CHAPTER 3:

SELECTION & SPECIATION

3.1: SELECTION

3.2: SPECIATION

LEARNING OUTCOMES: 3.2 SPECIATION

At the end of the lesson students should be able to:

a) Define biological species concept

b) Describe modes of speciation

c) State the processes that leads to speciation

d) Relate the processes to speciation

a) Define biological species concept

Definition of SPECIES

A group of populations whose members have potential to interbreed in nature and produce viable, fertile offspring **but** do not produce viable, fertile offspring if interbreed with members of other populations.

BIOLOGICAL SPECIES CONCEPT

Western meadowlark

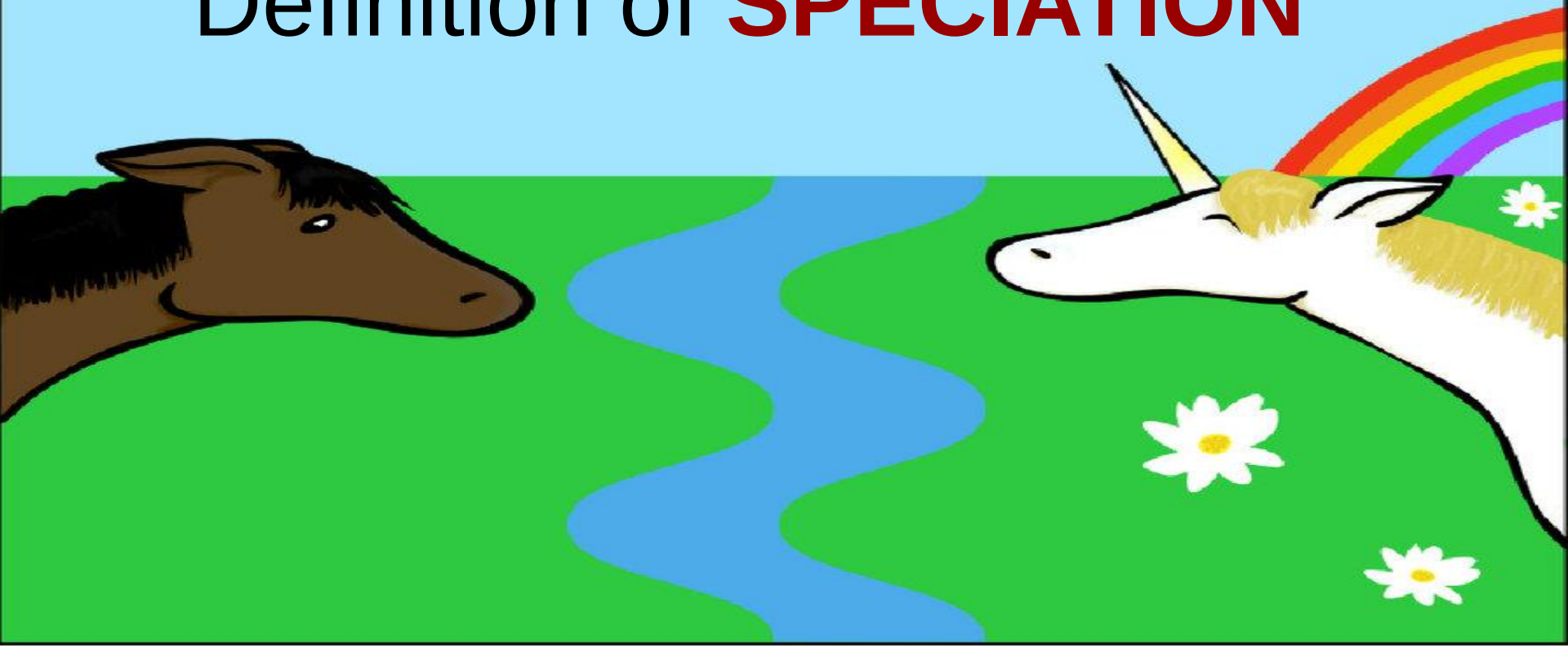
Eastern meadowlark

- Both are look alike and live in overlapping regions.
- But, they have different courtship pattern i.e. have different songs.
- So, they do not breed with one another.
- Most biologists say that they belong to different species because they cannot interbreed.

BIOLOGICAL SPECIES CONCEPT

- Two populations are considered as **distinct species** if:
  - they do not interbreed in nature
  - they mate but produce sterile offspring
- A horse and a donkey can mate producing a mule. But, mule is sterile. So, horse and donkey belong to different species.

Definition of **SPECIATION**



An evolutionary process in which one species splits into two or more species

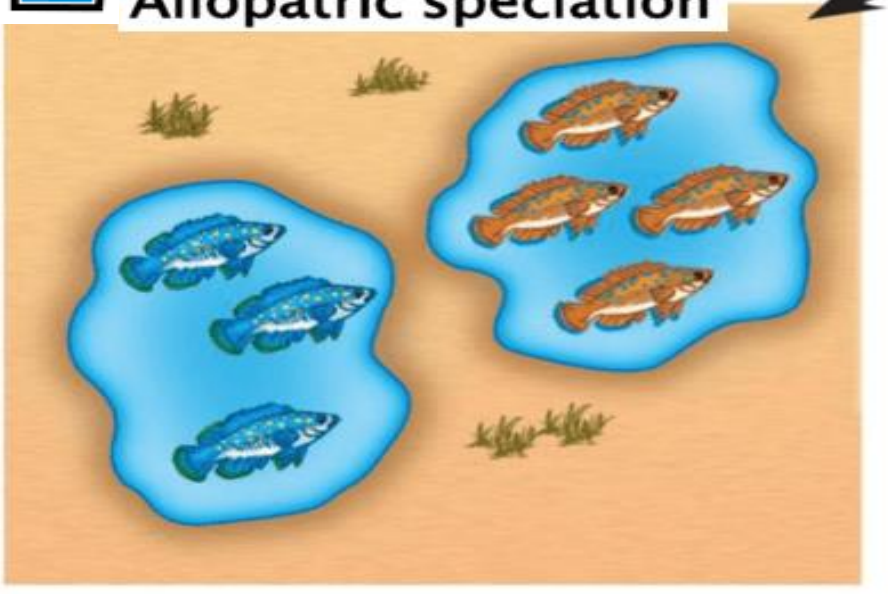
(A process by which one or more species arise from previously existing species)

b) Describe modes of speciation:

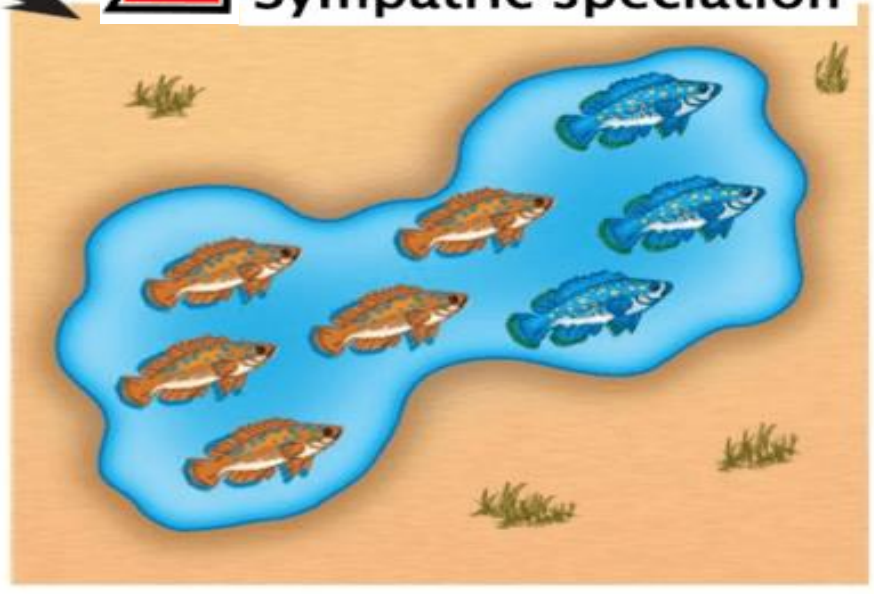
allopatric and sympatric

Types @ Modes of Speciation

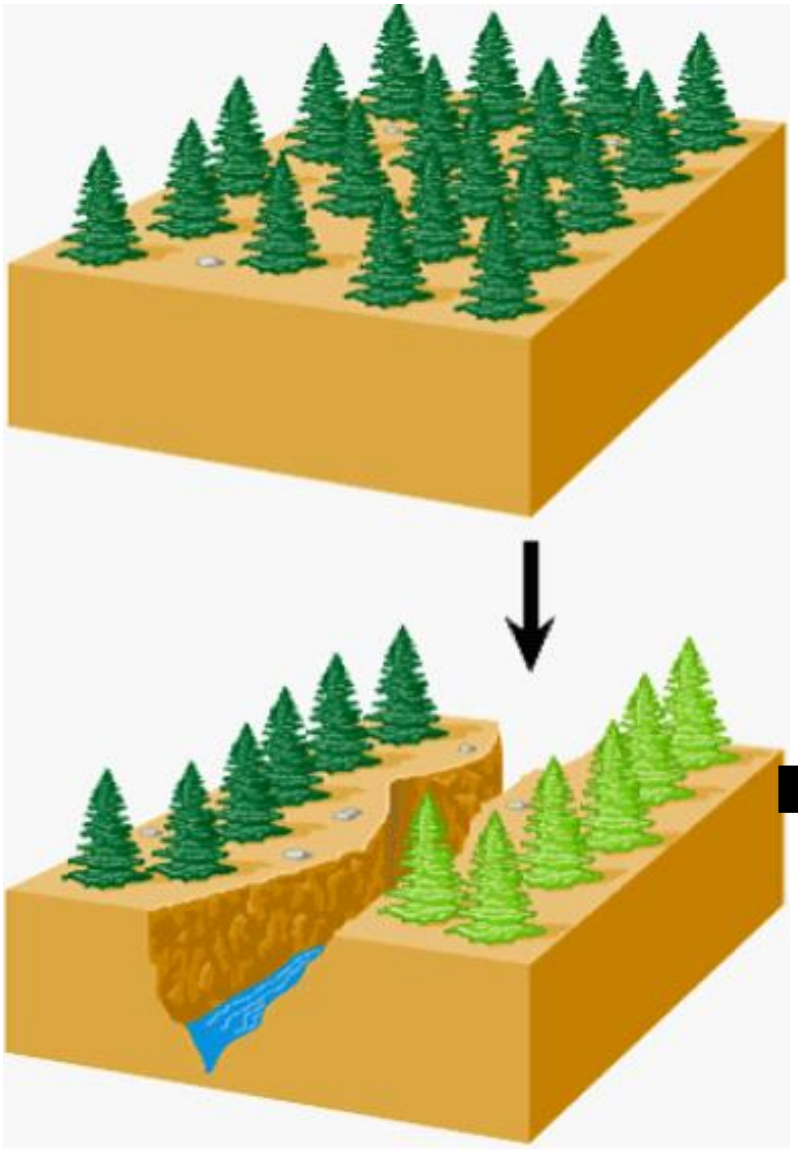
1 Allopatric speciation



2 Sympatric speciation



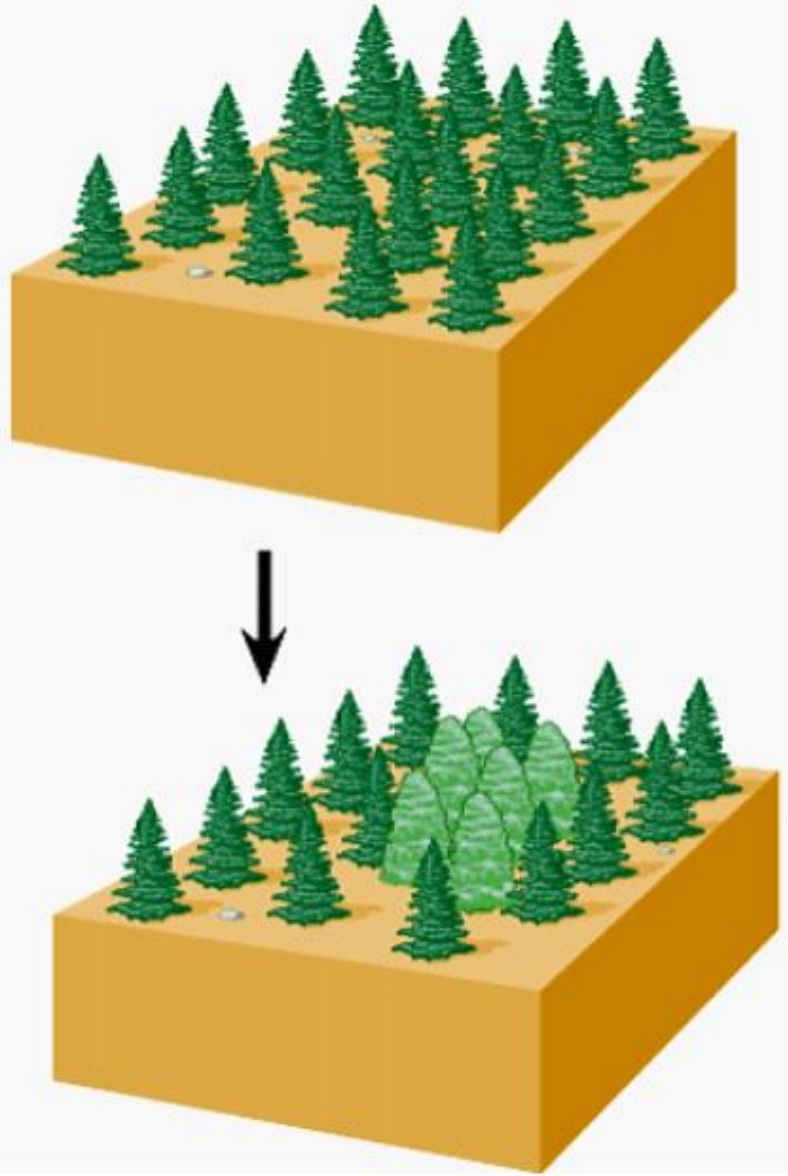
What is **allopatric** speciation?



Formation of new species in a population that is **geographically isolated** from one another

involve geographical barrier

What is sympatric speciation?

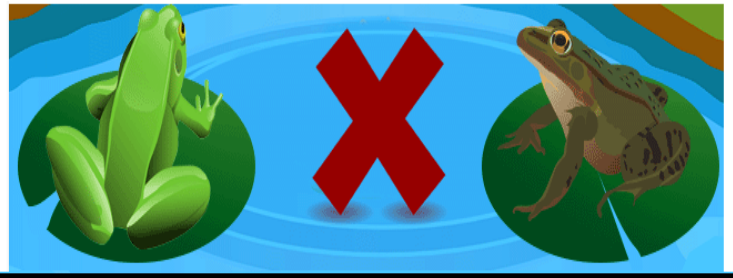


Formation of new species in a population that live in **same geographical area** from one another

➡ NOT involve geographical barrier

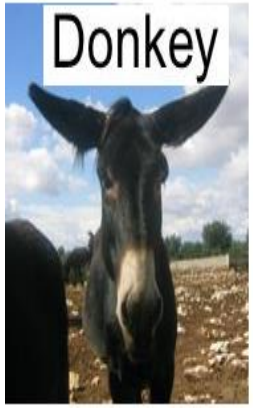
c) State the processes that leads to speciation

