AP Biology Unit 8
Ecology

One-page sprint review
Free at Sophriva

EXAM WEIGHT	MCQs	FRQ APPEARANCE	SPRINT TIME
10–15%	6–9	Very Frequent	~2 hours

Inside this pack

- **Quick Glance at every Unit topic with priority + format**
- **Topic-by-topic key traps, must-know rules, and exam frames**
- **Worked example questions on the highest-yield topics**

Unit 8 Ecology — Life in Context

AP Biology • Unit 8 • 10–15% of Exam • The Capstone Unit • Sprint Review

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At a Glance

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			speed change. Photoperiodism ≠ phototropism
8.2 Energy Flow & Cycles	★★★	MCQ, Calc, FRQ	Food web arrows point FROM prey TO predator. 10% rule: only ~10% transferred per level
8.3–8.4 Population Ecology	★★★	MCQ, Calc, Data	Logistic growth: max rate at N = K/2, NOT at K. Density-dependent ≠ density-independent
8.5 Community Ecology	★★★	MCQ, FRQ	Mutualism (+/+) ≠ commensalism (+/0). Competitive exclusion → niche partitioning
8.6 Biodiversity	★★★	MCQ, FRQ	Keystone species: disproportionate impact relative to abundance. Removal = community collapse
8.7 Disruptions	★★★	MCQ, FRQ	Biomagnification increases up trophic levels. Eutrophication: N + P → algae → O_2 crash

1 Responses to the Environment

A Movement Types — Taxis vs. Kinesis

- **Taxis:** directed movement toward (+) or away from (−) a stimulus; organism orients relative to stimulus.
- **Examples:** phototaxis, chemotaxis, gravitaxis.
- **Kinesis:** undirected change in movement speed or turning frequency in response to stimulus intensity; no orientation toward or away.
- **Exam test:** moving toward humidity = taxis; moving faster in dry air and slowing in humid air = kinesis.

B Plant Responses — Tropisms & Photoperiodism

- **Phototropism:** directed growth of plant toward or away from light.
- **Gravitropism:** roots grow down (positive); shoots grow up (negative).
- **Photoperiodism:** response to day length / night length; controls flowering, migration timing, hibernation, reproduction.
- Long-day plants flower when day length exceeds a critical length; short-day plants flower when days are shorter than a critical length.

C Behavior Evolution — Innate vs. Learned

- **Innate behavior:** genetically programmed, species-typical, does not require experience; examples include spider webs, migration routes, bee waggle dance.
- **Learned behavior:** modified by experience, requires neural plasticity, can spread by social learning; examples include bird song dialects and tool use in chimps.
- Both can be favored by natural selection if they affect fitness.
- **Optimal foraging theory:** organisms maximize energy gained per unit time while foraging.

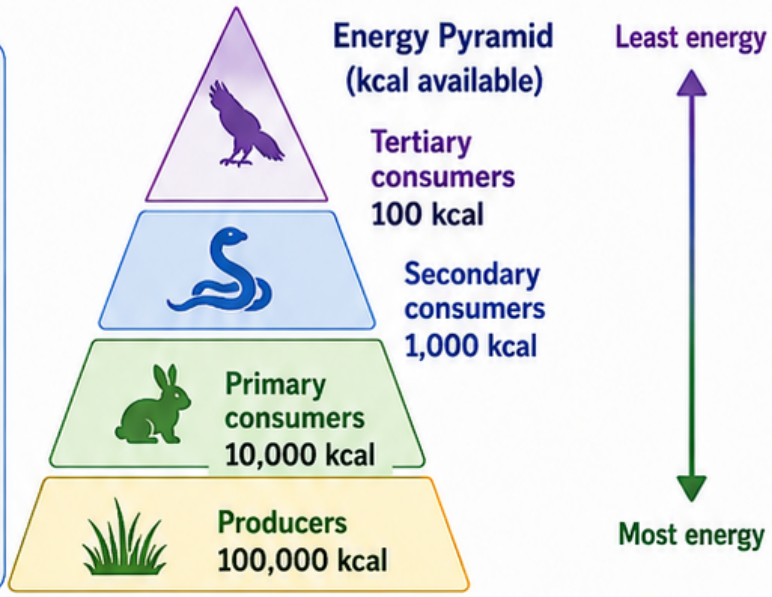
- Fruit flies turning more in dry areas but slowing in humid areas = kinesis,

