

**insects  
and food**

**nectar**

**seeds**

**fruit**



# The main mechanisms of speciation

Learning objective

- classify the main mechanisms of speciation

## Success criteria

1. Apply previous knowledge about main mechanisms of speciation.
2. Classify correctly at least four examples out of five.

# Terminology

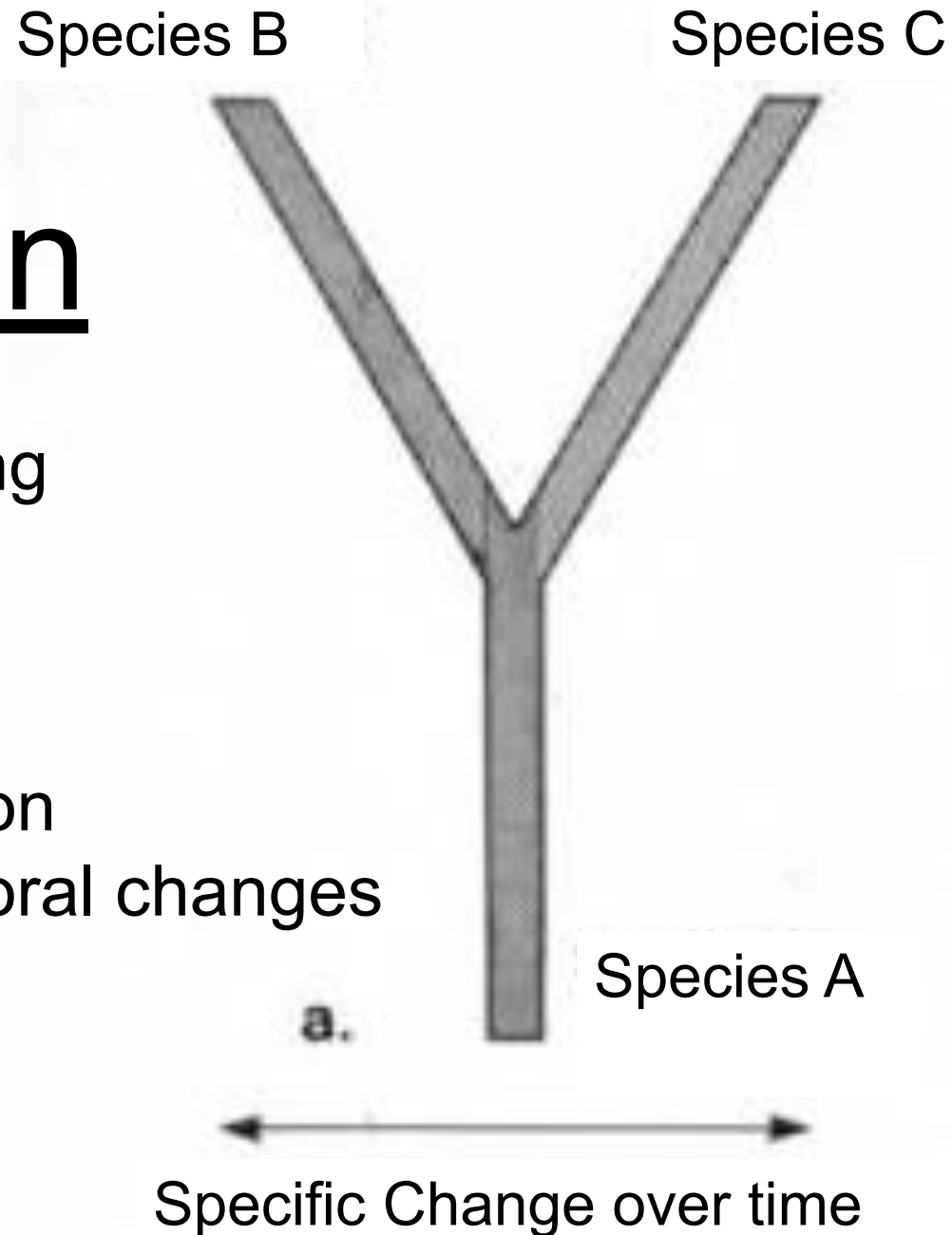
- Speciation, allopatric, sympatric, isolation: ecological and geographic, parapatric, peripatric, variation within population, adaptation, new species, mechanical isolation, behavioral isolation, gene pool, genoms, allele frequency, individuals, deme, anceryral species, barrier, polyploidy,