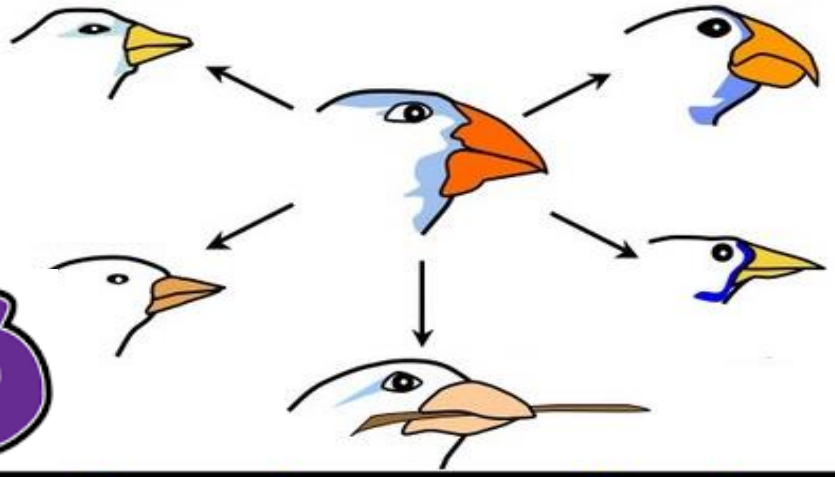
FOUR PROCESSES THAT LEADS TO SPECIATION



1 reproductive isolation

2 Hybridization





3 adaptive radiation

4 GENETIC DRIFT

d) Relate these processes to speciation:

reproductive isolation, genetic drift, hybridization, adaptive radiation

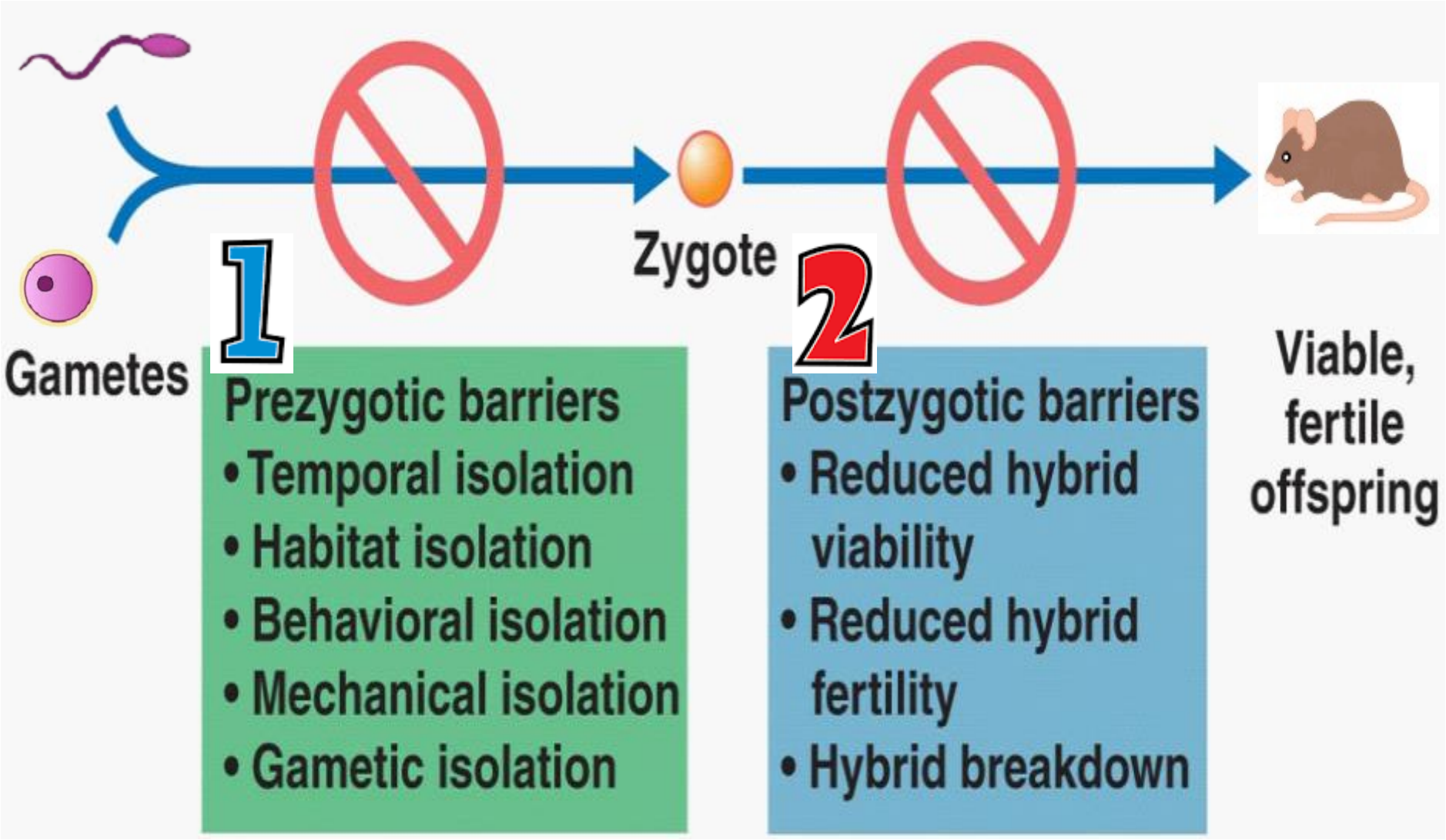
FOUR PROCESSES THAT LEADS TO SPECIATION

What is **reproductive isolation** ?

- Refers to the **inability of a species to breed successfully with related species**
- Can occur **before fertilization** (prezygotic) or **after fertilization** (postzygotic)
- There are **two mechanisms** of reproductive isolation :

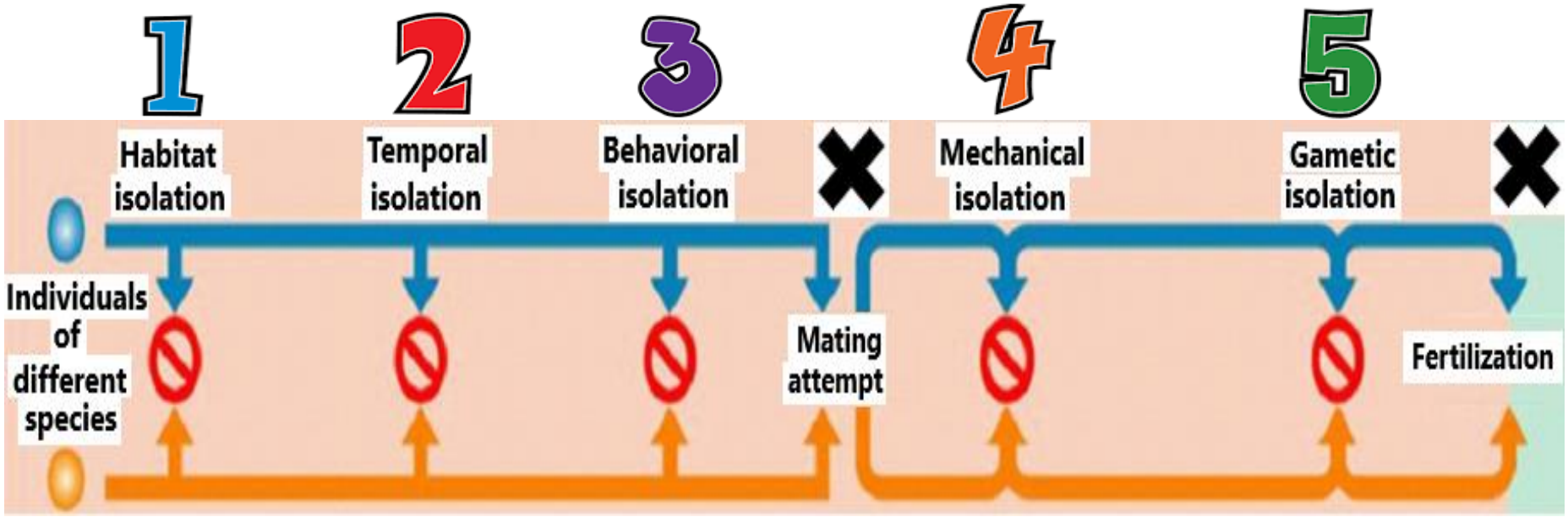
1 **Prezygotic barrier / isolation**	2 **Postzygotic barrier / isolation**
Prevent mating between individuals / fertilization between gametes, thus no gamete is formed	**Prevent formation of viable, fertile offspring (if fertilization occur)**

Two Mechanisms of Reproductive Isolation



Mechanisms of Reproductive Isolation:
Prezygotic barriers

- Prevent mating attempts between individuals
- Prevent fertilization between gametes (if mating occur)



Mechanisms of Reproductive Isolation :
Pre-zygotic barriers

1) Habitat isolation		Different species live in different habitats within same geographical area
2) Temporal isolation		Different species reproduce at different times
3) Behavioral isolation		Different animal species have different courtship patterns
4) Mechanical isolation		Different species have different genital / floral structures
5) Gametic isolation		Fertilization do not occur between gametes of different species

Habitat isolation: Different species live in different habitats within the same geographical area

- Two species of garter snakes in the genus *Thamnophis* live in the same area but one lives in water **(a)** while the other on land **(b)**.

