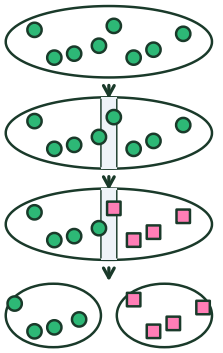
AP BIOLOGY | UNIT 7 | TOPICS 7.10 AND 7.12 | REVISION ON TWO PAGES

One species becomes *two*

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

THE ONE IDEA

A new species forms when populations stop sharing alleles and diverge. Life began in a window the rocks mark out, perhaps with RNA first.



The river changes no animal. It stops gene flow; selection, mutation and drift do the changing.

7.10.A START HERE

Speciation starts when gene flow *stops*

- The **biological species concept**: a species is a group that can interbreed and exchange genes to produce **viable, fertile offspring**.
- **Speciation** occurs when two populations become **reproductively isolated**. While they interbreed, gene flow keeps their gene pools alike and prevents divergence.
- Once gene flow stops, **selection, mutation and drift** act on each side separately, and the differences build up until the split is permanent.
- **Example:** chimpanzees north of the Congo River and bonobos south of it; neither swims, and their ancestors were divided roughly 1 to 2 million years ago.

TWO TESTS OF THE OFFSPRING

V Viable
the offspring survive

F Fertile
they can breed in turn

7.10.A THE CONCEPT

What makes a *species*

- **Looks do not decide it; breeding does.** A Great Dane and a Chihuahua are one species; two meadowlarks that look alike, each answering only its own song, are two.
- A horse and a donkey make a healthy mule, but it is **sterile**, so no alleles pass on: **two species**.
- The concept is for sexual reproduction. It **cannot be applied** to asexual organisms or fossils, which are grouped by structure and DNA.

64
chromosomes in a horse

62
in a donkey

63
in a mule: they cannot all pair at meiosis

7.10.C TWO ROUTES

Apart, or in the *same place*

- **Allopatric speciation**: populations are **geographically isolated** by a sea, river, mountain range or distance.
- **Sympatric speciation**: populations have **geographic overlap**, and something else stops them interbreeding.
- Both end in reproductive isolation; they differ in **geography**.

Apple maggot fly sympatric, under way
Flies mate on the fruit they lay in. Since the 1860s some use apples, which ripen weeks before hawthorns, so the two groups mostly mate apart.

Still one species host races
Some flies still cross between the groups, so gene flow has fallen but not stopped.

7.10.C PREZYGOTIC AND POSTZYGOTIC

What keeps two species *apart*

BARRIER	WHEN	ITS NAME, AND ONE CASE
P Place	Prezygotic	**Habitat isolation:** one garter snake lives mostly in water, another on land.
T Time	Prezygotic	**Temporal isolation:** two skunks breed in late winter and in late summer.
B Behavior	Prezygotic	**Behavioral isolation:** every firefly species flashes its own courtship pattern.
F Fit	Prezygotic	**Mechanical isolation:** snails whose shells coil opposite ways cannot mate.
G Gametes	Prezygotic	**Gametic isolation:** sea urchin sperm proteins match only their own eggs.
Hybrid dies	Postzygotic	**Reduced hybrid viability:** most sheep and goat embryos die early.
Hybrid sterile	Postzygotic	**Reduced hybrid fertility:** the mule.
Its young fail	Postzygotic	**Hybrid breakdown:** some rice hybrids are fertile, but their offspring are weak or sterile.

Ask first: did a zygote ever form? If not, the barrier is prezygotic.

Both kinds prevent gene flow.

7.10.B DIVERGENT

One ancestor, *many forms*

- **Divergent evolution**: adaptation to new habitats gives **phenotypic diversification**.
- In **adaptive radiation**, speciation is especially fast as **new habitats become available**: new islands or lakes, or habitats emptied by extinction.
- **Hawaiian *Drosophila*:** flies reached the island chain once or a very few times, on older islands now worn below the sea, and became on the order of a thousand species.
- **Darwin's finches:** about 18 species from one ancestor, each beak suited to its food.

7.10.B CONVERGENT

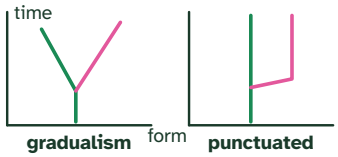
Different lineages, *one shape*

- **Convergent evolution**: **similar selective pressures** give similar adaptations in different populations or species.
- The traits arose separately: **analogous, not homologous**. Looking alike is weak evidence of relatedness.
- **Caribbean anoles:** each large island has twig, trunk and canopy forms, yet DNA shows each twig anole is closest to anoles on its own island.
- A shark and a dolphin; cacti and some euphorbias in two deserts.

7.10.B

Slow and steady, or long waits and *bursts*

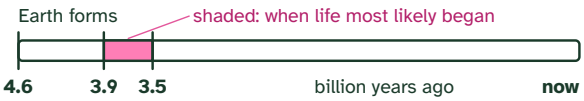
- **Gradualism**: evolution occurs **slowly**, over hundreds of thousands to millions of years.
- **Punctuated equilibrium**: **rapid change after a long period of stasis**. Rapid means thousands of years and many generations, never one.
- Both are in the fossil record. Stasis fits a steady environment; a burst fits new habitats. The evidence is long stasis, **not gaps**.



7.12.A WHEN

The window the *rocks* give

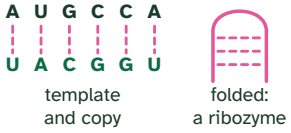
- Geological evidence supports models of the origin of life. Rocks are dated by **radioactive isotopes**.
- Earth formed about **4.6 bya**; it was **too hostile** for life (hot, struck from space) until about **3.9 bya**; the earliest fossils date to about **3.5 bya**.
- The oldest are **stromatolites**, mounds built by microbial mats, about 3.48 billion years old, in the Pilbara of Western Australia.
- The oldest fossils are the **latest** date by which life had begun, not its start. The window gives **when, not how**.



7.12.A HOW, PERHAPS

Why RNA may have come *first*

- The **RNA world hypothesis**: RNA could have been the **earliest genetic material**. It stores information in its bases, and some RNAs catalyze reactions: **ribozymes**.
- In every ribosome, RNA forms the peptide bond. No RNA that **fully copies itself** has been made yet.



1 **Copies**
RNA replication kept continuity.

2 **Pairs**
It needs base pairing.

3 **No proteins**
Proteins were not the catalysts.

WATCH OUT

Five mistakes that *cost points*

- ✕ **"They can mate" is not the test:** the offspring must be viable and fertile.
- ✕ **Both routes end in reproductive isolation;** they differ in geography.
- ✕ **No offspring is not always postzygotic:** did a zygote form?
- ✕ **Looking alike does not mean related:** convergence makes analogous traits.
- ✕ **The RNA world is a hypothesis,** not a proven account.

COVER THE SHEET

Can you *answer these?*

1. Describe the biological species concept.
2. Explain why horses and donkeys are two species.
3. Explain how a river can lead to two species.
4. Identify the barrier: two frogs breed in different months.
5. Describe the conditions for an adaptive radiation.
6. Explain how unrelated lizards come to look alike.
7. Describe gradualism and punctuated equilibrium.
8. Justify RNA, not DNA, as the first genetic material.

IN THE EXAM

Name what stops gene flow, then what makes the sides differ: "a barrier stops gene flow; different selection, mutation and drift make the gene pools diverge".

GO FURTHER

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