# Speciation

one species diverging into a new species

## Causes

- geographic isolation
- behavior or temporal changes



- **Speciation** is the process by which one species splits into two or more species
- Speciation explains the features shared between organisms due to inheritance from their recent common ancestor

- Speciation forms a conceptual bridge between microevolution and macroevolution
- **Microevolution** consists of changes in allele frequency in a population over time
- **Macroevolution** refers to broad patterns of evolutionary change above the species level



- *Species* is a Latin word meaning “kind” or “appearance”
- Biologists compare morphology, physiology, biochemistry, and DNA sequences when grouping organisms

- The **biological species concept** states that a **species** is a group of populations whose members have the potential to interbreed in nature and produce viable, fertile offspring; they do not breed successfully with other populations
- Gene flow between populations holds the populations together genetically



**(a) Similarity between different species**

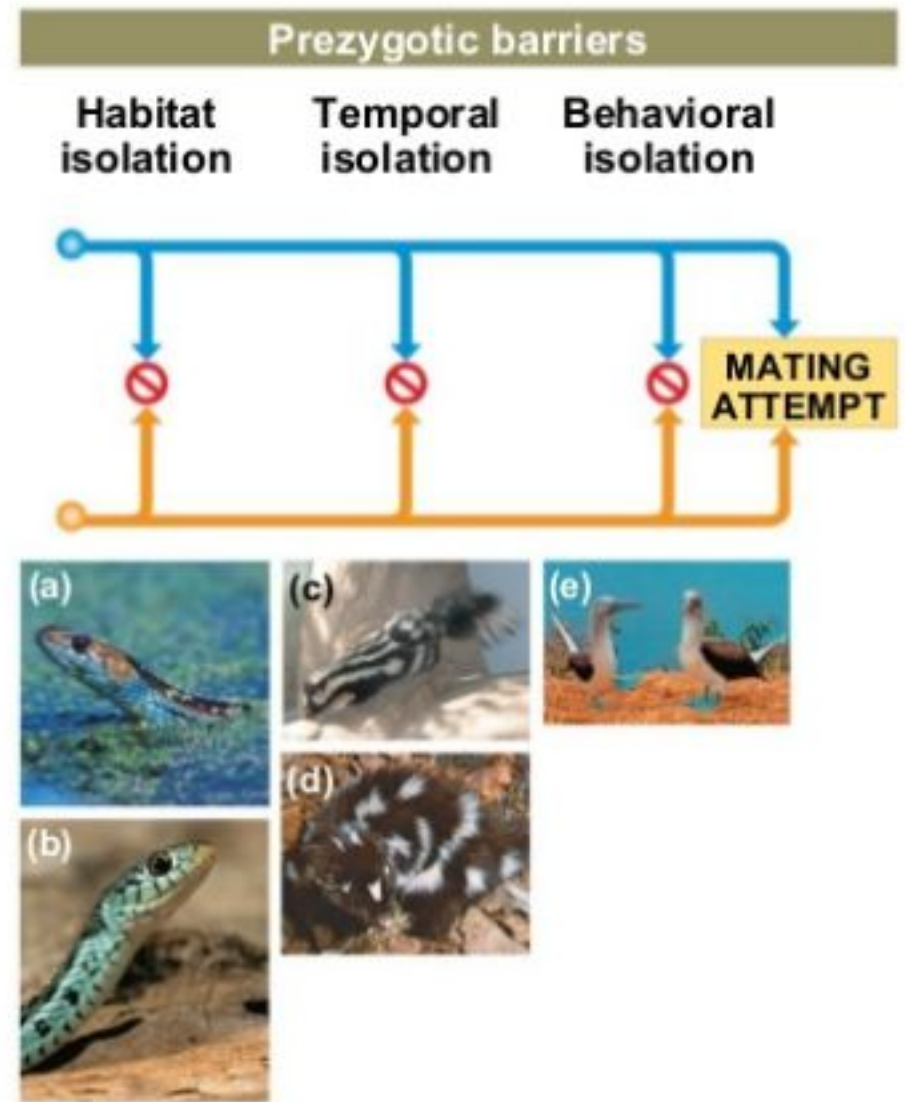


**(b) Diversity within a species**

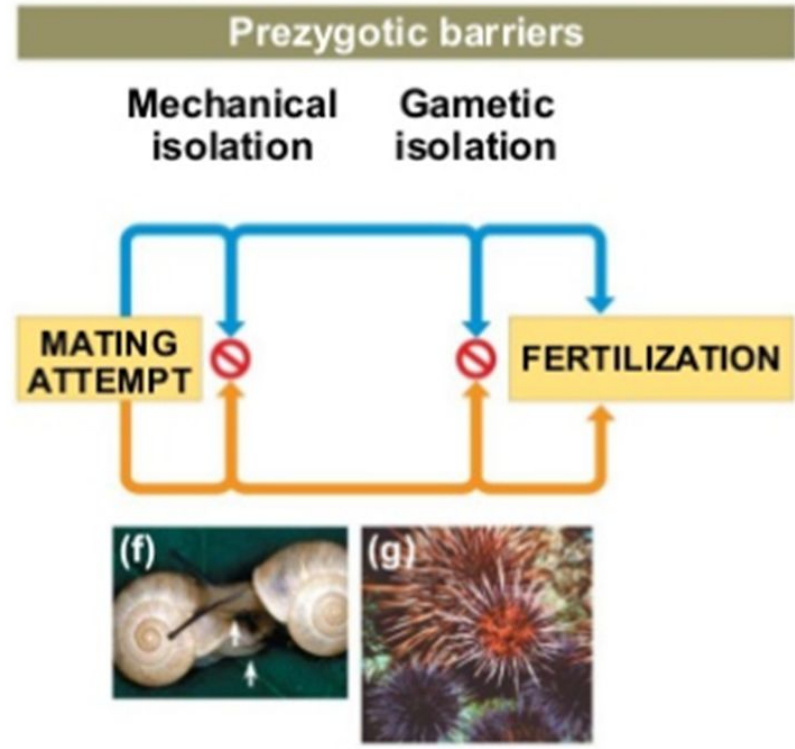
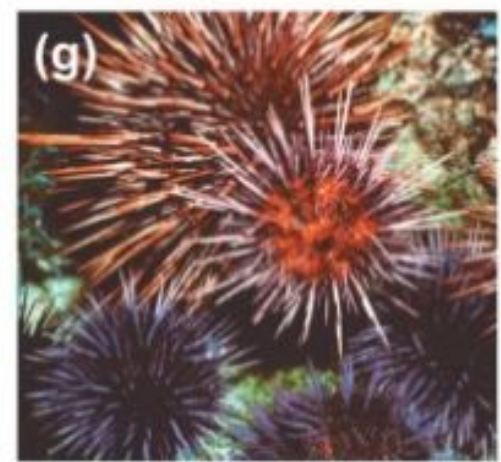
# Reproductive isolation

- **Reproductive isolation** is the existence of biological barriers that impede two species from producing viable, fertile offspring
- **Hybrids** are the offspring of crosses between different species
- Reproductive isolation can be classified by whether barriers act before or after fertilization

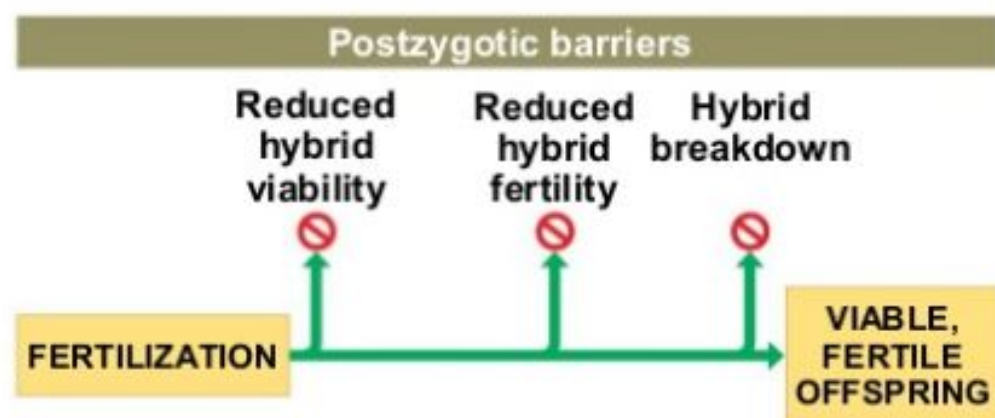
- **Prezygotic barriers** block fertilization from occurring by
  - Impeding different species from attempting to mate
  - Preventing the successful completion of mating
  - Hindering fertilization if mating is successful



