Key terms

Life cycle: all stages from one stage back to the same stage.

Thallus: simple body, no root, stem or leaf.

Pyrenoid: round body on a chloroplast; gathers food into starch.

Conjugation: two cells join by a tube; one's contents fuse with the other's.

Aplanogamete: gamete with no flagella; can't swim.

Physiological anisogamy: gametes alike in form; differ only in behavior.

Haplontic: adult haploid; meiosis in the zygote.

Trophozoite / cyst: active, feeding form / resting, infective form.

Excystation / encystment: leaving / forming the cyst.

Carrier (cyst passer): infected, no symptoms, passes cysts.

Semipermeable membrane: lets water through, not larger solutes.

Osmosis: water through a semipermeable membrane, **less concentrated** → **more concentrated**.

Hypotonic / isotonic / hypertonic: less / same / more concentrated than the cell sap.

Turgid: firm, cytoplasm pressed on the wall; **turgor pressure**.

Plasmolysis: protoplast shrinks from the wall (**deplasmolysis**: swells back).

Hemolysis / crenation: red cell bursts / shrinks and wrinkles.

Transpiration: water lost as **vapor** from a living plant's aerial parts.

Guttation: liquid drops at leaf edges, by root pressure; not transpiration.

Intracellular respiration: stepwise, enzyme-controlled breakdown of food inside cells; energy caught as ATP.

ATP: the cell's energy currency, from ADP + phosphate; about 30.5 kJ per mole.

Formulas and equations

- % change in mass = (final − initial) ÷ initial × 100%
  - ■ = hypotonic
  - − = hypertonic
  - zero = isotonic
- percent, not grams: strips start at different masses
- isotonic: between the + and − values, e.g. 0.2 + 0.2 × 7.1 ÷ (7.1 + 3.1) ≈ 0.34 mol/L
- potometer: $V = \pi r^2 d$ (or area × distance); rate = V ÷ time
- osmotic pressure $\pi = cRT$: c in mol/m^3, $R = 8.314$ J/(mol K), T in K
- aerobic: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy (about 2,870 kJ per mole)
- yeast: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ + 2 ATP
- muscle: $C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$ + 2 ATP
- 180 g glucose → 92 g ethanol + 88 g CO_2
- % in ATP = 38 × 30.5 ÷ 2,870 × 100% ≈ 40%; rest heat
- ATP: exams 38 (2 + 2 + 34); modern about 30–32

Spirogyra

Green alga of fresh water; about 400 species; **haploid** filament of cells, all alike.

- wall: inner **cellulose**, outer **pectin** → slimy mucilage; cross walls = septa
- ribbon **chloroplasts**, spiral, wavy edges; **pyrenoids** on them
- thin cytoplasm round a large vacuole; **nucleus** hung by strands

Vegetative: fragmentation; each piece → filament by mitosis.

Scalariform conjugation (two filaments; end of the season):

1. filaments side by side, held by mucilage
2. facing cells form **papillae**
3. tips meet, wall dissolves: **conjugation tube** (a ladder)
4. protoplasts lose water, round off: **aplanogametes**
5. one filament's gametes creep across (male); others wait (female)
6. fusion → **zygote (2n)** → three-layered wall: **zygospore**
7. one filament empty, other a row of zygospores

Lateral conjugation (one filament): tube round the septum, or a hole in it; every second cell empty.

Germination: meiosis → 4 haploid nuclei → **3 degenerate** → germ tube → mitosis → **one** filament.

- zygote is the only 2n cell (haplontic)
- thick wall: survives cold or dry season

Entamoeba histolytica

Parasitic protozoan of the human large intestine; **one host**; no sexual reproduction.

	Trophozoite	Cyst
job	feeds, divides, harms	rests, spreads, infects
size	15–30 μm (to 60)	10–15 μm
shape	irregular; one broad pseudopodium	round; thick wall
nuclei	1	1 → 2 → 4 (mature)
inside	food vacuoles, red blood cells	glycogen, chromatoid bodies
outside	dies in minutes to hours	lives for weeks

Nucleus: central **karyosome**, ring of chromatin. No contractile vacuole.

