

TOPIC: BIOLOGICAL SPECIES CONCEPT

Biological Species Concept

◆ **Biological Species Concept:** different species are _____ *isolated* from each other.

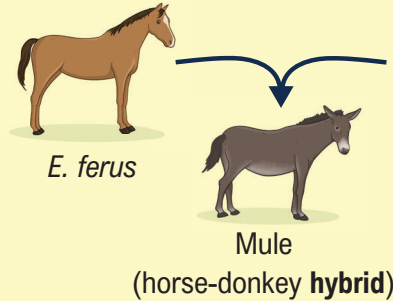
- **Reproductive Isolation:** the existence of a _____ that prevents gene flow between species.

1. No potential to _____ in nature.



E.g., humans and chimpanzees don't interbreed.

2. Do not produce _____ or _____ offspring.



E.g., mules are sterile.

◆ _____ can only occur if there is reproductive isolation.

EXAMPLE

Peppered moths are common in the United Kingdom, can be either light or dark in color, and the two color-morphs interbreed. Before the Industrial Revolution, virtually all moths were light-colored to camouflage with lichen. During the Industrial Revolution, when the trees were covered in soot, darker moths became more common.



- Based on this description, would you consider the dark moths to be a new species? _____
- Why or why not? _____

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PRACTICE

Which of the following is the primary criteria for defining species based on the biological species concept?

- a) Ability to produce viable hybrids.
- b) Geographical isolation.
- c) Reproductive isolation.
- d) Similarity in appearance.

PRACTICE

Giraffes live throughout large regions of Africa. Historically, only one species of giraffe has been recognized, but many scientists argue that giraffe populations actually represent four distinct species. What piece of evidence would best determine whether different giraffe populations should be considered different species according to the biological species concept?

- a) Whether or not there are regular identifiable physical characteristics that make the populations distinct.
- b) Whether or not the populations have historically interbred or are capable of producing offspring.
- c) Whether or not the populations interact with the environment differently in regular and meaningful ways.
- d) Whether or not there are regular differences in reproductive traits.

Types of Reproductive Isolation

◆ **Reproductive isolation** can be broken into two basic types of barriers:

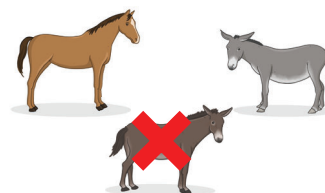
- **Prezygotic Barrier:** _____ fertilization.
 - _____ mating or hinder fertilization.
 - E.g., location, mating behavior, etc.

Summer mating

Winter mating



- **Postzygotic Barrier:** _____ fertilization.
 - Hybrids either do not survive or do not _____ (low fitness).
 - E.g., hybrid sterility, reduced viability, etc.



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EXAMPLE

H. davidii and *H. fordii* are two closely related species of orchids. For each statement below, if the statement represents a prezygotic barrier, write “Pre” on the line. If the statement represents a postzygotic barrier, write “Post” on the line. If the statement does not represent a reproductive barrier, write “None” on the line.

- a. _____ Both flowers are found in the same region.
- b. _____ When fertilized by pollen of the other species, hybrids fail to produce seeds.
- c. _____ *H. davidii* and *H. fordii* are both pollinated by a single pollinator, the hawkmoth.
- d. _____ Both flowers bloom in July.
- e. _____ The species' unique flower structures release pollen onto different body parts of the pollinator, so pollen is not transferred between the two species.

PRACTICE

Which of the following describes a postzygotic barrier?

- a) Hybrids between Muscovy and Mallard ducks are often larger than either parent species but are sterile.
- b) Songbirds are only attracted to songs made by birds of the same species.
- c) Jaguars live in South America, while leopards live in Africa and Asia.
- d) Different flower species often bloom at different times of the year, preventing cross-pollination.

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Prezygotic Barriers

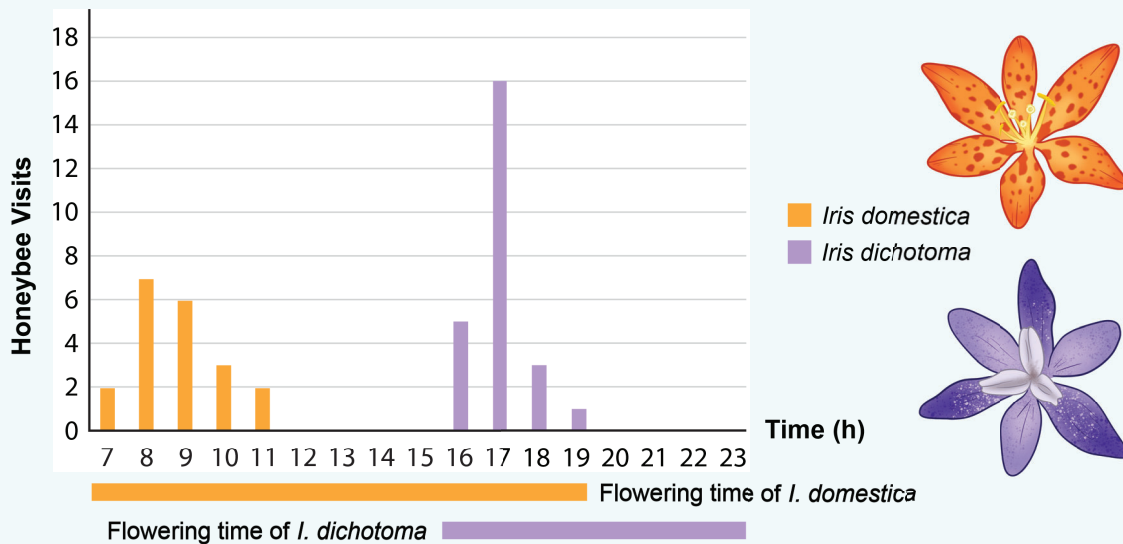
◆ Prezygotic barriers: prevent mating or _____: 5 main types.