- **Mechanical isolation:** Morphological differences prevent successful mating
- **Gametic isolation:** Sperm of one species may not be able to fertilize eggs of another species



- **Postzygotic barriers** prevent the hybrid zygote from developing into a viable, fertile adult by
  - Reduced hybrid viability
  - Reduced hybrid fertility
  - Hybrid breakdown



- **Reduced hybrid viability:** Genes of the different parent species may interact and impair the hybrid's development or survival
- **Reduced hybrid fertility:** Even if hybrids are vigorous, they may be sterile
- **Hybrid breakdown:** Some first-generation hybrids are fertile, but when they mate with another species or with either parent species, offspring of the next generation are feeble or sterile



# Speciation

When a species evolves (branches) into a new species as a result of natural selection; the new species can no longer interbreed producing fertile offspring.

## Examples

- geographical isolation
- mating behavior
- breeding habits
- changes in food sources

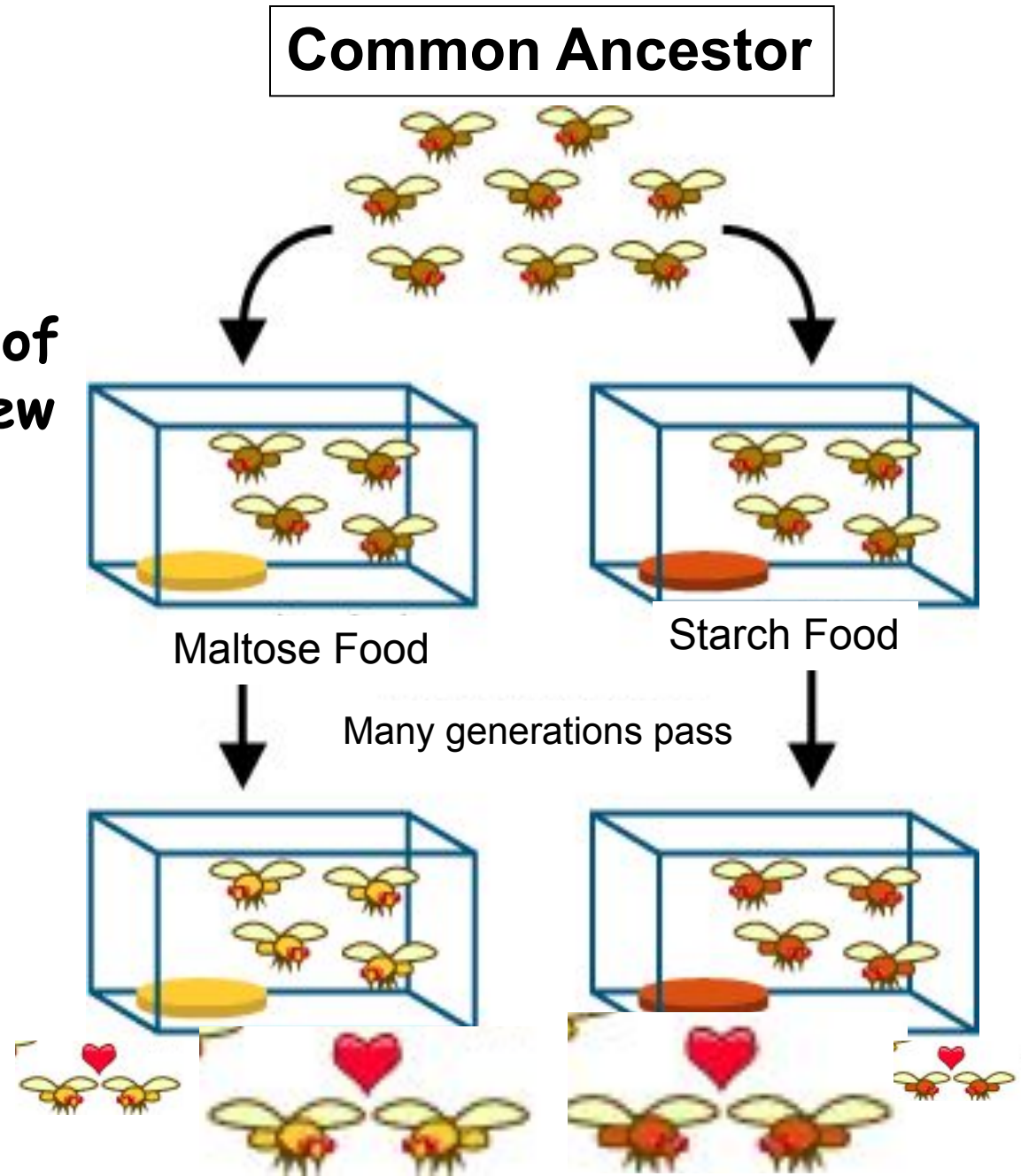
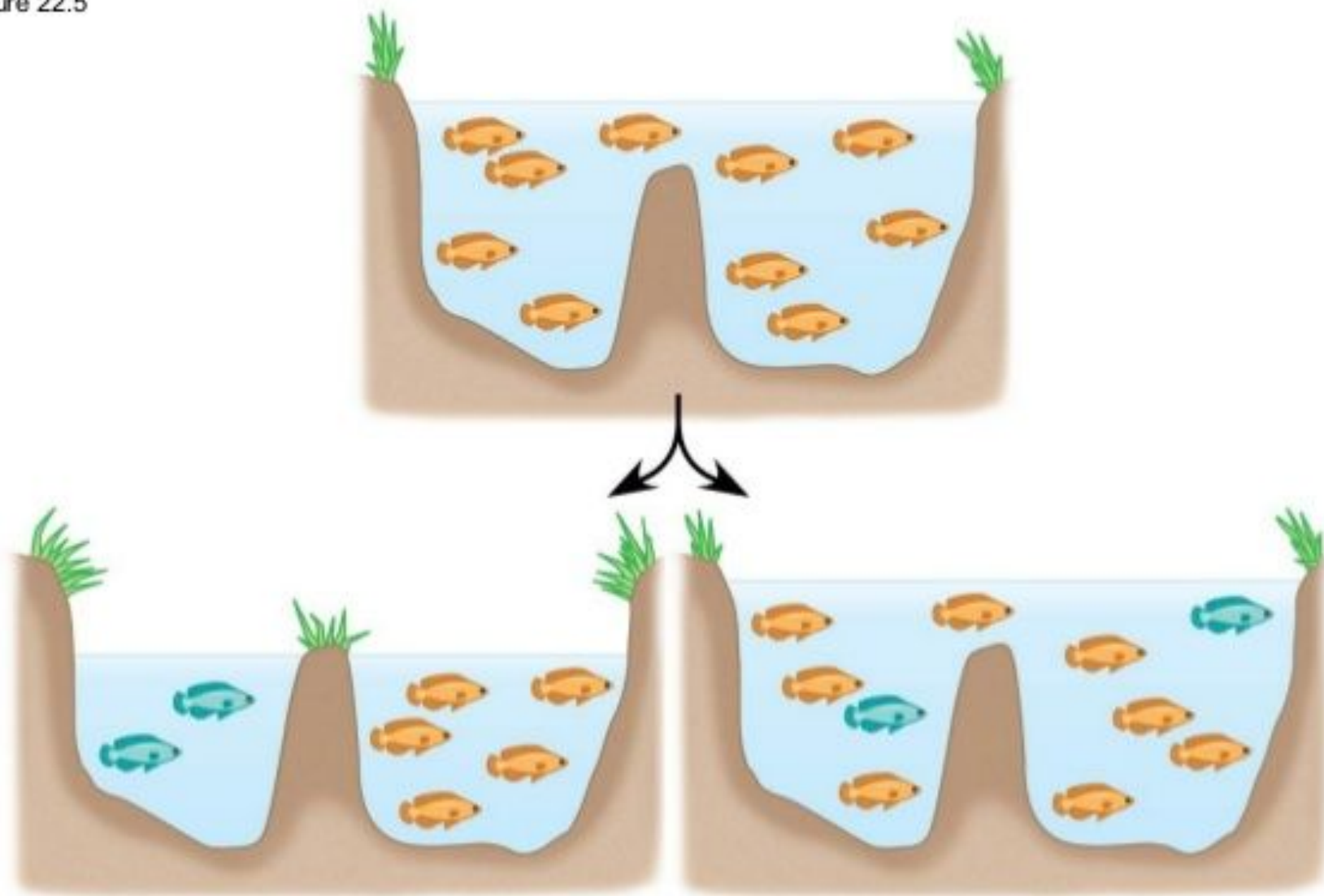
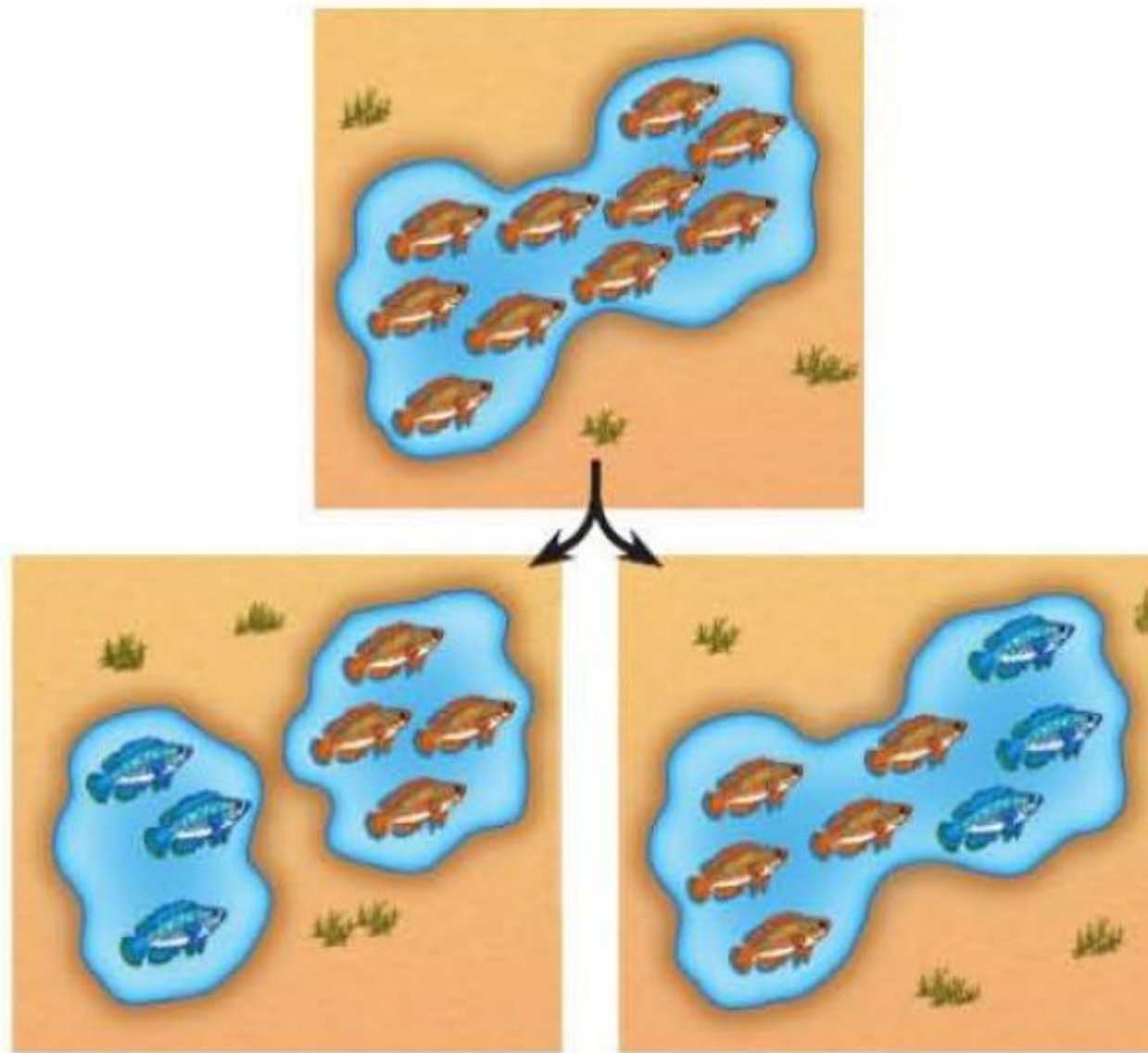


