9.2 Speciation: How Species Form

SBI3U1

Speciation

Biological Species*:* population where individuals are able to **interbreed** to produce **viable** offspring.

Speciation: the formation of a new species from an existing species (interbreeding can no longer produce viable offspring).

Two different species of zebra.

Speciation

Speciation can occur through reproductive isolating mechanisms.

Two main reproductive isolating mechanisms:

1. ***Pre-Zygotic Isolating Mechanism***:

2. ***Post-Zygotic Isolating Mechanism:***

1) Pre-Zygotic Isolation – Behavioural

Species have a **specific signal** or behaviour that prevents closely related species from **interbreeding.**

Both birds are very similar in appearance. Due to the differences in their song, these birds do not interbreed.

Western Meadowhalk

Eastern Meadowhalk

1) Pre-Zygotic Isolation – Habitat

Two species live in the same area but **different habitats**, they rarely interact with one another.

Garter snake (thamnophis sirtalis) perfers open areas.

Garter snake (thamnophis ordinoides) commonly found near water.

1) Pre-Zygotic Isolation – Temporal

Temporal conditions refers to time of day, year and season. Some organisms mate at different times which **limits their interaction**.

Very common in flower species. Most flowers respond to stimuli in their environment to open up their flowers. The flowering of the plant may also last for different periods of time.

1) Pre-Zygotic Isolation – Mechanical

Some species that are closely related do not have a **compatible genital anatomy** which prevents mating

*Very common **in insects.** It behaves as a **lock-and-key system***

*Also common in plants can have structures that **prevent pollen** from fertilizing the flower.*

1) Pre-Zygotic Isolation – Gametic

Occurs when a species' gametes are **able to meet,** however part of the gamete prevents them from fusing with one another.

Eg. Gametes are not able to survive within female **reproductive tract**

- Prevents gametes from interacting

2) Post-Zygotic Isolation – Gametic

Sperm and egg meet, but **zygote cannot develop into a viable offspring**.

Species still remain distinct from one another because **genetic information does not combine**.

There are 3 post-zygotic mechanisms:

1. Hybrid Inviability
2. Hybrid Sterility
3. Hybrid Breakdown

2) Post-Zygotic Isolation – Hybrid Inviability

When **genetic information** is not compatible **between species**. **Prevents** zygote from undergoing **mitotic division**, and zygote cannot develop further.

E.g. hybrid embryo between sheep and goats die before birth

2) Post-Zygotic Isolation – Hybrid Sterility

Two species **can mate** and produce **inviable offspring**. The **hybrid offspring** cannot undergo regular **meiosis** and cannot produce eggs or sperm.

The hybrid offspring is sterile and thus cannot reproduce to create a population of mules.

2) Post-Zygotic Isolation – Hybrid Breakdown

Two organisms are able to mate and produce viable and fertile offspring. When the **hybrid species mate**, their offspring are weak and **sterile**.

Different species of cotton plants produce fertile hybrids, but their offspring die as seeds

Types of Speciation

The process of speciation requires that two groups of species remain isolated form one another so that no interbreeding may occur.

Type of Speciation:

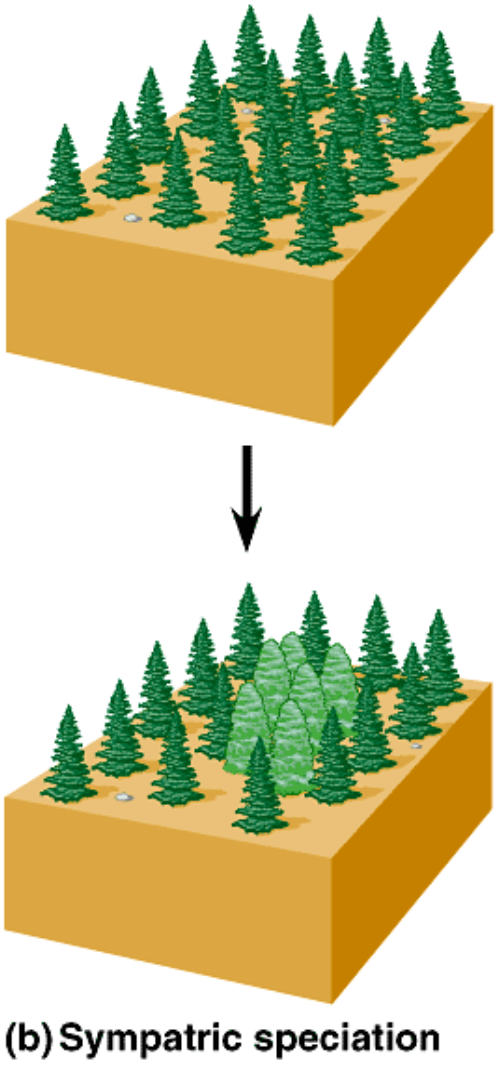
1) Sympatric Speciation

2) Allopatric Speciation

Sympatric Speciation

Populations in same geographical area become reproductively isolated

This can occur due to chromosomal changes (plants) or non-random mating (animals).

