Unit 14 · Ecological Adaptation

STUDY NOTES

WHAT NEB'S GRADE 11 EXAM ASKS

- **CDC's grid (2077):** Ecology (Units 13–15 together): 6 of 75 marks, 1 short answer and 1 MCQ; with Floral Diversity and Vegetation a combined 26
- **The paper:** 11 MCQs × 1 · 8 short × 5 · 3 long × 8; 3 hours; 1 mark per expected point
- **CDC's model paper:** MCQ (1): the habitat of xerophytes
- **MCQ (1 mark)**
  - kind of adaptation (stomata shut at noon: physiological)
  - category of a hydrophyte (*Trapa*: rooted with floating leaves)
  - why submerged leaves are divided; why floating leaves have stomata above
  - mesophyte example; where its stomata are
  - kind of xerophyte (ephemeral); how sunken stomata work
- **Short (in parts)**
  - ecological adaptation and why it matters
  - plants where not all needs are met
  - anatomical and physiological adaptations of hydrophytes
  - ephemerals; xerophytes and their adaptations
  - true xerophytes vs the other kinds

Key terms

Ecological adaptation: process, and the features, by which organisms adjust to their environment to survive and reproduce.

Hydrophyte (*hydor* water): plant of water or very wet places.

Mesophyte (*mesos* middle): plant of moderate, regular water.

Xerophyte (*xeros* dry): plant of dry places.

Aerenchyma: tissue with large air spaces.

Root pocket: loose sheath replacing the root cap (*Eichhornia*, *Pistia*, *Lemna*).

Heterophylly: two kinds of leaf on one plant (*Sagittaria*).

Compensation point: light at which photosynthesis just equals respiration.

Phylloclade: green, flattened stem doing a leaf's work (*Opuntia*, *Euphorbia*).

Stomatal crypt: hairy pit holding sunken stomata (*Nerium*).

CAM (crassulacean acid metabolism): stomata open at night; CO_2 stored as acid, used by day.

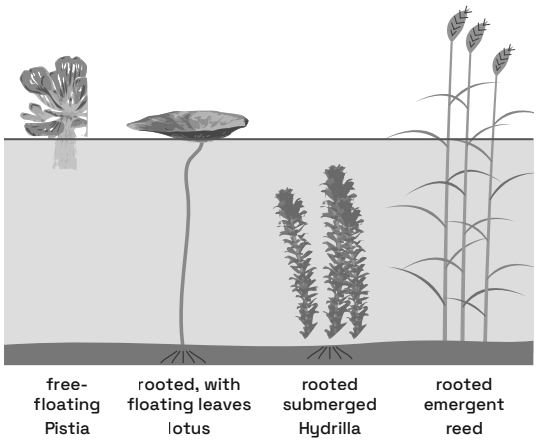
Adaptation

- **natural selection** over generations builds features that fit a species to its home
- kinds
  - **morphological** (structural): cactus spines, floating leaves
  - **physiological**: stomata closed in the heat of the day
  - **behavioral**: leaves fold at night; migration
- aim: **food and space**, chance to **reproduce**
- an adaptation is **inherited**, not one plant's response (bending to light, wilting)
- needs: light, air, water, nutrients, soil, climate; pond: too much water, little O_2; desert: little water, much heat
- by water: **hydrophytes**, **mesophytes**, **xerophytes**

Hydrophytes

- e.g. *Hydrilla*, *Pistia*, *Eichhornia* (jalkumbhi), *Lemna*

Category	Contact	Examples
free-floating	water, air; **not soil**	*Pistia*, *Eichhornia*, *Lemna*
rooted, floating leaves	roots in mud; leaves on surface	*Nymphaea*, *Nelumbo*, *Marsilea*, *Trapa*
submerged floating	**only water**; not rooted	*Ceratophyllum* (no roots), *Utricularia*
rooted submerged	under water; rooted	*Hydrilla*, *Vallisneria*, *Chara*
rooted emergent (amphibious)	shallow edge; shoots above water	*Typha*, *Sagittaria*, *Ranunculus*



Hydrophytes where they grow: free-floating *Pistia*, lotus with floating leaf, rooted submerged *Hydrilla*, emergent reeds.