8.2 Energy Flow Through Ecosystems

Energy flows one way; matter cycles

1 The Two Rules

- **Energy flows ONE WAY:** sunlight → producers → consumers → heat.
- **~90% of energy** is lost at each trophic level through respiration, heat, and waste.
- Only **~10%** transfers to the next trophic level **(10% rule).**
- This limits food chains to about 4–5 trophic levels.
- **Matter cycles:** the same atoms are reused through biogeochemical cycles.
- Food web arrows point FROM prey TO predator — the direction of energy flow.



2 Trophic Level Roles

Producers (autotrophs)

capture energy from sunlight or chemicals; base of food web.

Primary consumers

herbivores that eat producers.

Secondary and tertiary consumers

carnivores that eat lower consumers.

Detritivores

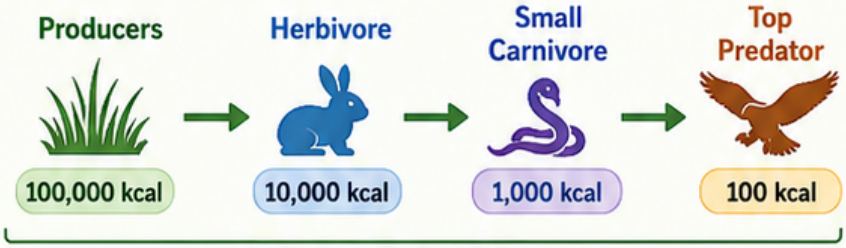
physically ingest dead organic matter; examples: earthworms, beetles.

Decomposers

fungi and bacteria that chemically break down dead matter and return nutrients to soil.

ℹ Detritivores ≠ decomposers — the mechanism differs.

3 Energy Pyramid — The 10% Rule Visualized



Top predators require large territories because little energy reaches them.

Example: If producers store **500,000 kcal**, primary consumers get **50,000 kcal** and secondary consumers get **5,000 kcal.**

Exam Sniper

- 500,000 kcal at producers → 5,000 kcal at secondary consumers.
- Arrows grass → rabbit → fox show energy moving from grass into rabbit and from rabbit into fox.
- **Decomposers are essential** for returning nutrients from organic matter to inorganic forms in soil.

Trap Alert

- Food web arrows point FROM prey TO predator.
- The 90% is mostly lost as heat — not stored for the next level.
- Phosphorus has no atmospheric component.

8.2 Biogeochemical Cycles

Reservoirs, processes, and human disruption

	Main Reservoir	Key Processes	Human Disruption
Carbon (CO_2)	Oceans (largest active reservoir), atmosphere as CO_2, fossil fuels.	Photosynthesis: CO_2 → organic molecules; respiration and combustion: organic molecules → CO_2; decomposition returns carbon.	Fossil fuel burning and deforestation increase atmospheric CO_2 and strengthen the greenhouse effect.
Nitrogen (N_2)	Atmosphere as N_2 (78%); most organisms cannot use N_2 directly.	Nitrogen fixation: N_2 → NH_3 by *Rhizobium*, free-living bacteria, or lightning; nitrification: NH_3 → NO_3^-; assimilation; ammonification; denitrification: NO_3^- → N_2.	Fertilizer runoff causes eutrophication; industrial NOx contributes to acid rain.
Phosphorus	Rocks and sediments — no atmospheric reservoir.	Weathering releases phosphate; plant uptake; animal consumption; decomposition returns phosphorus to soil; runoff moves phosphorus to water.	Fertilizer runoff drives eutrophication; phosphorus often limits freshwater ecosystems.
Water	Oceans (~97%).	Evaporation, transpiration, condensation, precipitation, runoff, infiltration.	Deforestation lowers transpiration; urbanization increases runoff and decreases infiltration.