Temporal isolation: Different species reproduce at different times

- Eastern spotted skunk (*Spilogale putorius*) **(c)** mate in late winter
- Western spotted skunk (*Spilogale gracilis*) **(d)** mate in late summer

Behavioral isolation: Different animal species have different courtship patterns

- Eastern meadowlark and Western meadowlark do not mate with each other because they use different songs to attract mates

Western meadowlark

Eastern meadowlark

Mechanical isolation: Different species have different genital / floral structures

- The shells of two species of snails in the genus *Bradybaena* spiral in different directions.
- As a result, the snails' genital openings are not aligned, and mating cannot be completed.

Gametic isolation: Fertilization cannot occur between gametes from different species

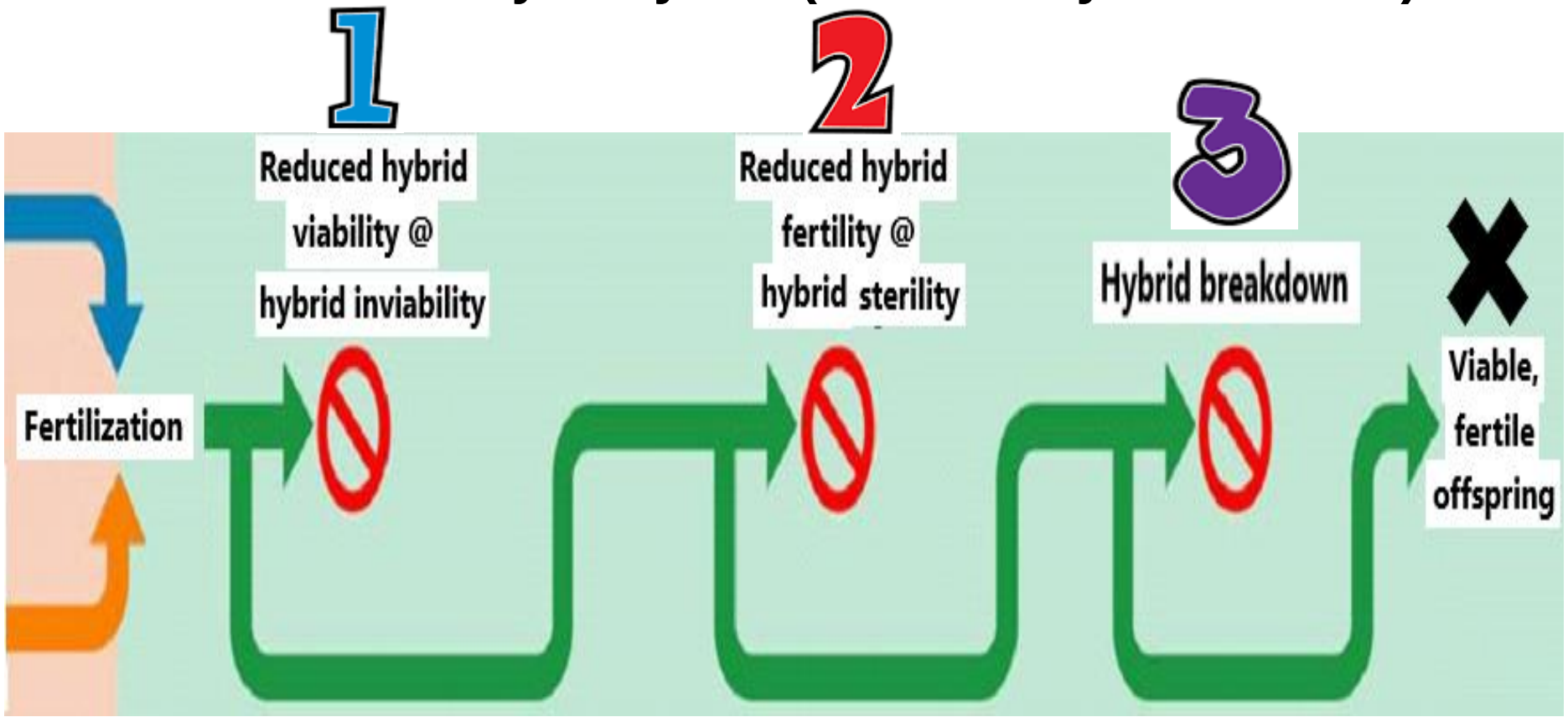
- Two different species of sea urchins (red sea urchin and purple sea urchin).
- The ovum of one species have different receptor proteins that cannot bind with sperm of another species.

Purple sea urchin
(*Strongylocentrotus purpuratus*)

Red sea urchin
(*Strongylocentrotus franciscanus*)

Mechanisms of Reproductive Isolation :
Post-zygotic barriers

- Prevent development of viable offspring (after fertilization occur
- Prevent fertility of hybrid (after the hybrid is born)



Mechanisms of Reproductive Isolation :
Post-zygotic barriers

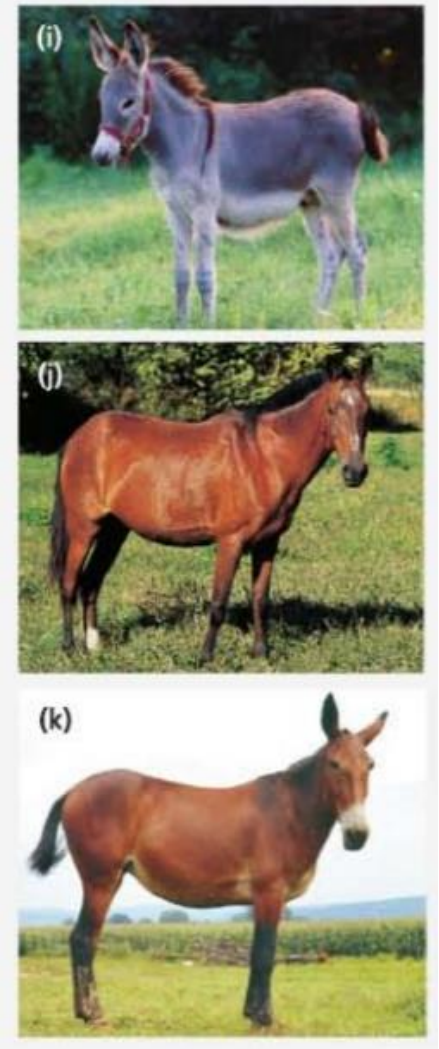
1) Hybrid inviability @ Reduced hybrid viability	**Hybrid not viable (not fully developed) or died (not survive long enough to reproduce)**
2) Hybrid sterility @ Reduced hybrid fertility	**Hybrid develop into sterile adult**
3) Hybrid breakdown	**Produce viable and fertile hybrid in F_1 generation but next generation is sterile**

Hybrid inviability / Reduced hybrid viability

- Hybrid not viable (not fully developed) OR died (not survived long enough to reproduce).