- problems: plenty of water; little **oxygen**, less **light** with depth; water **moves**, **holds the plant up**

Morphological

- **roots**: absent (*Ceratophyllum*, *Utricularia*) or poorly developed; no root hairs, no root caps; free-floating: many fibrous roots for **balance**; **root pockets**; short, little branched
- **stems**: free-floating short, thick, **spongy** (runners); submerged long, slender, **flexible**
- **leaves**
  - submerged: thin, small, ribbon-like, **finely divided** (gases, light reach cells; current passes)
  - floating: **large, flat**, **waxy** upper surface
  - **heterophylly** (*Sagittaria*)
- **reproduction**: flowers rare in submerged ones, open **on or above the water**; pollination by water, insects, birds; **vegetative** common (*Eichhornia*, *Hydrilla* spread fast)

Anatomical

- **aerenchyma**: stores O_2 and CO_2, carries O_2 to roots in mud, **buoyancy** (water hyacinth stalk)
- **mechanical** and **vascular** tissue (xylem) **poorly developed**
- **cuticle** absent or thin in submerged parts
- **stomata**: none on submerged leaves; floating leaves **upper surface only**

Physiological

- **low compensation point** (dim light)
- **low osmotic concentration** of cell sap
- nutrients and gases through the **whole surface** (epidermis)
- **no transpiration** when submerged; floating, emergent ones transpire fast

Mesophytes

- **moderate, regular** water; air neither very dry nor saturated
- most crops, garden plants; hill trees: chilaune, katus, oak
- branched roots with **root hairs, root caps**
- erect stems; vascular, mechanical tissue well developed
- broad, flat, thin leaves; moderate cuticle; stomata mostly on the **lower** surface
- uptake balances transpiration; in dry spells close stomata, wilt

Xerophytes

- **dry (arid)** places, water scarce much of the year; deserts, semi-deserts (many grow where water is plentiful too)
- e.g. *Opuntia*, *Aloe* (ghiu kumari), *Agave*, *Euphorbia*
- Nepal: *Euphorbia royleana* (siundi) on dry slopes, hedges; *Agave* in dry inner valleys; **Upper Mustang** (rain shadow)

Kind	How	Examples
ephemerals (drought **evaders**)	grow, flower, seed in a few weeks while wet; dry season as **seeds**	*Solanum xanthocarpum*, *Tephrosia purpurea*, *Tribulus terrestris*
succulents (drought **endurers**)	**water-storing** parenchyma; fleshy root, stem or leaf	root *Asparagus*; stem *Opuntia*, *Euphorbia*; leaf *Aloe*, *Agave*, *Bryophyllum*
true xerophytes (drought **resisters**)	**keep growing** in dry heat; store **no** water; deep roots, small hard leaves, thick cuticle	*Acacia nilotica*, *Nerium*, *Zizyphus*

- task: **get**, **store**, **lose** little water

Morphological

- **roots**: **very deep** (mesquite > 50 m) or **wide** just under the surface (cacti); many root hairs near tips
- **leaves**: small, **scales**, **spines** (*Opuntia*); **roll or fold** (grasses); shed in dry season; **shiny, waxy** (reflect light, heat)
- **stems**: woody, hard (true xerophytes) or fleshy (succulents); **phylloclade** (*Opuntia*, *Euphorbia*); **thorns**
- **reproduction**: flowers after rain; insects, birds, bats; **vegetative** (fallen *Opuntia* pad roots)
- spines also **protect** from thirsty animals, shade the stem, slow the wind

Anatomical

- **thick cuticle**; thick-walled, **multi-layered epidermis** (*Nerium*); **wax**
- **sunken stomata** in **crypts** with hairs: still, moist air slows escape; lower surface, fewer
- **vascular** and **mechanical** tissue **well developed** (no collapse)
- water-storing parenchyma (succulents)

Physiological

- **high osmotic concentration**: draws water from dry soil
- **CAM**: stomata open at **night**, CO_2 stored as acid; photosynthesis by day, stomata shut (*Opuntia*, *Aloe*, *Agave*)

Feature	Hydrophyte	Xerophyte
roots	absent or few, short; no root hairs; root pockets	deep or wide-spreading; many root hairs
stem	soft, spongy, flexible	woody, or fleshy; flat green, or thorny
leaves	thin, divided, or broad floating	small, scaly, spiny, rolled, or absent
cuticle	absent or thin	thick, waxy
stomata	absent (submerged); upper surface (floating)	sunken, few, mostly lower surface
air spaces	large (aerenchyma)	few, small
mechanical, vascular tissue	poor	well developed
cell sap	low osmotic concentration	high osmotic concentration

COMMON MISTAKES

✗ Bending to light is an adaptation
✓ a **response** of one plant; adaptations are **inherited**.

✗ Hydrophytes have well-developed xylem
✓ **poorly developed**: water holds them up and is everywhere.

✗ Floating leaves have stomata below
✓ on the **upper** surface only, facing the air.

✗ *Begonia* is a xerophyte
✓ a **mesophyte** of moist, shady forest floors.

✗ Ephemerals resist drought
✓ they **evade** it, living through the dry season as seeds.

✗ True xerophytes store water
✓ they **don't**; succulents do.

✗ The pads of *Opuntia* are leaves
✓ **stems** (phylloclades); leaves are spines.