Process Keywords to Memorize

Carbon (CO_2)
- photosynthesis
- respiration
- combustion
- decomposition

Nitrogen (N_2)
- fixation
- nitrification
- assimilation
- ammonification
- denitrification

Phosphorus
- weathering
- uptake
- decomposition
- runoff

Water
- evaporation
- transpiration
- condensation
- precipitation
- infiltration

Exam Sniper

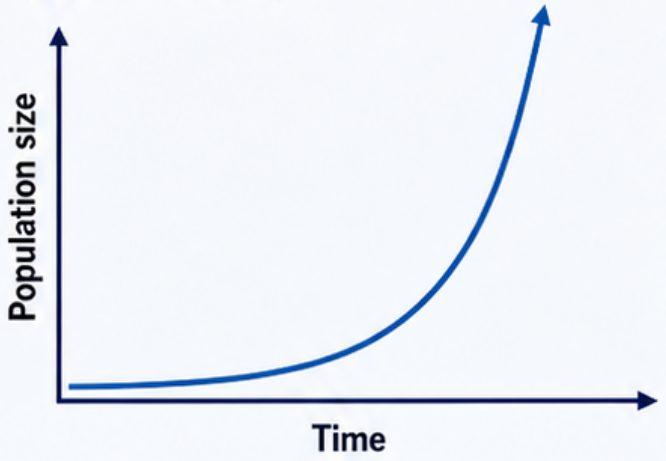
- Phosphorus often limits freshwater because it has no atmospheric reservoir.
- Nitrogen fixation makes atmospheric N_2 biologically usable.
- Denitrification returns nitrogen to the atmosphere.
- Carbon and nitrogen have large atmospheric pools; phosphorus does not.

8.3–8.4 Population Ecology & Density Effects

Exponential vs. logistic growth, regulation, and life history strategies

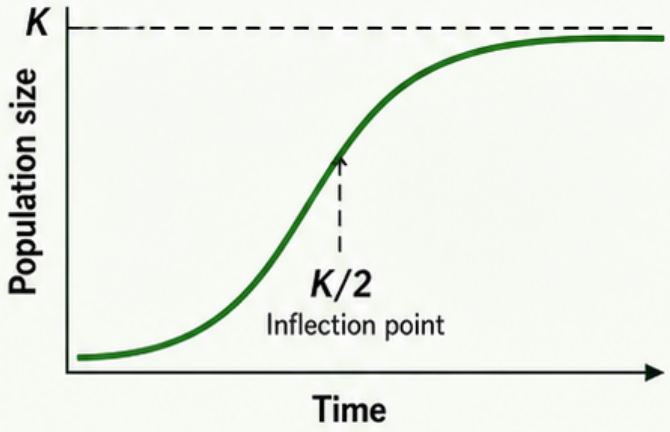
A Exponential Growth

- Occurs when resources are unlimited.
- Growth rate accelerates as population size increases.
- Per-capita growth rate = r_{max}.
- **Equation:** $dN/dt = rN$.
- J-shaped curve; population does not level off.
- **Examples:** introduced species, new habitats, post-disaster recovery.



B Logistic Growth

- Occurs when resources become limiting.
- **Equation:** $dN/dt = rN(K–N)/K$.
- K = carrying capacity, the maximum sustainable population size.
- Growth slows as N approaches K.
- Maximum growth rate occurs at $N = K/2$, not at K.
- S-shaped curve; growth levels off at K.



Density-Dependent Regulation

- **Competition** intensifies as crowding increases.
- **Predation** often increases when prey are abundant.
- Disease and parasitism spread faster in dense populations.
- Stress and territoriality can lower reproduction.
- These factors help keep populations near K.

Density-Independent Factors

- Affect populations regardless of density.
- **Examples:** drought, fire, flood, blizzard, earthquake, hurricane.
- Can cause sudden crashes followed by recovery.
- **Example:** a tornado kills deer regardless of whether population size is small or large.

Life History Strategies — *r* vs. K

r-selected

Many small offspring, high reproductive rate, short lifespan, little parental care, pioneer species, unpredictable environments.

Examples: mice, insects, weeds.

K-selected

Few large offspring, low reproductive rate, long lifespan, high parental care, stable populations near K, predictable environments.

Examples: elephants, humans, large trees.