- Example: Most of the hybrids of some salamander of the genus *Ensatina* do not complete development, and those that do are frail **(h)**.

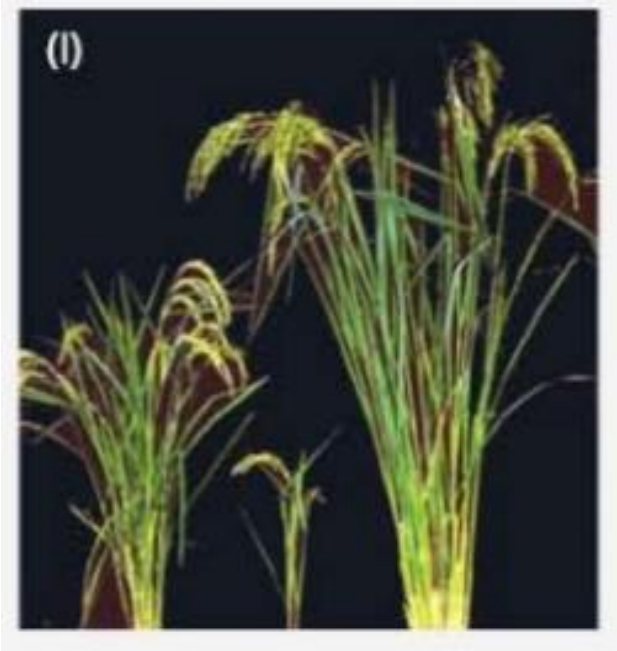
Hybrid sterility / Reduced hybrid fertility



- Hybrid develop into sterile adult.
- Example: Mule **(k)** is sterile hybrid formed through mating between donkey **(i)** and horse **(j)**.

Hybrid breakdown

- Produce viable and fertile hybrid in F_1 generation, but next generation is sterile.

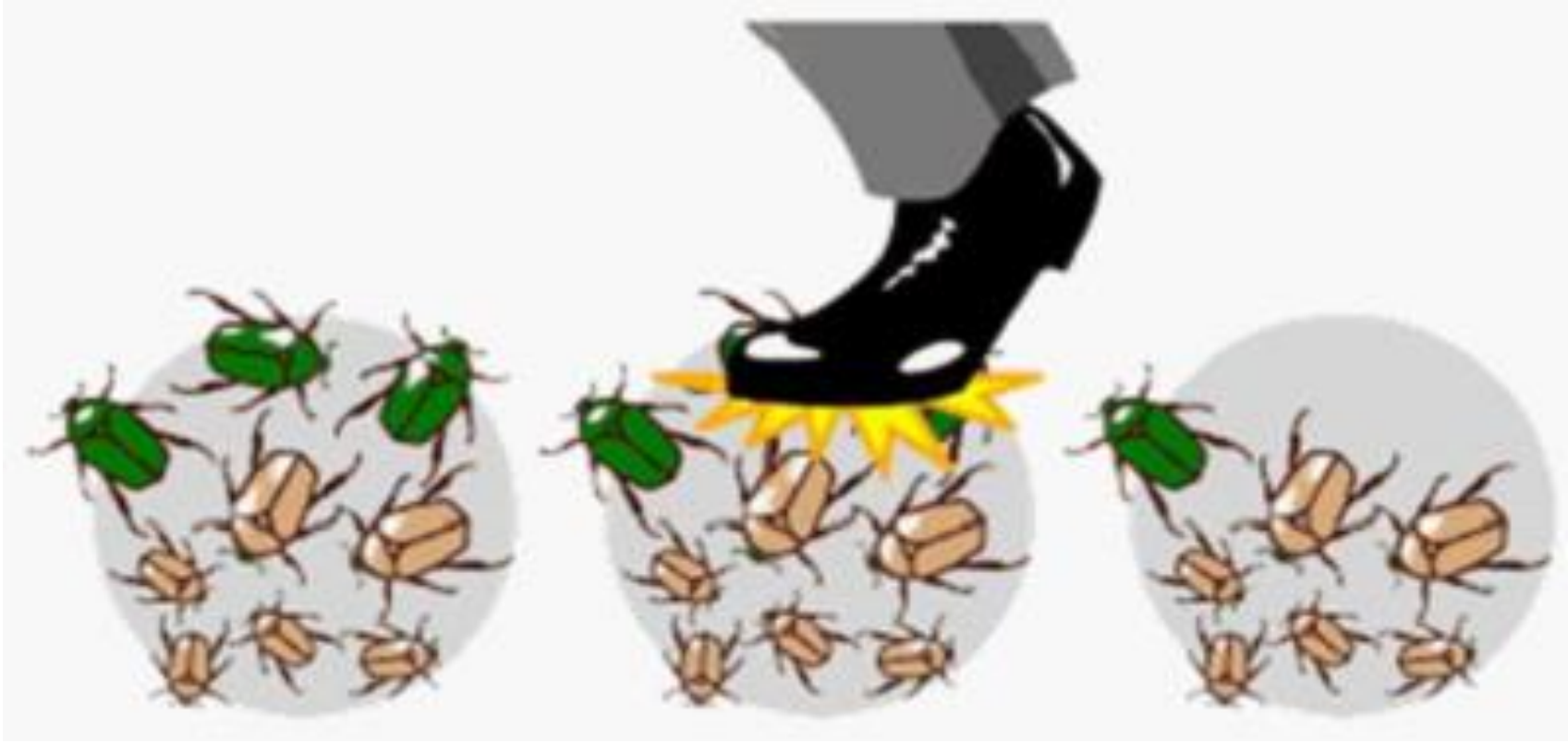


- Example: Rice hybrids on the left and right are fertile, but their next generation (in the middle) are sterile.

FOUR PROCESSES THAT LEADS TO SPECIATION

What is genetic drift ?

Change in allele and genotype frequencies due to chance (rather than by natural selection)



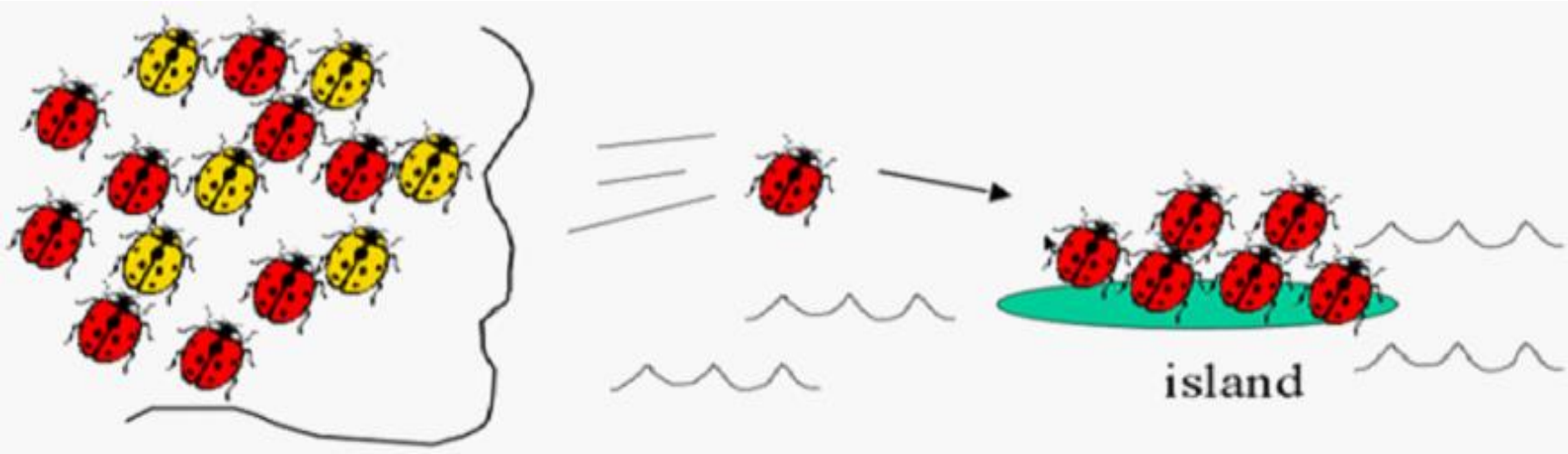
Types of Genetic Drift

1. Founder effect

2. Bottleneck effect

Types of Genetic Drift :
Founder effect

- Occurs when **a new colony is started by a few individuals of the original population**
- **Small population size** of the new colony have **less genetic variation** compared to the original population