Life cycle

1. **swallowed**: mature 4-nucleate cyst, in water or food with feces
2. **excystation** (lower small intestine): 4 → 8 nuclei → **8 small amoebae**
3. **large intestine**: trophozoites; **binary fission**; most people unharmed
4. **invasion** (some): flask-shaped ulcers, dysentery; by portal vein to the liver (abscess); a dead end
5. **encystment**: stop feeding, round up (precystic), wall forms
6. **maturing**: nucleus divides twice by mitosis
7. **passed out** in feces

Prevention:

- boil water (chlorine not reliable)
- soap
- toilets away from wells
- clean vegetables, cover food
- no night soil on vegetables
- treat patients and carriers (metronidazole, then a cyst-clearing medicine)
- *E. dispar*: harmless, same cysts; only protein or DNA tests separate them

Osmosis

Three things: **water** moves; through a **semipermeable membrane**; **dilute** → **concentrated**.

Outside	Water	Plant cell	Red blood cell
hypotonic	in (endosmosis)	turgid	bursts
isotonic	no net flow	no change	no change
hypertonic	out (exosmosis)	plasmolyzed	crenated

- normal saline, 0.9% NaCl: isotonic with blood; never plain water in a drip
- **potato osmometer**: raw potato: level rises; **boiled** (control): no rise; so living membranes are needed

Importance:

- root hairs absorb water
- turgor holds up soft stems, wilting when lost
- stomata open and close
- touch-me-not droops
- water back from the large intestine and kidney

Daily life:

- salt and sugar preserve food
- too much fertilizer burns roots
- sea water can't quench thirst

Transpiration

- about **97%** of the water absorbed is lost as vapor
- wet mesophyll → air spaces → open stomata → outside

Kind	Through	Share
stomatal	stomata	about 90%
cuticular	cuticle	about 5–10%
lenticular	lenticels	well under 1%

Transpiration pull: evaporation pulls a thread of water up the xylem, held by **cohesion** and **adhesion**; over 110 m in coast redwoods; root pressure only a few meters.

Experiments

- **bell jar**:
  - pot and soil in polythene

- drops in the jar, control dry
- drop turns cobalt chloride blue → pink

- **cobalt chloride paper**: lower surface pink first, more stomata (maize: both alike)
- **potometer** measures **uptake**, nearly equal to loss

Factor	Faster when	Why
light	light	stomata open; leaf warms
temperature	warm	faster evaporation
humidity	dry air	larger vapor difference
wind	windy (up to a point)	vapor swept away
soil water	moist	dry soil: stomata close
leaf	many open stomata	sunken, thick cuticle, hairs, spines: slower

Importance:

- lifts water and minerals
- cools (about 2,400 J per gram)
- keeps water moving
- open stomata take in CO_2
- brings rain

Cost: wilting. **A necessary evil.**

Intracellular respiration

External respiration (breathing) only exchanges gases; respiration is in **every living cell**, day and night. Not burning: small enzyme steps, at body temperature, energy caught in ATP.

Stage	Where	Gives
glycolysis	cytoplasm	2 pyruvic acid, net 2 ATP, NADH; no O_2 needed
Krebs cycle	matrix	CO_2, hydrogen to NAD and FAD, 2 ATP
electron transport chain	cristae	most ATP; O_2 → water

Aerobic	Anaerobic
with O_2	no O_2
cytoplasm + mitochondria	cytoplasm
complete breakdown	partial
CO_2 + H_2O (harmless)	ethanol + CO_2, or lactic acid
38 ATP (about 30–32)	2 ATP

Advantages:

- energy for all life processes
- small usable steps
- body heat (about 37 °C)
- building materials
- CO_2 for plants
- works without oxygen for a short time
- useful fermentation (bread, *jaand*, *dahi*, *gundruk*, gobar gas)
- sprint: lactic acid → panting after (liver, heart use it)

COMMON MISTAKES

✗ Osmosis "high to low concentration"
✓ dilute → concentrated solution; or high → low **water** concentration.

✗ Four filaments per zygospore
✓ **one**: three nuclei degenerate.

✗ Trophozoite infects
✓ only the mature **cyst**; acid kills trophozoites.

✗ Respiration = breathing, or burning
✓ inside cells, in small steps.

✗ Guttation is transpiration
✓ transpiration is always **vapor**.

✗ Next-day soreness from lactic acid
✓ tiny fiber injuries; lactic acid clears within about an hour.