***r*-selected species recover faster after disturbances; K-selected species are more vulnerable to disturbance.**

Exam Sniper

- Maximum logistic growth rate is at N = K/2.
- At K, net growth = 0.
- Disease spreading in a crowd = density-dependent; drought or wildfire = density-independent.

8.5 Community Ecology

Species interactions, niche partitioning, cascades, and succession

Exam Weight: 10–15%	~MCQs: 6–9	FRQ Appearance: Very Frequent	Sprint Time: ~2 hours

1 Six Species Interactions — Know Signs & Examples

Mutualism (+/+)

Both species benefit.

Examples: clownfish and anemone; mycorrhizal fungi and plant roots; *Rhizobium* and legumes; cleaner fish and larger fish.

Predation (+/−)

Predator benefits, prey is harmed.

Examples: wolf and elk; lion and zebra; hawk and mouse. Can drive coevolution.

Herbivory (+/−)

Animal consumes plant or algae.

Examples: deer eating shrubs; caterpillar feeding on leaves.

Parasitism (+/−)

Parasite benefits, host is harmed, usually not killed immediately.

Examples: tapeworm and human; tick and deer; mistletoe and tree.

Commensalism (+/0)

One benefits, the other is unaffected.

Examples: barnacles on whales; epiphytes on trees; cattle egrets near grazing cattle.

Competition (−/−)

Both are harmed as they compete for the same limited resource.

2 Competitive Exclusion & Niche Partitioning

- **Competitive exclusion principle:** two species cannot occupy the same niche indefinitely; one will outcompete the other.
- **Niche partitioning** allows coexistence by dividing resources. **Example:** MacArthur's warblers feeding at different heights in the same tree.
- **Character displacement:** competing species evolve more different phenotypes where they co-occur. **Example:** Darwin's finches and beak divergence.
- **Ecological niche** includes both biotic and abiotic conditions; fundamental niche is potential, realized niche is actual after competition.

3 Trophic Cascades

Yellowstone wolves: wolves removed → elk increase → overgrazing → vegetation loss → stream bank erosion; reintroduction helps vegetation and stream recovery.

Sea otters: otters control sea urchins; without otters, urchins overgraze kelp forests and biodiversity falls.

Top predators can have outsized top-down effects on communities.

4 Primary & Secondary Succession

- **Primary succession:** begins on bare rock or newly exposed land with no soil; pioneer species such as lichens and mosses start the process.
- **Secondary succession:** follows disturbance where soil remains; faster recovery; examples include abandoned farms and post-fire forests.
- Pioneer species tolerate harsh conditions and help create conditions for later species.
- Both may progress toward a more stable mature community.

Exam Sniper

- Warblers feeding at different heights = niche partitioning.
- Wolves affecting elk, plants, and streams = trophic cascade.
- Watch wording: gut bacteria and humans are often mutualism, not commensalism, if both benefit.

8.6 Biodiversity

Resilience, keystone species, and diversity measurement

1 Why Diversity Matters

- Higher species diversity increases ecosystem resilience to disturbance.
- More diverse communities usually have more stable productivity and better nutrient cycling.
- Genetic diversity within species allows populations to adapt to environmental change.
- Low diversity increases extinction risk; monocultures are vulnerable to a single pathogen or pest.
- Ecosystem services such as clean water, pollination, carbon sequestration, and air purification depend on biodiversity.

2 Keystone Species

- A keystone species has a disproportionately large effect on community structure relative to its abundance.
- Removal can cause major structural changes or community collapse.
- **Examples:** sea otters maintain kelp forests by controlling sea urchins; wolves trigger trophic cascades; sharks regulate prey populations; fig trees support many tropical species.

Key idea = impact relative to abundance.

3 Ecosystem Engineers

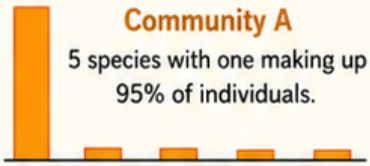
- Ecosystem engineers physically modify the environment.
- **Examples:** beavers create wetlands; prairie dogs create habitat by burrowing.
- Not every influential species is a keystone species; ecosystem engineer refers specifically to physical habitat modification.