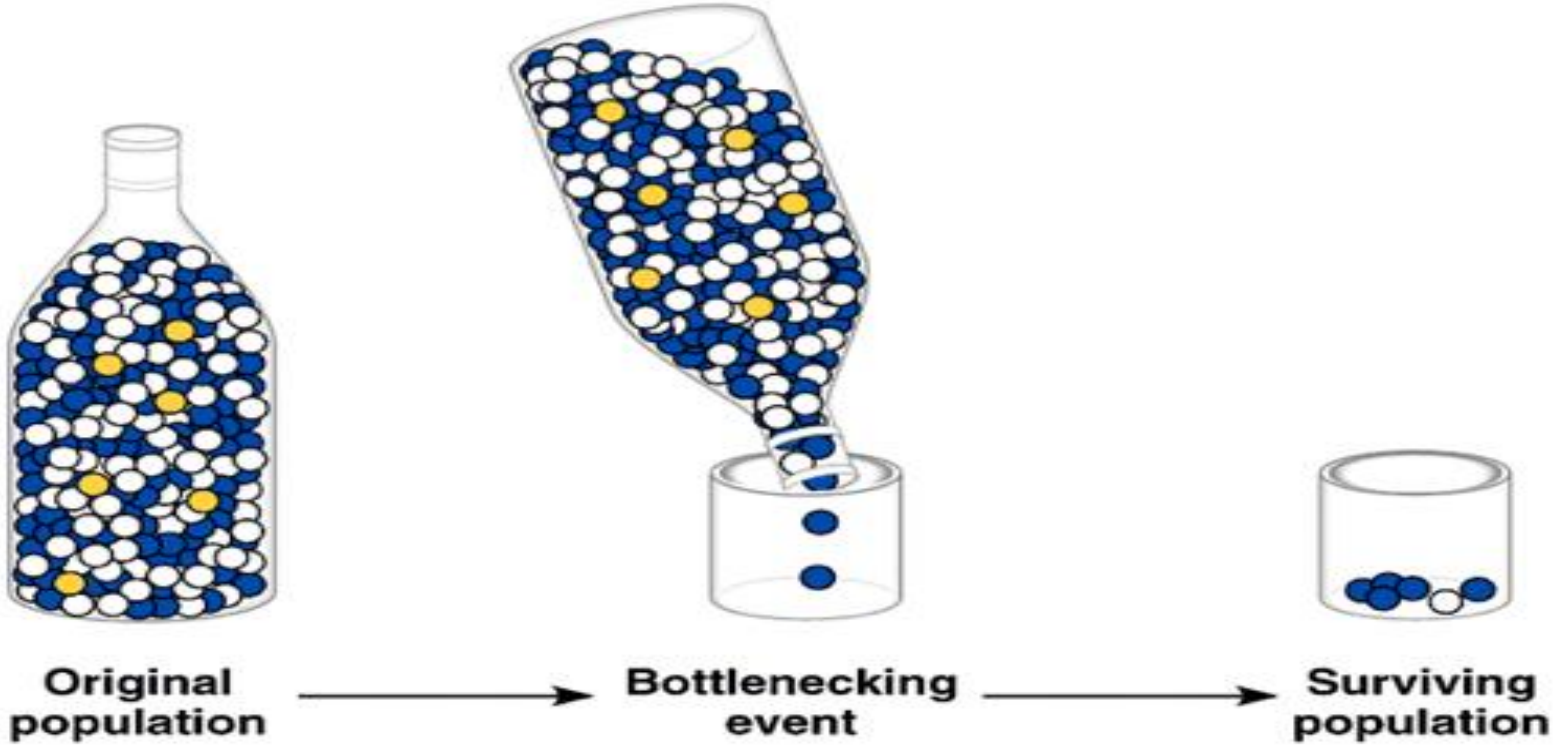


Example of **Founder effect** ?

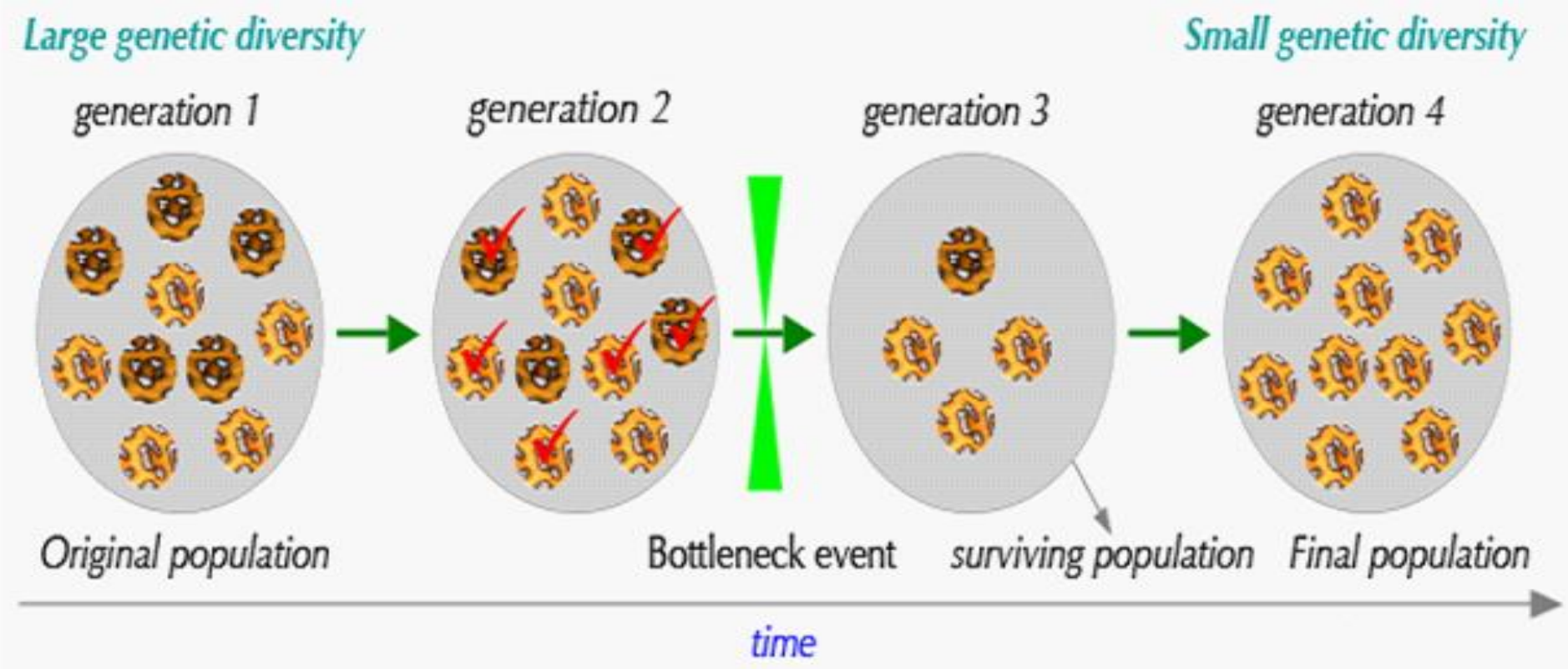
- In 1700s, a small group of Europeans migrated to eastern Pennsylvania
- In the small group there is individuals who carried allele for Ellis-van Creveld syndrome
- Allele for the syndrome is found at frequency of 7% in the Pennsylvania population compared to only 0.1% in original European population

Types of Genetic Drift :
Bottleneck effect

- Occurs when there is **sudden drastic decrease in population** due to adverse environmental factors such as **natural disaster**