Figure 22.5



**(a) Allopatric speciation: forms a new species while geographically isolated.**

**(b) Sympatric speciation: a subset forms a new species without geographic separation.**



**(a) Allopatric speciation.** A population forms a new species while geographically isolated from its parent population.

**(b) Sympatric speciation.** A small population becomes a new species without geographic separation.

# Allopatric (“Other Country”) Speciation

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- In **allopatric speciation**, gene flow is interrupted when a population is divided into geographically isolated subpopulations
  - For example, the flightless cormorant of the Galápagos likely originated from a flying species on the mainland



*A. formosus*



*A. nuttingi*



ATLANTIC  
OCEAN

Isthmus of Panama

PACIFIC  
OCEAN



*A. panamensis*



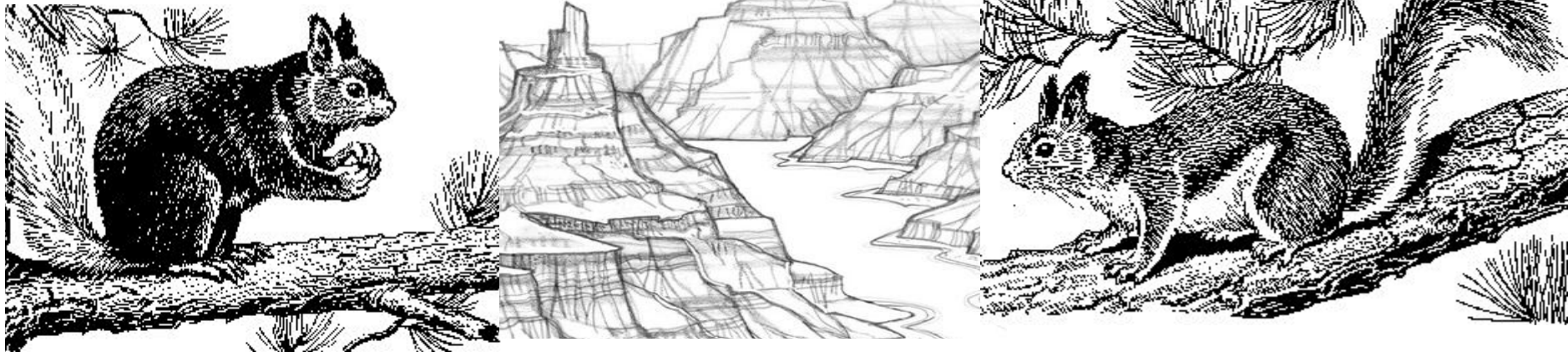
*A. millsae*

# Geographic Isolation

Two populations are separated by geographical barriers such as, Mountains, Lakes, Oceans, Rivers, Deserts...over time speciation will occur.

Kaibab squirrel has a black belly and lives on the North Rim.