4 Simpson's Diversity Index

$$D = 1 - \sum \left(\frac{n_i}{N}\right)^2$$

- n_i = number of individuals of species i; N = total individuals.
- Higher D means greater diversity.
- The index reflects both species richness and evenness.
- A community with equal abundances is more diverse than one with the same number of species but one dominant species.

Community A
5 species with one making up 95% of individuals.



VS.

Community B
5 species evenly distributed.

Community B is more diverse.

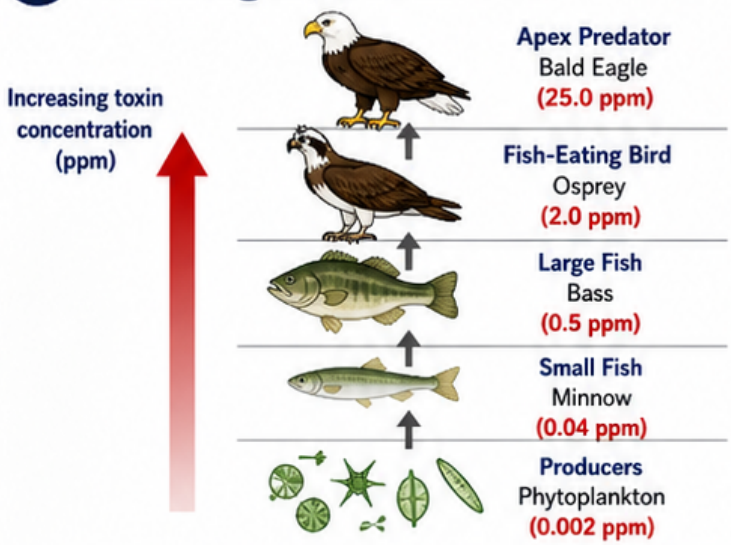
Exam Sniper

- Sea otters are keystone species because kelp forests collapse when otters are removed.
- Same richness but better evenness = higher diversity.
- Maintaining biodiversity improves resilience because other species can partially fill lost roles.

8.7 Disruptions in Ecosystems

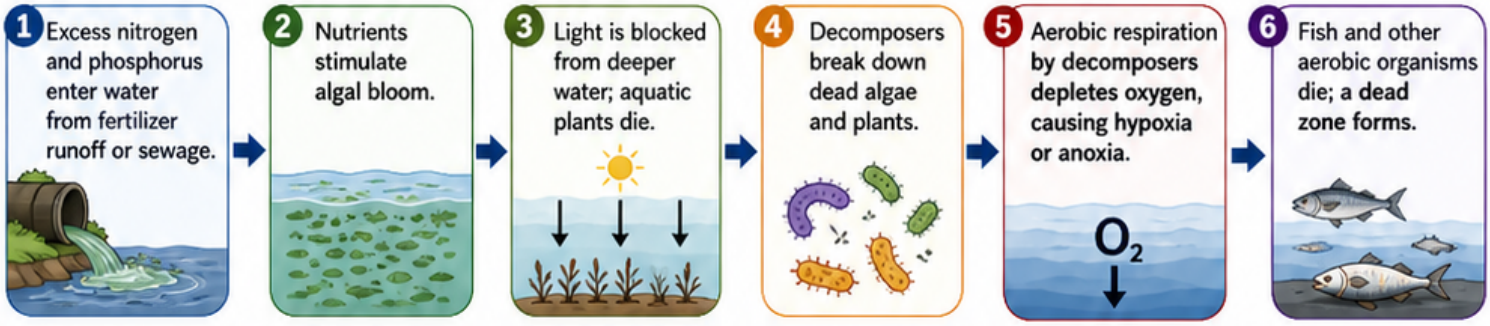
Biomagnification, eutrophication, invasive species, habitat loss, and acid rain

1 Biomagnification



- **Biomagnification** is the increase in concentration of fat-soluble toxins at higher trophic levels.
- Fat-soluble toxins such as DDT, PCBs, and methylmercury are stored in tissues and are not easily excreted.
- Each predator consumes many prey, concentrating the toxin burden.
- Highest concentrations occur in apex predators.
- Classic example: DDT caused eggshell thinning in bald eagles.
- Water-soluble toxins do not biomagnify because they are excreted.

