DP Biology – A4.1 (HL extension)

How new species arise

- What evidence supports evolution?
- What do analogous and homologous structures show about what organisms share and how they differ?

HL statements A4.1.8–11. Textbook pp. 151–155.
Image: the Grand Canyon, a geographic barrier. CC BY-SA 2.5.



Objectives for each class

Class	Statements	By the end of the class, you can...
1	A4.1.8–9	Compare allopatric and sympatric speciation, and explain adaptive radiation
2	A4.1.10–11	Explain barriers to hybridization, and abrupt speciation by hybridization and polyploidy

Allopatric and sympatric speciation

A4.1.8

	Allopatric	Sympatric
Where	Populations in different places	Populations in the same place
Isolation	Geographic: rivers, mountains, sea	Behavioural or temporal
Same in both	Gene pools are separated; selection and mutation make them diverge	Gene pools are separated; selection and mutation make them diverge
End result	A new species that cannot interbreed with the original	A new species that cannot interbreed with the original

Key idea

Speciation needs reproductive isolation first. The difference between the two types is how the isolation arises.

Three kinds of reproductive isolation

A4.1.8



Western meadowlark. Kevin Cole, CC BY 2.0.

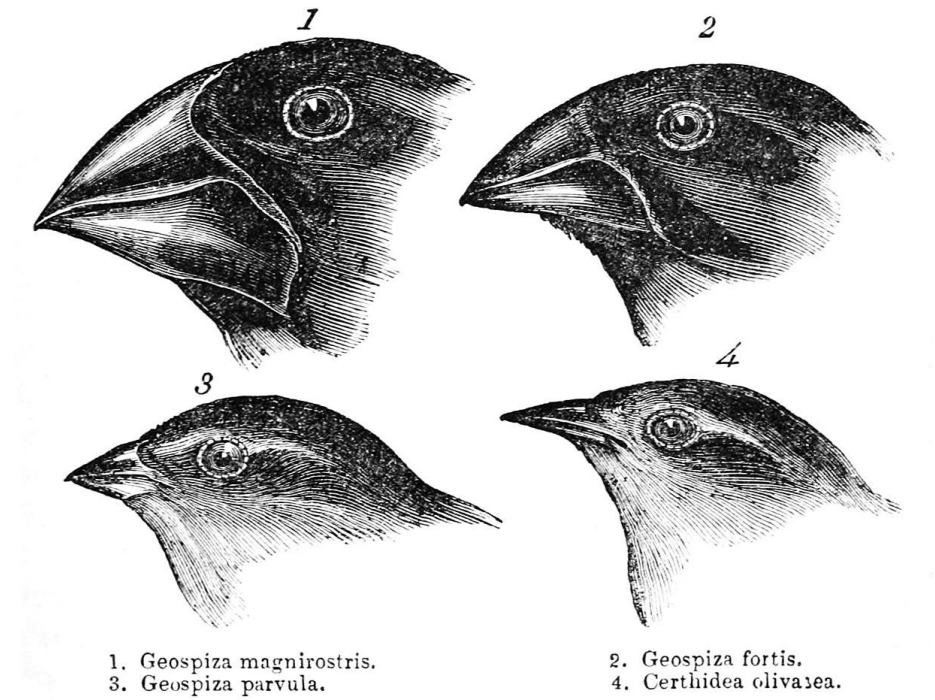
Type	Example
Geographic	Antelope squirrels on opposite sides of the Grand Canyon
Temporal	Eastern and western spotted skunks: their ranges overlap, but they mate in different seasons
Behavioural	Eastern and western meadowlarks look alike but have different songs, so they rarely interbreed

Try it

Classify each example as leading to allopatric or sympatric speciation, and explain your choice.

Adaptive radiation

A4.1.9



Beaks of Galapagos finches, drawn in 1845. Public domain.

- One ancestral species diversifies into many species that each fill a different **niche**
- Vacant niches, as on new islands, give the opportunity
- Different beak shapes suit different foods
- Because they use different resources, close relatives can **coexist without competing**
- So adaptive radiation increases biodiversity

Link

Compare the pentadactyl limb: one ancestral plan adapted for grasping, running, flying and swimming (A4.1.4).

A plant example: bromeliads

A4.1.9



A bromeliad: leaves form a water-holding tank. Dinkum, CC0.

- The pineapple family has spread into many habitats
- Some species root in bog or on sandstone and take nutrients from it
- Others have overlapping leaves that collect rain and debris in a tank
- Some get nutrients from ants that live on them

Think about it

Why might competition between close relatives drive them to use different resources?

Keeping alleles apart

A4.1.10



A mule, a sterile hybrid. CC BY-SA 3.0.

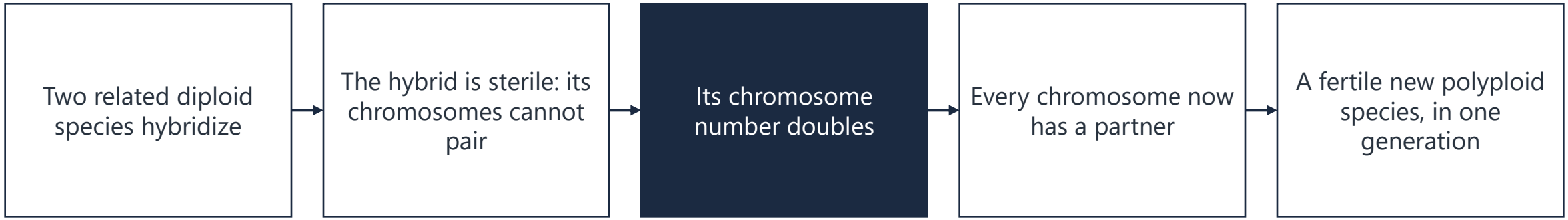
- **Before mating**: courtship is species-specific, so individuals usually mate only with their own species
- **After mating**: hybrids may die or be sterile
- A mule has 63 chromosomes, so meiosis fails and it passes on no alleles

Why it matters

Producing sterile offspring wastes resources, so selection favours individuals that avoid mating with other species. Barriers stop alleles mixing, keeping species distinct.

Abrupt speciation by polyploidy

A4.1.11



Why it is instant

The new polyploid cannot breed successfully with its parents: offspring would have an odd number of chromosome sets and be sterile. So it is reproductively isolated at once.

Two kinds

Autopolyploids get extra sets from one species. Allopolyploids combine sets from two species. Polyploids are often larger or more vigorous, and are common in plants such as wheat and kiwifruit.

Knotweeds and smartweeds

A4.1.11



A smartweed, Persicaria maculosa. The Cosmonaut, CC BY-SA 2.5 ca.

- The genus **Persicaria** has many species formed by hybridization and polyploidy
- Many of its species are **allopolyploids**
- One diploid, pale smartweed, has taken part in several separate hybridizations
- Polyploid species can become established quickly in new habitats

Try it

A diploid species has 2n = 22. How many chromosomes would an allotetraploid have if both its parents had this number?

Check that you can explain

1. How allopatric and sympatric speciation are alike and different
2. Geographic, temporal and behavioural isolation, with examples
3. What adaptive radiation is, and why it raises biodiversity
4. How courtship and hybrid sterility keep alleles apart
5. How hybridization and polyploidy can make a new species in one step

Exit activity: 5 minutes

On your own and without notes. Hand this in as you leave.

1. Distinguish between allopatric and sympatric speciation.
2. Explain how adaptive radiation lets close relatives live in the same area.
3. Explain why a new polyploid plant is reproductively isolated from its parents.

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