Habitual Isolation	Isolated by _____.	Kaibab squirrels and Abert's squirrels separated by the _____. 
Temporal Isolation	Isolated by mating _____ or season.	<i>Spilogale gracilis</i> and <i>Spilogale putorius</i> skunks mate in different _____. 
Behavioral Isolation	Isolated by mating _____.	The Southern Cricket frog and Northern Cricket frog have different mating _____. 
Mechanical Isolation	Isolated by _____ differences.	Species of damselfly have reproductive structures that are _____ differently. 
Gametic Isolation	Isolated by _____ sperm & egg.	Adhesion of <i>Arabidopsis thaliana</i> pollen requires a specific _____ interaction. 

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EXAMPLE

Two closely related species of iris, *I. domestica* and *I. dichotoma*, have overlapping ranges, flowering season, use the same pollinators, and deposit pollen on the same body parts of the honeybees that visit them. Use the graph below to determine how these species may be reproductively isolated.



a. Type of reproductive isolation: _____

b. How do you know? _____

R. Liu, Y. Gao, Z. Fan, et al., Within-day temporal isolation of two species of Iris (Iridaceae) sharing the same pollinator. Biological Journal of the Linnean Society, July 2020, Vol. 130 No 3., Page 447-457.

PRACTICE

Abalone, a type of sea snail, are broadcast spawners, meaning they release their gametes into open water, where the sperm and egg drift until they meet and fertilization occurs. The sperm of the red abalone does not recognize the eggs of the pink abalone and vice versa due to biochemical incompatibilities. This is an example of what type of reproductive barrier?

a) Mechanical isolation.

c) Gametic isolation.

b) Habitual isolation.

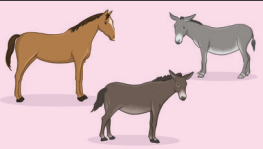
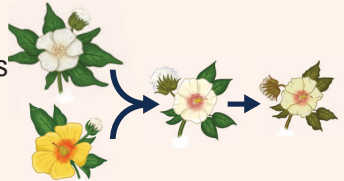
d) Behavioral isolation.



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Postzygotic Barriers

◆ Postzygotic barriers: incompatibilities that ____ the fitness of an offspring.

Reduced Viability	Hybrids are less likely to _____ compared to non-hybrids.	Hybrid offspring of different species of <i>Ficedula</i> are less likely to _____. 
Hybrid Sterility	Hybrids are viable but can't _____.	Horse and donkey create a mule which is strong but _____. 
Hybrid Breakdown	First generation hybrids: _____ Further generations: ____ fitness.	Second generation cotton hybrids are _____ and infertile. 

EXAMPLE

Around the world, people have bred domestic cattle (*Bos taurus*) with other local, related species. In Nepal, it is common to breed cattle with domestic yaks (*Bos grunniens*). The offspring, called dzo, are usually larger and stronger than either parent species and contain desirable traits from both. Male dzo are usually sterile, but the females are fertile. Still, the females are seldom bred because the second-generation hybrids tend to be smaller and weaker compared to both yaks and domestic cattle.

- a) Based on this description, should yaks and domestic cattle be considered different species? (Y / N)
- b) If yes, is the barrier prezygotic or postzygotic? _____
- c) If a prezygotic or postzygotic barrier is present, specifically, what type of pre- or postzygotic barrier is it?
If more than one type is described, list all types of barriers. _____

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PRACTICE

Which of the following pairs correctly matches the postzygotic barrier with its definition?

- a) Hybrid sterility: reduced fitness of hybrids after the first generation.
- b) Hybrid breakdown: hybrids are unable to reproduce.
- c) Gametic isolation: hybrid offspring are sterile.
- d) Reduced viability: decreased fitness of hybrid offspring.

PRACTICE

“Ring species” are species that are distributed across a habitat in a ring-like distribution. Every population is able to breed with neighboring populations, but where the ring closes, the populations at the two “ends” do not interbreed. One example of a ring species is *Ensatina escholtzii*, a species of salamander in California. The species began as a single population in the North, and spread South on either side of the California Central Valley. Each color on the map shows the distribution of different named population of *E. escholtzii*. Hybrids created by interbreeding of the populations marked with the circle are sterile. If hybrid sterility is present, why do you think these populations are still considered the same species?



- a) To be considered separate species there must be pre- and postzygotic barriers.
- b) Because each population interbreeds with its neighbor, gene flow is possible throughout the entire species.
- c) This is a postzygotic barrier; prezygotic barriers are necessary for speciation.
- d) To become distinct species the populations would need to be geographically isolated.