2 Eutrophication — Step-by-Step



⚠ Oxygen crash is caused **indirectly** by decomposition, not directly by algae.

3 Other Major Human Impacts

- **Invasive species:** introduced organisms often lack natural predators and can outcompete natives; examples: kudzu, zebra mussels, cane toads.
- **Habitat destruction** is a leading cause of extinction and reduces population size, increasing extinction risk and genetic drift.
- **Climate change** alters temperature, precipitation, species ranges, and phenology.
- **Deforestation** reduces carbon fixation, disrupts the water cycle, destroys habitat, and increases erosion.
- **Overharvesting** removes individuals faster than they can recover; examples include Atlantic cod and bluefin tuna.

4 Acid Rain

- Industrial SO_2 and NO_x react with atmospheric water to form sulfuric and nitric acids.
- Acid rain lowers soil and water pH, harms aquatic life, leaches nutrients, and damages forests.
- This connects human activity to disruption of biogeochemical cycles.

Exam Sniper

- Mercury is highest in tuna and sharks because methylmercury biomagnifies.
- Eutrophication chain: N + P → algal bloom → plant death → decomposition → oxygen depletion → dead zone.
- Only fat-soluble toxins biomagnify.

Trap Alert

- Biomagnification increases up trophic levels.
- Water-soluble pollutants usually do not biomagnify.
- Decomposition, not algae themselves, causes the oxygen crash in eutrophication.

Unit 8 Sprint Practice — Mixed Questions

Three high-frequency AP Biology review problems

1 Practice 1 — Logistic Growth

Question Summary

A rabbit population on a new island grows rapidly, then slows and stabilizes at 2,000 individuals. At approximately what population size is growth rate highest, and what is the name of the population ceiling?

Answer Logic

1. The pattern is logistic growth because growth slows and levels off.
2. The ceiling is carrying capacity, K = 2,000.
3. Maximum logistic growth rate occurs at N = K/2.
4. K/2 = 1,000 individuals.

Final Answer

Highest growth rate at ~1,000; the ceiling is the carrying capacity (K).

2 Practice 2 — 10% Rule Calculation

Question Summary

Grass stores 800,000 kcal. Grasshoppers eat grass, deer mice eat grasshoppers, and red-tailed hawks eat deer mice. How much energy is available to the hawks?

Answer Logic

1. Producer level = 800,000 kcal.
2. Primary consumers receive 10% = 80,000 kcal.
3. Secondary consumers receive 10% of that = 8,000 kcal.
4. Tertiary consumers receive 10% of that = 800 kcal.
5. After three trophic transfers, only 0.1% of original energy remains.

Final Answer

Red-tailed hawks: 800 kcal.

3 Practice 3 — Keystone Species

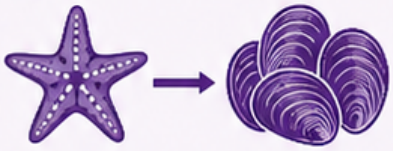
Question Summary

Sea star *Pisaster* is removed from a rocky intertidal plot. Mussels quickly dominate the substrate and many other species disappear. What does this show, and what term describes *Pisaster*?

Answer Logic

1. Pisaster normally keeps mussels from excluding other species.
2. Without Pisaster, competitive exclusion allows mussels to dominate.
3. Community diversity collapses after the sea star is removed.
4. A species with a disproportionate effect relative to abundance is a keystone species.

Final Answer



This demonstrates top-down regulation and competitive exclusion; *Pisaster* is a keystone species.

Exam Sniper

- Logistic max growth at K/2.
- Three trophic transfers = multiply by 0.001.
- Keystone species removal often collapses biodiversity.

Unit 8 High-Frequency Exam Traps

Common mistakes and a 10-minute checklist

1 Seven High-Frequency Exam Traps

1  Food web arrows point FROM prey TO predator — they show direction of energy transfer.

2 

Maximum logistic growth rate is at N = K/2, not at K. At K, net growth = 0.