Types of Genetic Drift :
Bottleneck effect



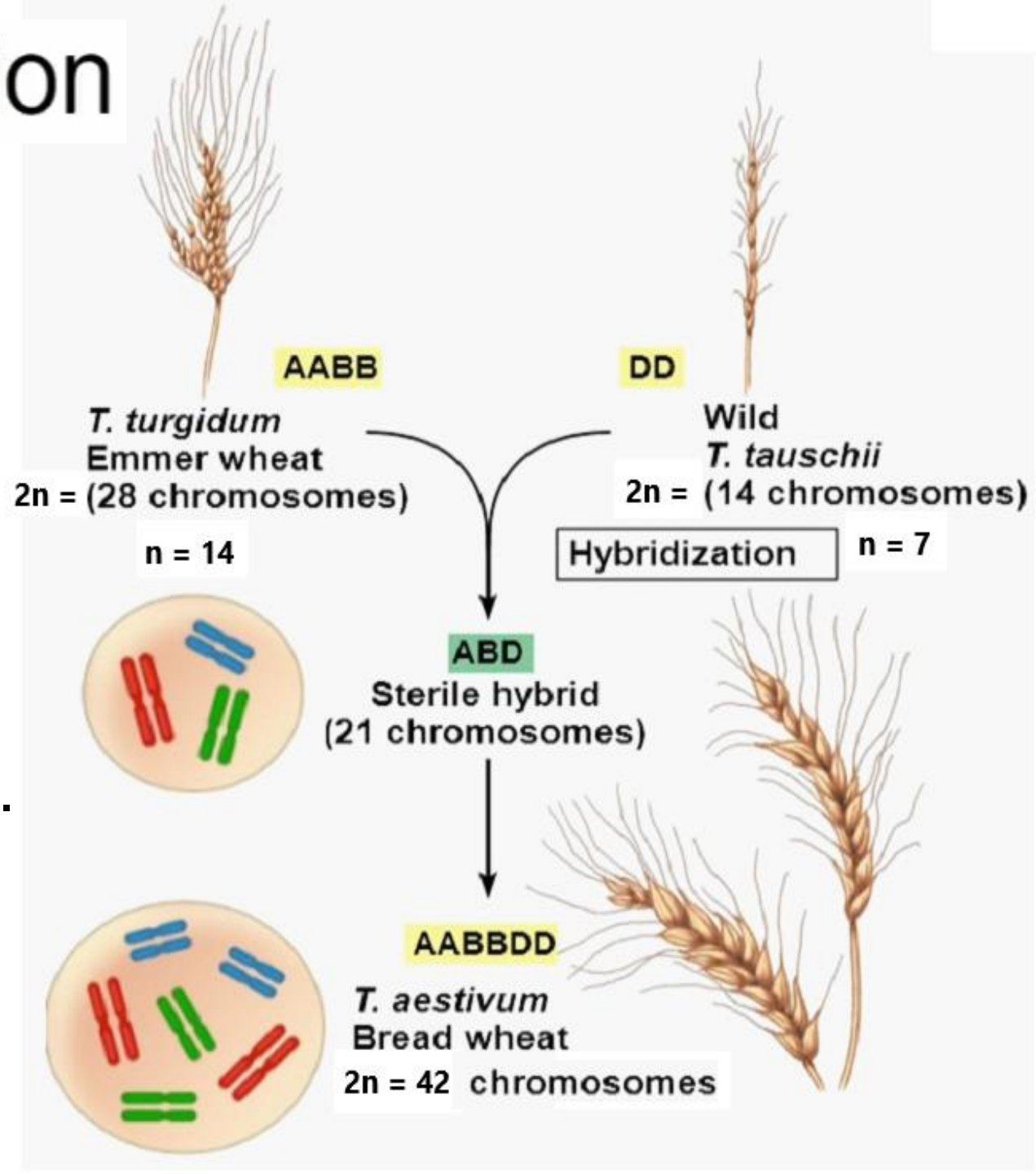
- The **small number of individuals** in surviving population have **less genetic variation** compared to the original population

FOUR PROCESSES THAT LEADS TO SPECIATION

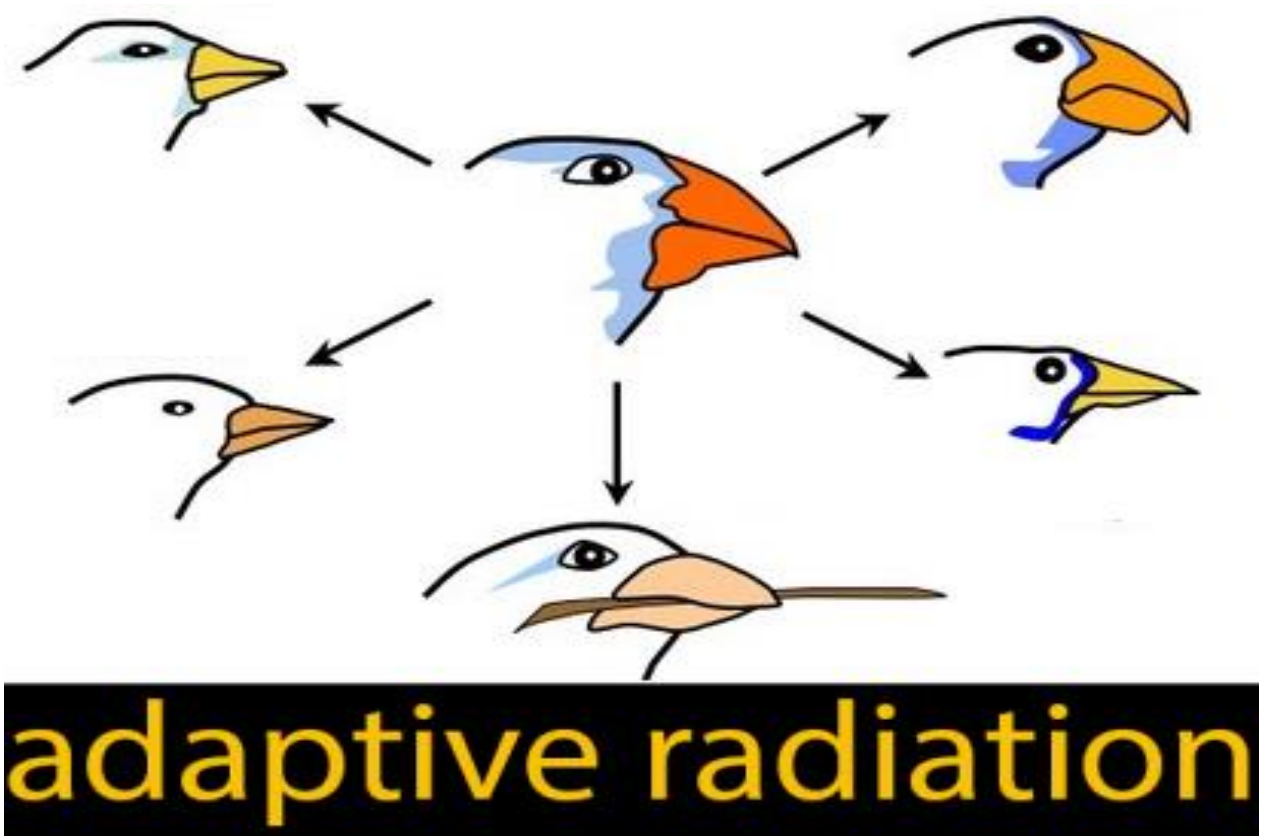
Hybridization

Hybridization

- Refer to allopolyploidy
- Occurs when different species interbreed producing sterile hybrid.
- The sterile hybrid can still propagate asexually (in plants).
- After chromosome doubling, the sterile hybrid change to fertile polyploid.

