AP BIOLOGY | UNIT 8 | TOPIC 8.2

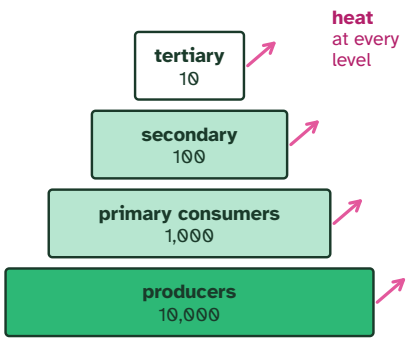
REVISION ON TWO PAGES

Energy *flows*, matter cycles

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

Energy enters as light, passes up the trophic levels and leaves as heat: never recycled. Atoms are conserved and cycle between reservoirs.



kJ per m² per year, at one tenth a step

Draw it like this. Each bar as wide as the energy it holds; heat leaves every level.

8.2.B START HERE

Energy flows up, then *leaves as heat*

- Each feeding step is a **trophic level**: producers, then primary, secondary and tertiary consumers. An arrow points **from the eaten to the eater**, the way the energy goes.
- Most of a level's energy is **not passed on**. Only what is built into **new tissue** can be eaten: often about a tenth, though it **varies widely**.
- So each level holds less than the one below and food chains are short, **seldom over four or five levels**.
- Heat cannot become chemical energy again: **energy is never recycled**. Efficiency = energy at one level ÷ the level below × 100.

WHERE A LEVEL'S ENERGY GOES

Rabbit: 60 heat, 30 feces, 10 tissue

R Respired released as heat	**N** Not eaten roots, bark, bones	**F** Feces never absorbed	**G** Growth the only part passed on

8.2.B SMALL TO LARGE

Levels of *organization*

- Energy flows through an ecosystem; **matter cycles** within it. Living parts are **biotic**; temperature, water, minerals and light are **abiotic**.

P **Population** One species in one area.	C **Community** All the populations there.
E **Ecosystem** The community and its surroundings.	B **Biome** A kind of ecosystem set by climate.

Please Come Eat Breakfast

8.2.D TWO WAYS TO FEED

Make it or *take it*

- **Autotrophs** capture energy from their surroundings and make carbon compounds from carbon dioxide.
- **Heterotrophs** eat organic matter that came from autotrophs: herbivores, carnivores, omnivores, scavengers and decomposers.

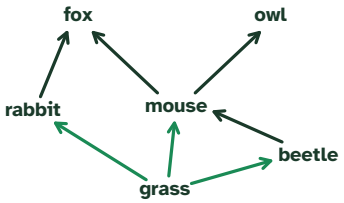
Photosynthetic from light
Plants, algae, cyanobacteria. What they store is the **primary productivity**.

Chemosynthetic from inorganic reactions
Bacteria at deep-sea vents oxidize **hydrogen sulfide**, in total darkness.

8.2.B 8.2.C WHO EATS WHOM

Food chains and *webs*

- A **food web** is chains that share members. Draw producers at the bottom, then **one arrow per eating pair**, food to eater.
- Name the level **along each chain**: a mouse eating seeds is a primary consumer; eating a beetle, a secondary one.
- Decomposers are fed by **every level**.



8.2.D 8.2.C THE ENERGY AT THE BASE

Primary *productivity*

- **Primary productivity**: the rate producers store energy in new organic matter, per area per year. **Light, water, temperature and nutrients** limit it: high in a rainforest, low in a desert or the tundra.
- Producers respire too, day and night. What consumers can use is **what producers fix minus their own respiration**.
- **Light and dark jars:** the dark jar's fall in oxygen is respiration; the light jar's rise is what was made beyond that. Together, all that was made.

+1.6 mg/L in the light: made minus used	**−1.4** mg/L in the dark: used	**3.0** mg/L made in all

8.2.C ENERGY AVAILABILITY

Change the *energy*, change everything

- Less light or fewer producers means **less energy at every level** above, so populations shrink all the way up.
- The **top level**, smallest to start with, may **disappear**: the web loses a level. More energy at the base can support larger populations and, in time, another level.
- **Off Peru:** in an El Niño year cold upwelling weakens, phytoplankton fall, and anchovies and seabirds crash.

−25% producers: 18,000 kJ in place of 24,000	**All** levels above fall by about a quarter

8.2.A ENDOTHERMS AND ECTOTHERMS

One animal's *energy budget*

- Energy in as food, out as heat, movement and upkeep. A **net gain** means storage, growth and more offspring; a **net loss**, mass lost, fewer offspring and in the end death.