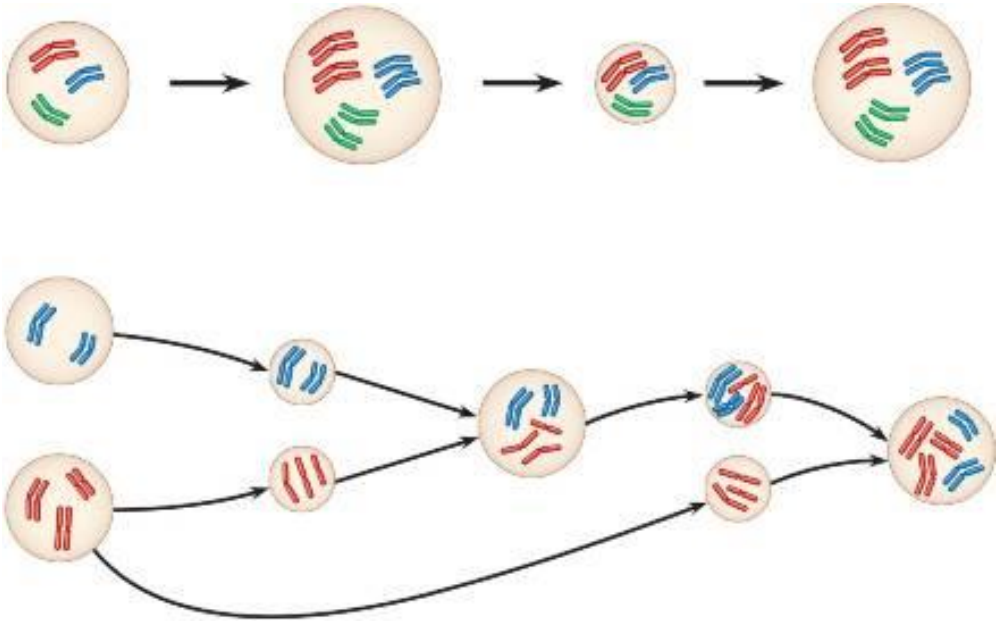


(b) Sympatric speciation

Sympatric Speciation

If the chromosomal changes are significant, this may cause isolation within the first generation.

Because plants are able to self-fertilize, they themselves are able to reproduce and propagate their genes forward. However, polyploidy plants would not be able to reproduce with diploid plants.



Sympatric Speciation - Polyploidy

Chromosomes fail to separate during meiosis

- **cells become diploid** instead of haploid

Ability to self-fertilize enables diploid cells to fuse with one another

- produce **tetraploid species**

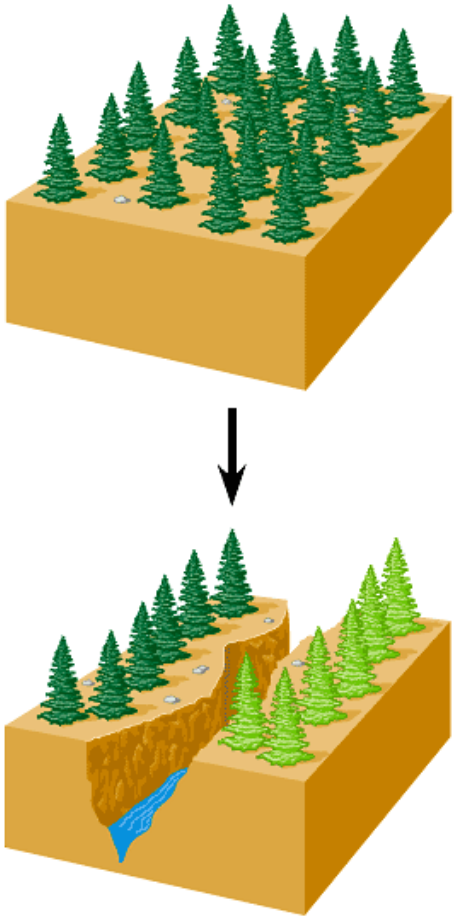
Polyploid cells cannot be crossed with a haploid or else it would form **triploid cells which are infertile.**

Allopatric Speciation

When gene flow is interrupted due to the division into subpopulations.

