The Simple AP® Biology Unit 7 Cheat Sheet

7.1–7.3 Natural & Artificial Selection

How Natural Selection Works

Variation: individuals in a population differ in traits they can pass on to offspring (heritable).
Overproduction: more offspring are born than can survive → competition for resources.
Selection: those with helpful traits survive and reproduce more, passing those traits on.
Adaptation: helpful alleles become more common in the population over many generations.

Key Ideas

Fitness = how many offspring survive and reproduce, not strength, size or speed.
Populations evolve; individuals don't.
Environment decides which traits help (e.g., bigger finch beaks win in a drought year).
Pressures: predators, disease, climate, food supply, and competition for mates.

Artificial Selection

	Natural	Artificial
Who selects	Environment	Humans
Example	Drug resistance	Dog breeds

Wild mustard → broccoli, kale, cabbage, cauliflower by selective breeding.
Convergent evolution: unrelated species evolve similar traits in similar environments.

⚠ Organisms don't evolve because they need to. Variation comes first; then selection sorts it.

✓ FRQ: variation → pressure → who reproduces more → allele frequency change over time.

7.4 Population Genetics

Evolution = Allele Change

Gene pool: all alleles in a population. **Evolution**: their frequencies change over time.

Mechanism	What it does
Natural selection	Favors helpful alleles
Genetic drift	Random changes
Gene flow	Moves alleles between pops
Mutation	New alleles

Genetic Drift

Drift: random, chance changes in allele frequency; biggest effect in **small populations**.
Bottleneck: disaster leaves only a few survivors → alleles lost by chance (cheetahs).
Founder effect: a few individuals start a new population, with only some of the alleles.

Types of Selection

Directional: one extreme favored → average shifts.
Stabilizing: middle favored → less variety, extremes lost (e.g., human birth weight).
Disruptive: both extremes favored → two peaks.
Sexual selection: mate choice → showy traits (peacock tails), even if they're risky.
Gene flow makes populations more alike.
Nonrandom mating changes the genotype mix (e.g., inbreeding → more homozygotes).

⚠ Drift is random. Only natural selection reliably makes a population better adapted.

✓ Graph Q: shift → directional; narrow → stabilizing; split into 2 peaks → disruptive.

7.5 Hardy-Weinberg Equilibrium

Equations (Formula Sheet)

Alleles: $p + q = 1$ (p = dominant, q = recessive).
Genotypes: $p^2 + 2pq + q^2 = 1$ (AA, Aa, aa).

5 Conditions (No Evolution)

Large population, **no migration**, **no mutation**, **random mating**, **no natural selection**.
Real populations rarely meet all 5 → HW is a baseline that shows when evolution is happening.
Broken rule → cause: small pop → drift; migration → gene flow; selection → adaptation.

Solving Problems

Start with q^2 = the fraction showing the recessive trait (aa). Then find $q = \sqrt{q^2}$, then p.
Then: $p = 1 - q$. Plug into p^2, $2pq$, q^2.
Example: 16% aa → $q^2 = 0.16$ → $q = 0.4$ → $p = 0.6$.

Genotype	Formula	Value
AA	p^2	0.36
Aa	$2pq$	0.48
aa	q^2	0.16

Carriers (Aa) are much more common than affected people (aa) for rare recessive traits.
Testing: compare real genotype counts to HW predictions with χ^2 (use the Unit 5 steps).
X-linked traits: % of affected males = q.

⚠ Never take the square root of the dominant %; it includes AA and Aa. Start from q^2.

✓ Check: $p + q = 1$ and all genotypes add to 1.

7.6–7.8 Evidence & Common Ancestry

Evidence of Evolution

Type	Example
Fossils	Whale ancestors
Homologous	Arm, wing, flipper
Vestigial	Whale hip bones
Molecular	DNA similarities
Embryos	Similar early stages

Homologous = same origin → shared ancestor.
Analogous = same job, different origin.
Fossils: deeper rock layers = older.
Transitional fossils show in-between forms (e.g., *Tiktaalik*: fish → four-legged land animals).

7.7 Common Ancestry

All life shares DNA, the genetic code, ribosomes and ATP → strong sign of one common origin.
Fewer DNA differences → more closely related.
Eukaryotes share membrane-bound organelles, linear chromosomes and introns.

7.8 Continuing Evolution

Antibiotic resistance: resistant bacteria survive the drug, then multiply and take over.
Evolution is ongoing: every living species is still evolving (e.g., HIV, flu, crop pests).