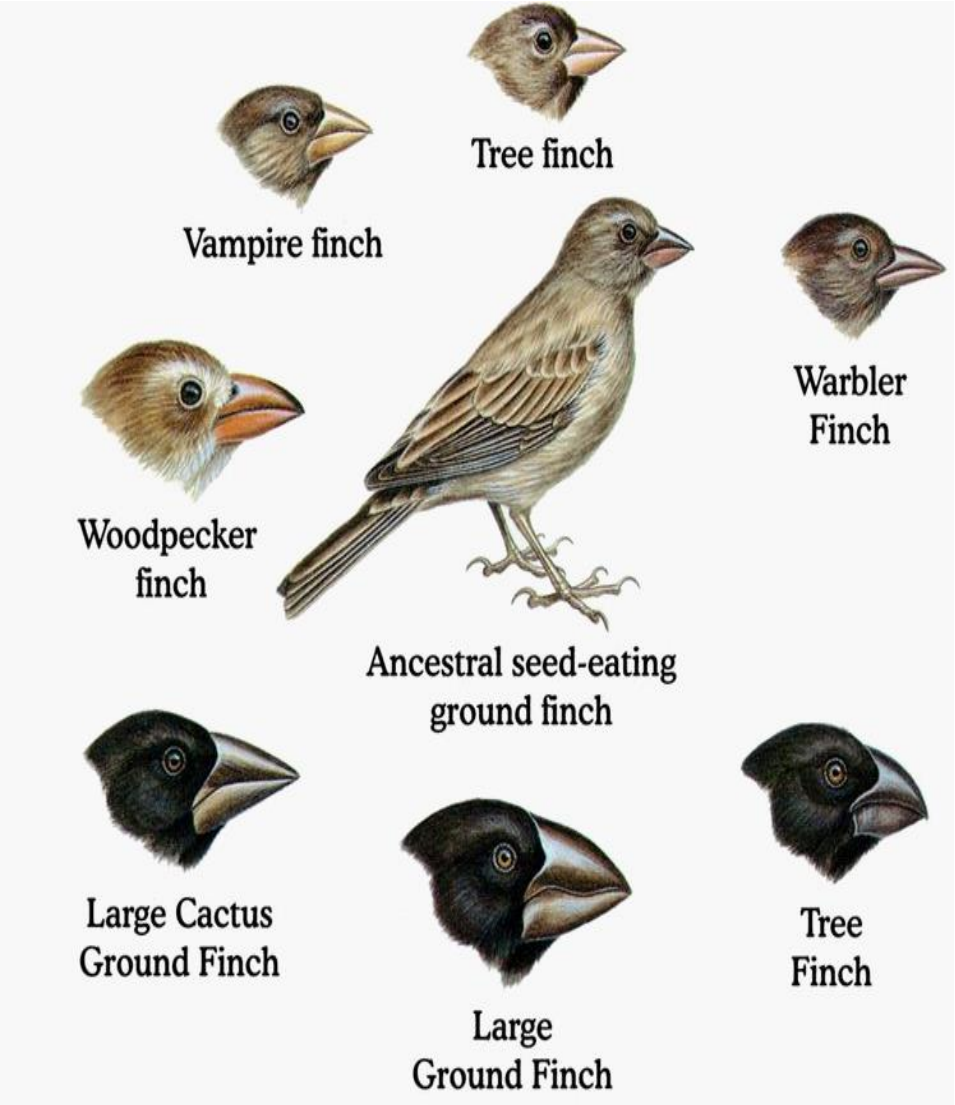


FOUR PROCESSES THAT LEADS TO SPECIATION



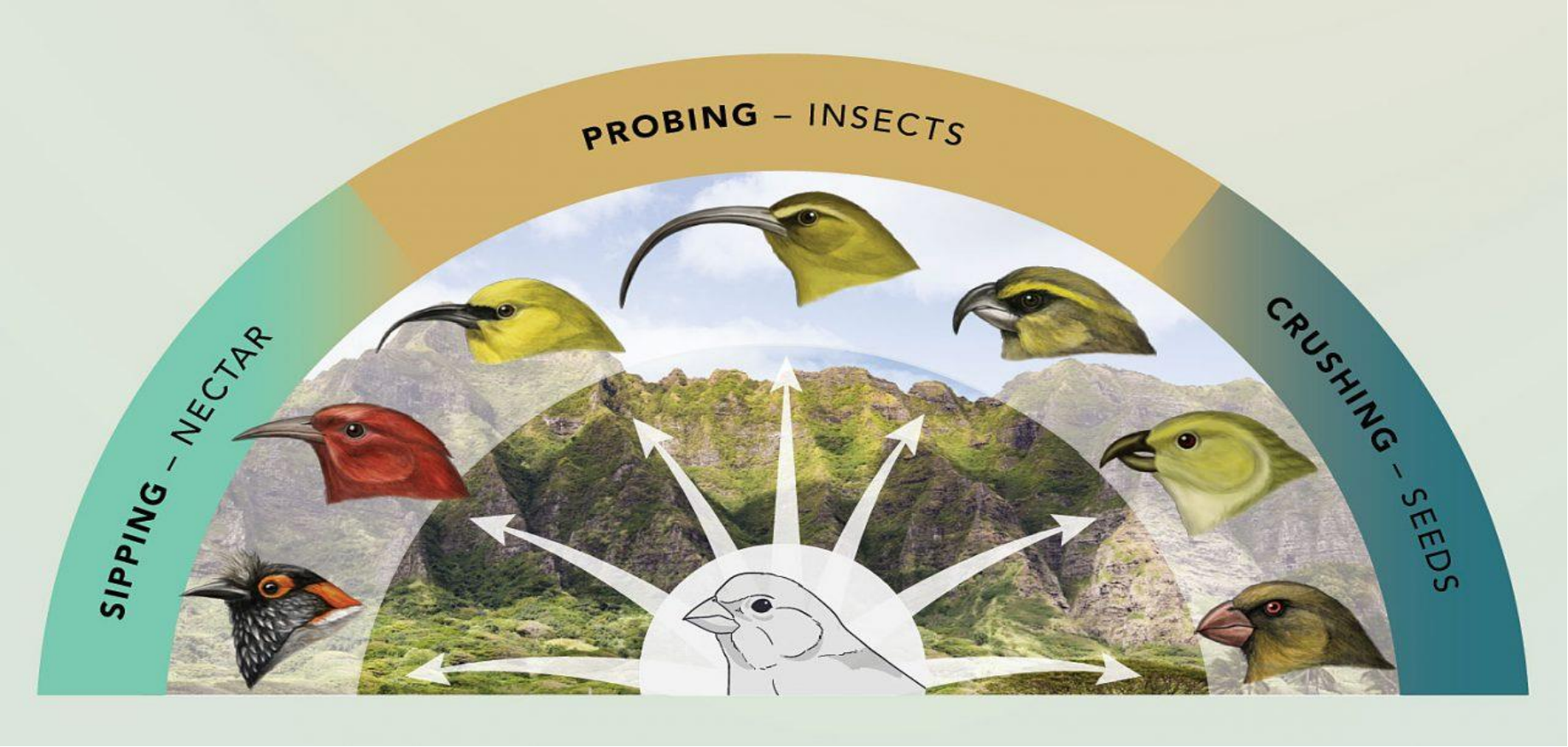
Adaptive Radiation

The evolution of diverse species from a common ancestor due to adaptation to various new environmental conditions



Example of Adaptive Radiation : Finches of Galapagos Island

- There are many species of closely related finches.
- Their beak shapes and sizes are adapted to specific food (diet) available in their habitat on the island.



Question 1

"*Different species have different genital or floral structures*."

The statement above explains about:

a. Gametic isolation
b. Mechanical isolation
c. Behavioural isolation
d. Temporal isolation

Question 2

Which of the following mechanism of reproductive isolation does NOT occur before fertilization?

a. Habitat isolation

b. Temporal isolation

c. Behavioral isolation

d. Hybrid breakdown

Question 3

Different beak shapes and sizes of finches of Galapagos Island is an example of:

a. Reproductive isolation
b. Hybridization
c. Adaptive radiation
d. Genetic drift