The separated gene pools evolve due to different selective pressures

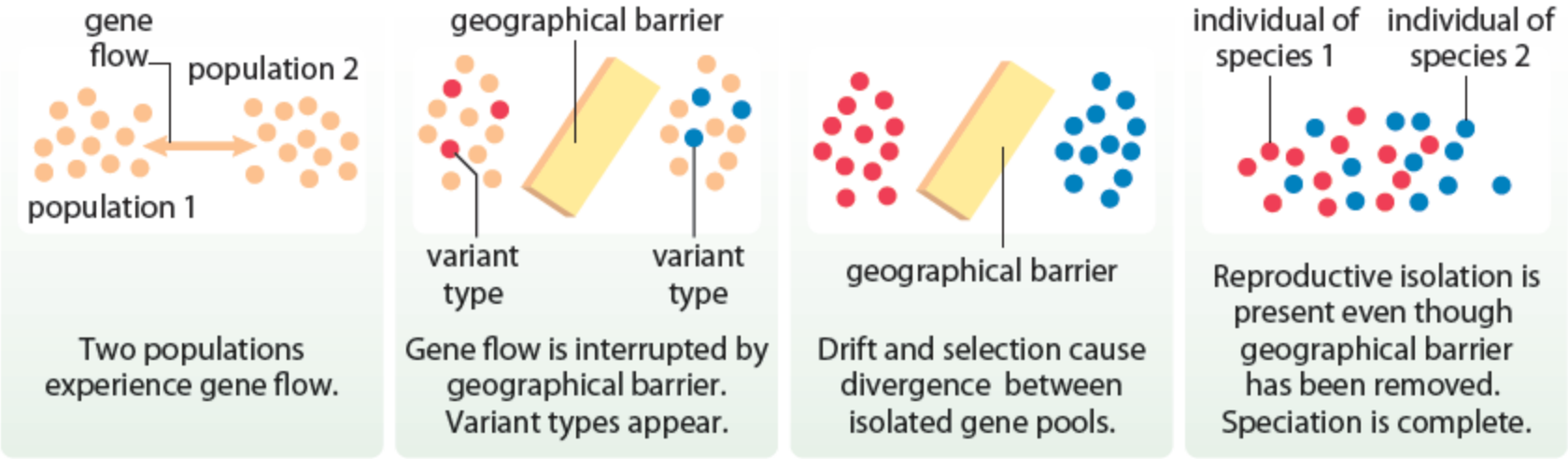
Separation may occur due to river, water level change, geological remodelling etc.



(a) Allopatric speciation

Allopatric Speciation

Smaller populations are more affected by allopatric speciation. Changes in the genetic information may become fixed in a small population due the effects of genetic drift.



Adaptive Radiation

Adaptive Radiation:

Islands are a prime example of adaptive radiation. The original population disperses into separate islands where they have the opportunity to adapt and change with their environment. Thus leading to speciation.

E.g: A few seed eating birds occupy an empty niche with fruit. Mutation makes the birds good fruit eaters. Fruit and seed eaters no longer mate

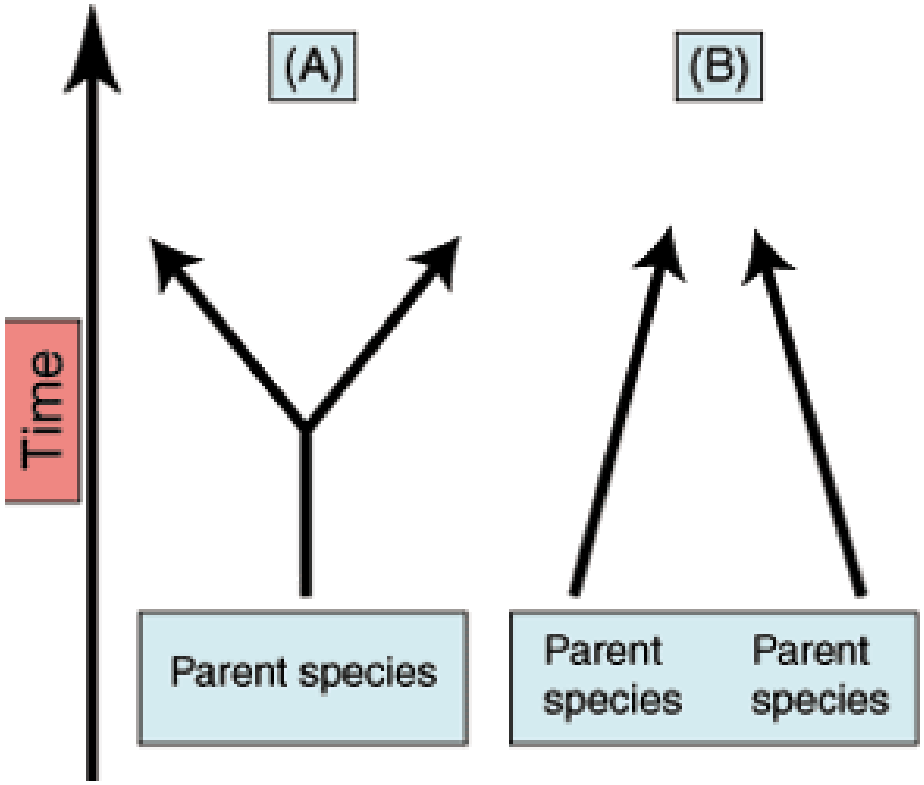
Divergent vs. Convergent Evolution

Divergent Evolution:

Species that were similar to the **ancestral species** diverge and become increasingly **distinct**.

