (2n) → sporophyte → meiosis → spores (n) → gametophyte
- **gametophyte**: large, long-lived, independent, **dominant**; **sporophyte**: small, short-lived, dependent
- significance: the plant we see makes gametes; needs water for fertilization; spores spread it
- *M. polymorpha*: lab plant; haploid body shows gene changes at once; genome read 2017

Economic importance

1. **ecological**
   - **bog succession**: *Sphagnum*, sedges → **quaking bog** → marsh → shrubs → **forest**
   - **soil formation**: **pioneers** after lichens on bare rock; trap dust, hold water, acids break rock
   - **food and shelter**: mites, springtails, insects, snails, tardigrades; birds' nests
   - **soil conservation**: mats bind soil; soak up rain, release slowly → springs flow
   - **pollution indicators**: no cuticle, no roots; absorb over whole surface; die with **SO_2**; collect **heavy metals** (lead, cadmium, zinc)
2. **medicine**: antibacterial substances; ringworm, skin infections; moss ash for wounds; *Sphagnum* **antiseptic, absorbent dressing**
3. **packing**: glassware, live plants; damp *Sphagnum* round seedlings' roots
4. **fuel**: **peat** (Ireland, Scotland, Finland); peatlands ~3 % of land, ~⅓ of soil carbon
5. **experimental botany**: genetics, development; *Marchantia polymorpha*, *Physcomitrium patens*
6. **gardens**: moss gardens, terrariums, bonsai; *Sphagnum*, peat in potting soil, orchids
7. **industry**: peat → alcohol, ammonium sulphate, paraffin, dyes, tanning; mattress stuffing; mosses in carpets (CDC's book)

- **health of the environment**: sensitive kinds vanish with SO_2; metals measured in mosses show pollution; their presence shows clean, damp air

COMMON MISTAKES

✗ The umbrellas of *Marchantia* are sporophytes
✓ they are **gametophore** branches of the gametophyte.

✗ The bryophyte plant body is diploid
✓ the gametophyte is **haploid**; only the sporophyte is diploid.

✗ Bryophytes have xylem and phloem
✓ **no vascular tissue**.

✗ Liverworts have a columella and protonema
✓ **neither**; hornworts and mosses have a columella.

✗ Moss rhizoids are unicellular
✓ **multicellular** with oblique walls; liverworts' are unicellular.

✗ A gemma grows into one plant
✓ **each notch** grows a thallus: two plants.

✗ Liverworts cure liver disease
✓ an old belief from their shape; **no evidence**.

✗ Sporophyte of *Marchantia* is independent
✓ **completely dependent** on the gametophyte.