3 

Mutualism (+/+) is not commensalism (+/0). Check whether both species benefit.

4  Biomagnification means toxin concentration increases up trophic levels, especially in apex predators.

5  Keystone species are defined by impact relative to abundance — not merely by having a large effect.

6 

Eutrophication depletes oxygen indirectly through decomposition of dead algae and plants.

7 

Disease spreading in a crowd is density-dependent; a hurricane is density-independent.

2 Pre-Exam 10-Minute Checklist — Unit 8

A Energy Flow & Cycles (8.2)

- ☐ Food web arrows go from prey to predator.
- ☐ Only ~10% transfers to the next trophic level.
- ☐ Phosphorus has no atmospheric reservoir.
- ☐ Nitrogen fixation: $N_2 \rightarrow NH_3$; denitrification: $NO_3^- \rightarrow N_2$.
- ☐ Decomposers chemically break down matter; detritivores ingest it.

B Population Ecology (8.3–8.4)

- ☐ Exponential growth: $dN/dt = rN$.
- ☐ Logistic growth: $dN/dt = rN(K-N)/K$.
- ☐ K = carrying capacity.
- ☐ Maximum logistic growth occurs at K/2.
- ☐ Know density-dependent vs density-independent factors.

C Community Ecology & Biodiversity (8.5–8.6)

- ☐ Know signs and examples for mutualism, predation, herbivory, parasitism, commensalism, and competition.
- ☐ Competitive exclusion can lead to niche partitioning.
- ☐ Keystone species have disproportionate effects.
- ☐ Higher biodiversity improves resilience.

D Disruptions (8.7)

- ☐ Biomagnification increases up food chains.
- ☐ Eutrophication chain ends in hypoxia / dead zone.
- ☐ Invasive species can outcompete natives.
- ☐ Habitat loss and climate change reduce biodiversity.

Final Sprint Strategy

- Top five exam hits: 10% rule, logistic growth at K/2, biomagnification direction, eutrophication chain, keystone species definition.
- Unit 8 FRQs often connect to Unit 3 respiration, Unit 7 genetic diversity, and Unit 1 nitrogen in biomolecules.
- Recognize J-curve vs S-curve quickly on graphs.

Unit 8 Final Cheat Sheet

Top hits, cross-unit connections, and exam-day strategy

1 Top 8 Must-Know Ideas

1 Taxis = directed movement; kinesis = undirected change in speed or turning.

2 Photoperiodism is response to day length; phototropism is growth toward light.

3 Energy flows one way; matter cycles.

4 Food web arrows point from prey to predator.

5 

Maximum logistic growth occurs at N = K/2.

6 Competition can lead to niche partitioning; top predators can cause trophic cascades.

7 Keystone species have disproportionate impact relative to abundance.

8 Biomagnification increases up trophic levels; eutrophication ends in oxygen depletion and dead zones.

2 Cross-Unit Connections

Unit 1 →	Nitrogen cycle connects to amino acids and proteins; phosphorus connects to ATP, DNA, and phospholipids.
Unit 3 →	Energy lost between trophic levels is largely due to cellular respiration and heat.
Unit 7 →	Genetic diversity within populations supports adaptation and ecosystem resilience.
Whole course →	Ecology integrates molecular, cellular, organismal, population, and community biology.

3 AP Exam Day Strategy

- For MCQs, eliminate obvious wrong answers and look for the most direct mechanism.
- For FRQs, use precise biological language and organize answers in clear steps or bullet points.
- When explaining ecology, connect cause and effect explicitly.
- On graphs, identify axes, units, and overall pattern before interpreting details.
- If unsure, use core principles: energy transfer, limiting resources, natural selection, and structure-function.

4 Final Motivator

Individuals respond, populations grow, communities interact, ecosystems cycle matter, and ecology ties the whole course together.

★ *You are ready for the AP Biology exam.* ★

Remember: *arrows show energy flow, start logistic reasoning with K and K/2, and follow the eutrophication chain step by step.*

Done with the sheet? Now get marked.

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1

Score

Marked against the published College Board rubric.

2

See

The exact rubric point you gained or dropped, line by line.

3

Practice

Turn around your weak rubric points before exam day.

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