Convergent Evolution:

Similar traits arise because different species have **independently adapted** to similar environmental conditions.



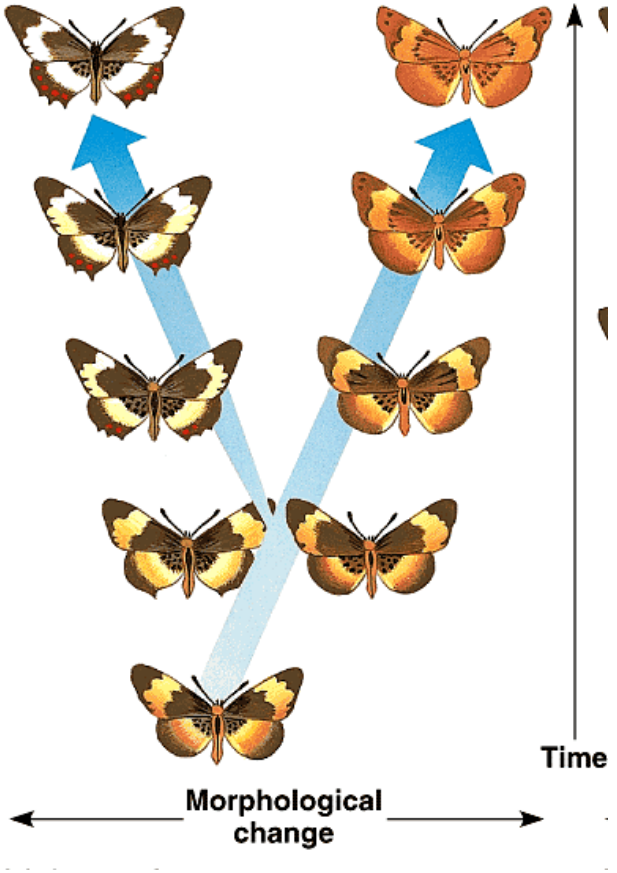
Divergent Evolution

Convergent Evolution

Speed of Evolutionary Change

Gradualism: views evolution as a slow and steady pace before divergence. Big changes occur due to an accumulation of small changes.

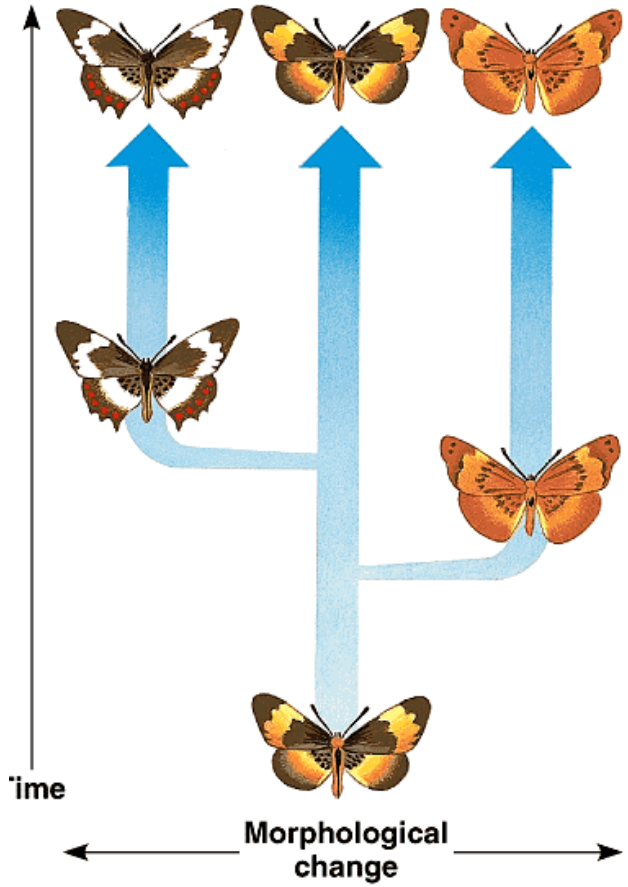
This pattern of evolution is very rare within the fossil record.



Punctuated Equlibrium

Punctuated Equilibrium: Views evolution as long period with no change, which are later interrupted by periods of divergence.

Species usually undergo a dramatic change when they are first isolated and then stabilize. This is the most common pattern shown in the fossil history.



Homework

Textbook:

a) Write summary notes on the effects of human activity on speciation) pg. 370 – 372

b) Questions: pg.2, 3, 4, 7 & 11