	ENDOTHERM	ECTOTHERM
Heat	From its own metabolism	From its surroundings
Body	Held steady, as near 37 °C	Follows the air, unless behavior changes it
Cost	**High: much food**	**Low: little food**
Cold	Respires more food to stay warm	Cools and slows down

Endotherms: birds and mammals. Ectotherms: most other animals. Never say cold-blooded.

8.2.A REPRODUCTIVE STRATEGIES

Breed when the *food* is there

- Reproduction costs energy, so organisms **match its timing and kind to the energy available**.

1 **Seasonal**
Chicks hatch when caterpillars peak.

2 **Switch**
Water fleas clone while food lasts, then make males and tough fertilized eggs.

3 **Store first**
Biennial carrots store food, then flower the next year.

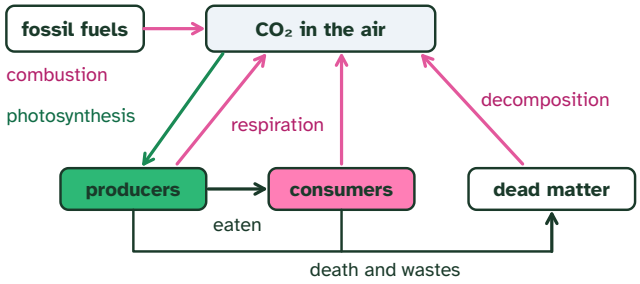
4 **Pause**
Monarchs that fly south breed only the next spring: diapause.

Asexual is fast; sexual gives varied offspring.

8.2.B FOUR PARTS

The *carbon* cycle

- A **biogeochemical cycle**: reservoirs, living and not, and the processes between them. **Matter is conserved**, only used again.
- Carbon enters life by **photosynthesis** and returns as carbon dioxide by **respiration, decomposition and combustion**.

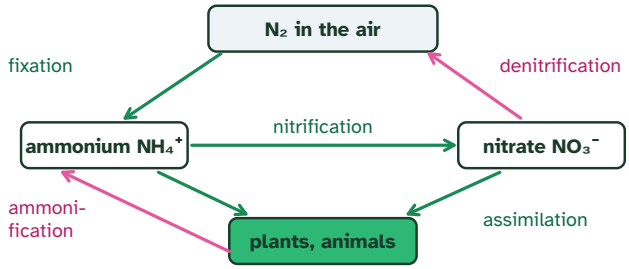


WATER
Oceans, surface water, air, life
Evaporation, transpiration, condensation, precipitation.

8.2.B FROM THE AIR

The *nitrogen* cycle

- The air is about **78% N_2**, which most organisms cannot use. **Fixation** by bacteria, free in soil or in legume root nodules, makes ammonium. Plants take up **nitrate and ammonium** through roots. *Farmers Need All Available Dirt.*



PHOSPHORUS
Rock; no gas at all
Weathering releases phosphate; decomposition and excretion return it. Slowest, so often limiting.

WATCH OUT

Five mistakes that *cost points*

- ✕ **Energy is never recycled.** It leaves as heat; decomposers release it as heat too. Only matter cycles.
- ✕ **Arrows point from eaten to eater.** Grass to rabbit to fox, the way the energy goes.
- ✕ **"About a tenth" is not a law.** Work from the numbers given.
- ✕ **Plants respire day and night.** They photosynthesize as well as respiring, not instead.
- ✕ **A tree's mass comes mostly from the air.** Carbon enters as carbon dioxide; the soil gives water and minerals.

COVER THE SHEET

Can you *answer these?*

1. Explain why food chains seldom have over five levels.
2. Calculate efficiency: 2,160 kJ from 24,000 kJ.
3. Identify the energy source of bacteria at a deep-sea vent.
4. Predict which level is lost first if the producers fall.
5. Explain why a mouse eats more than a lizard at 10 °C.
6. Explain why water fleas switch to sex as food runs short.
7. Describe how a carbon atom in the air can reach a fox.
8. Describe how nitrogen in the air reaches a protein.

IN THE EXAM
Energy and matter are different stories: energy flows one way and leaves as heat; atoms cycle. Name the process on every arrow, and for a calculation show (new − old) ÷ old × 100 with units.

GO FURTHER
Animated figures, a dry lab and a marked Check are in the full guide online.