⚠ Antibiotics don't create resistance mutations; they only select for the ones already there.

✓ Homologous → related. Analogous → similar environment, not close relatedness.

7.9 Phylogeny

Reading Trees

Phylogenetic tree: a diagram (hypothesis) of how species are related by descent.
Node = common ancestor. **Root** = oldest ancestor.
Sister taxa share the most recent ancestor.
Closest relatives: follow the branches back to the nearest shared node (common ancestor).
Branches can rotate at any node without changing any of the relationships the tree shows.

Building Trees

Shared derived traits (new features, like hair or feathers) group species together.
Outgroup: a related species outside the group, used to spot which traits are older.
Parsimony: the best tree has the fewest changes.

Trait	Frog	Lizard	Mouse
4 limbs	+	+	+
Amnion egg	–	+	+
Hair	–	–	+

DNA data usually beats body shape for building trees (fewer misleading look-alikes).
Clade = an ancestor and all its descendants.
Trees are hypotheses; scientists revise them as new fossils or DNA data appear.

⚠ Neighbors at the tips aren't always closest relatives. Follow the nodes back instead.

✓ More shared derived traits = more closely related = closer together on the tree.

7.10 Speciation

What Is a Species

Biological species: a group that can interbreed in nature and have fertile offspring.
Doesn't work for fossils or for organisms that reproduce asexually, like bacteria.

Reproductive Barriers

Before mating	Example
Habitat	Live in different places
Timing	Breed at different times
Behavior	Different courtship
Mechanical	Parts don't fit
Gametic	Sperm can't fertilize

After mating: hybrids die or are sterile (mule).

How Species Form

Allopatric: a physical barrier splits a population.
Sympatric: new species in the same place (e.g., extra chromosome sets in plants).
Polyploidy: doubled chromosome sets → plant can't breed with parents → new species.
Adaptive radiation: one ancestor → many species filling different niches (Darwin's finches).

Speed

Gradual change vs **punctuated equilibrium** (long pauses, then quick bursts of change).
Hybrid zones: places where related species meet and sometimes mate and produce hybrids.

⚠ Mules: sterile hybrids, not a species.

✓ Name the barrier and how it stops gene flow.

7.11–7.12 Extinction & Variation

7.11 Extinction

Background extinction: normal, slow rate.
Mass extinction: many species lost quickly (e.g., the dinosaurs after an asteroid hit Earth).
Causes: climate change, habitat loss, invasive species, overhunting and pollution.
Afterward: empty niches → survivors evolve into many new species fast (mammals).
Today: humans are driving extinction rates far above the normal background rate.

7.12 Variation in Populations

More genetic diversity → better chance some individuals survive a sudden change.
Low diversity → whole population at risk (Irish potato famine: all clones, so all got sick).

Population	When things change
High diversity	Some survive
Low diversity	Many die

Gene flow can restore diversity (Florida panthers).
Heterozygote advantage: Aa favored (sickle cell + malaria) → both alleles stay common.
Bacteria adapt fast: huge numbers, fast reproduction, and sharing genes on plasmids.
Conservation: protect diversity with habitat corridors, seed banks, captive breeding.

⚠ Variation must exist BEFORE change.

✓ FRQ chain: low diversity → fewer resistant individuals → higher risk of extinction.

7.13 Origin of Life & Exam Strategy

Timeline

Earth: ~4.6 billion years old. **First life**: ~3.5–3.9 billion years ago (simple prokaryotes).
Early Earth: little free oxygen; energy came from lightning, UV light and volcanoes.
Oldest fossils: stromatolites, layered rock mats built up by ancient cyanobacteria.

Steps to Life

1) Simple molecules formed (Miller–Urey made amino acids from gases + sparks).
2) Polymers formed. **3) Membranes**: lipid bubbles enclosed them, making protocells.
4) RNA world: early RNA both stored genetic info and sped up chemical reactions.
Why RNA first: it can carry genes and also act as an enzyme (a ribozyme) at the same time.

Exam Moves

Selection FRQ: name the trait, the pressure, who reproduces more, and the allele change.
HW math: always start from q^2 (the aa %).
Trees: use nodes and shared traits.
Graphs: steady trend in allele freq. over time → selection; random ups and downs → drift.
Links: Unit 5 alleles & χ^2, Unit 6 mutation, Unit 8 populations, communities and ecosystems.

⚠ Say "the population evolves" or "allele frequency changes", never "it adapts".

✓ Always include heritable variation + differential reproduction in every evolution answer.