Abert squirrel has a light colored belly and lives on the South Rim



Grand Canyon, Arizona



Common Ancestor



## Sympatric (“Same Country”) Speciation

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- In **sympatric speciation**, speciation takes place in populations that live in the same geographic area
- Sympatric speciation occurs when gene flow is reduced between groups that remain in contact through factors including
  - Polyploidy
  - Habitat differentiation
  - Sexual selection

## Experiment

Normal light

Monochromatic  
orange light

*P. pundamilia*



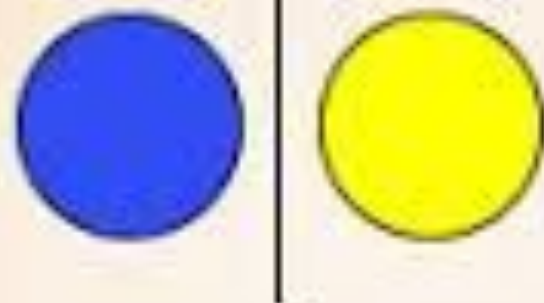
*P. nyererei*



Speciation in cichlid fish in Lake Victoria

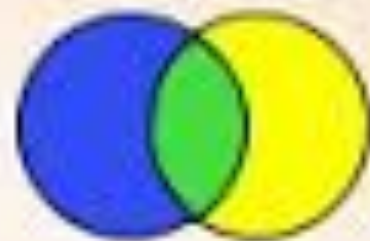


Allopatric



Geographical barrier

Parapatric



Partial spatial  
isolation

Sympatric



Genetic  
polymorphism

Peripatric



Isolation of a  
population at  
the periphery

# Speciation

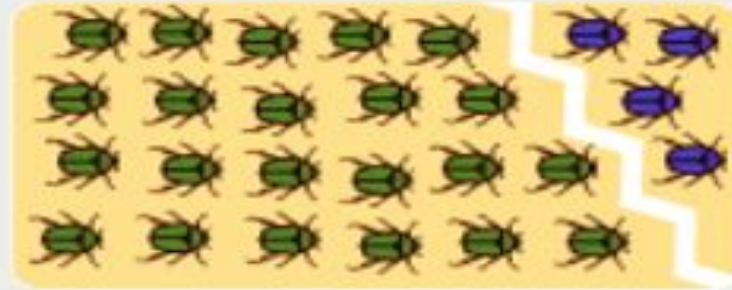
**Allopatric**  
(allo = other,  
patric = place)

geographically  
isolated  
populations



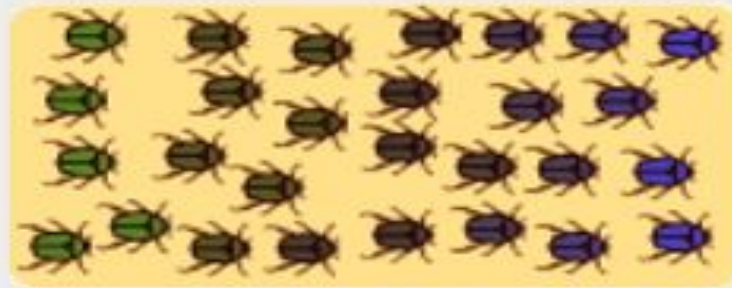
**Peripatric**  
(peri = near,  
patric = place)

a small population  
isolated at the  
edge of a larger  
population



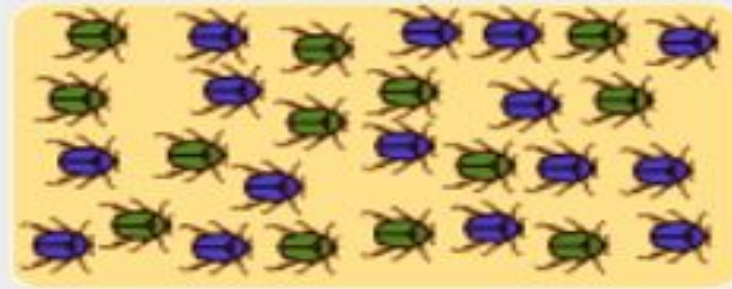
**Parapatric**  
(para = beside,  
patric = place)

a continuously  
distributed  
population



**Sympatric**  
(sym = same,  
patric = place)

within the range  
of the ancestral  
population



- A **hybrid zone** is a region in which members of different species mate and produce hybrids
- Hybrids are the result of mating between species with incomplete reproductive barriers
- A hybrid zone can occur in a single band where adjacent species meet
  - For example, two species of toad in the genus *Bombina* interbreed in a long and narrow hybrid zone

