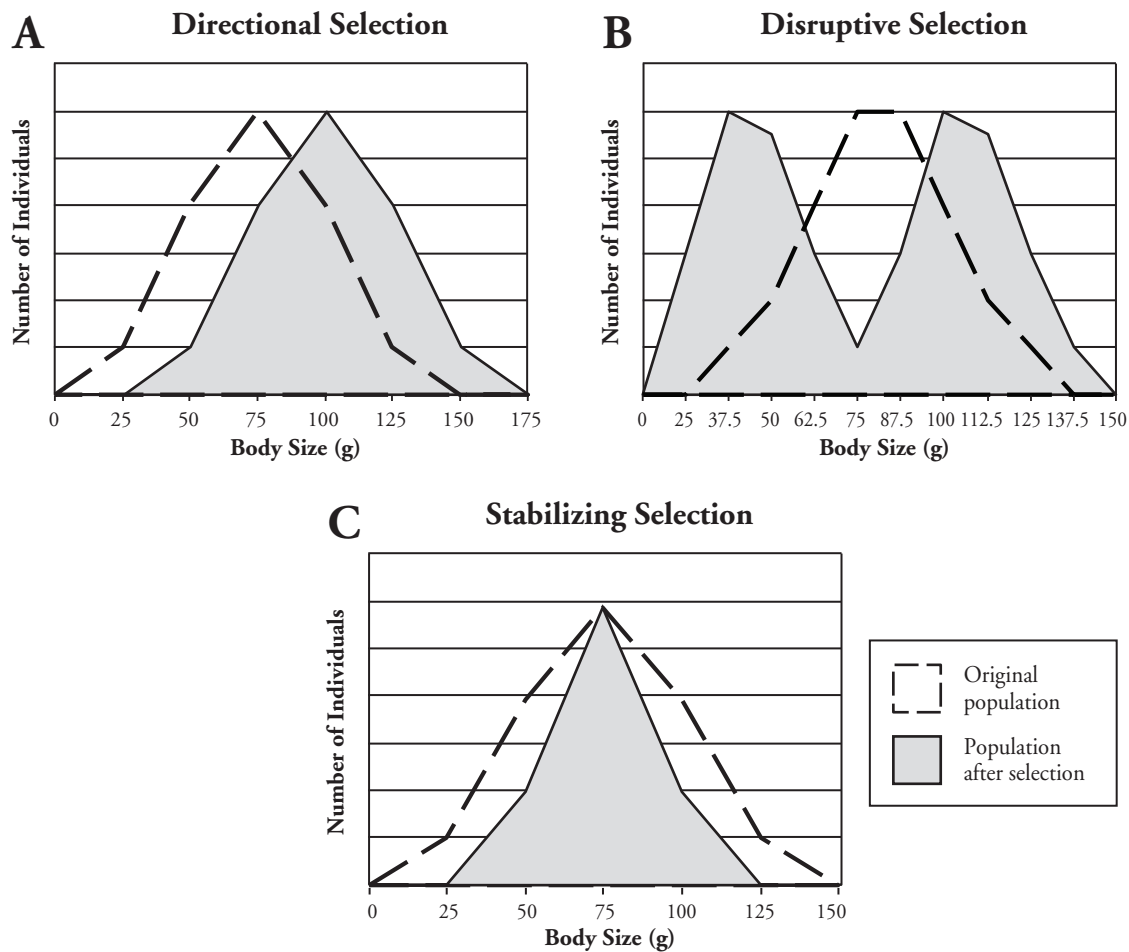# Selection and Speciation

How can changes in a population result in the formation of a new species?

Why?

Have you ever wondered how the great diversity of life on Earth has come about or how a single new species forms? Environmental pressures may cause populations to change over time or evolve. This is because an organism's ability to live to adulthood in its current environment will determine its reproductive success and ability to pass on its genes. But changes within a population can occur without creating a new species. At what point do scientists start thinking of a new name for a species?

Model 1 – Three Types of Selection

A **Directional Selection**

B **Disruptive Selection**

C **Stabilizing Selection**

Legend:
- Original population (dashed)
- Population after selection (shaded)

1. What variables do the graphs in Model 1 compare?

2. What are the three types of selection illustrated in the graphs in Model 1?

3. According to the graphs in Model 1, there is variation in the body mass in the original population. Using your knowledge of genetics, describe how this variation is possible.

4. Refer to graph A of Model 1.

   a. How is the population that has experienced selection different from the original population?

   b. **Fitness** is defined as the relative ability of an individual (or population) to survive, reproduce, and pass on genes. Which individuals in the original population appear to display better fitness?

   c. As a group, propose some characteristics of the environment that could lead to the population changes illustrated in graph A.

5. Refer to graph B of Model 1.

   a. How is the population that has experienced selection different from the original population?

   b. Which individuals in the original population appear to display better fitness?

   c. As a group, propose some characteristics of the environment that could lead to the population changes illustrated in graph B.

6. Refer to graph C of Model 1.

   a. How is the population that has experienced selection different from the original population?

   b. Which individuals in the original population appear to display better fitness?

   c. As a group, propose some characteristics of the environment that could lead to the population changes illustrated in graph C.

7. As a group, define the following terms in grammatically correct sentences. Each definition should contain the following words: population, selection, fitness, and environment.
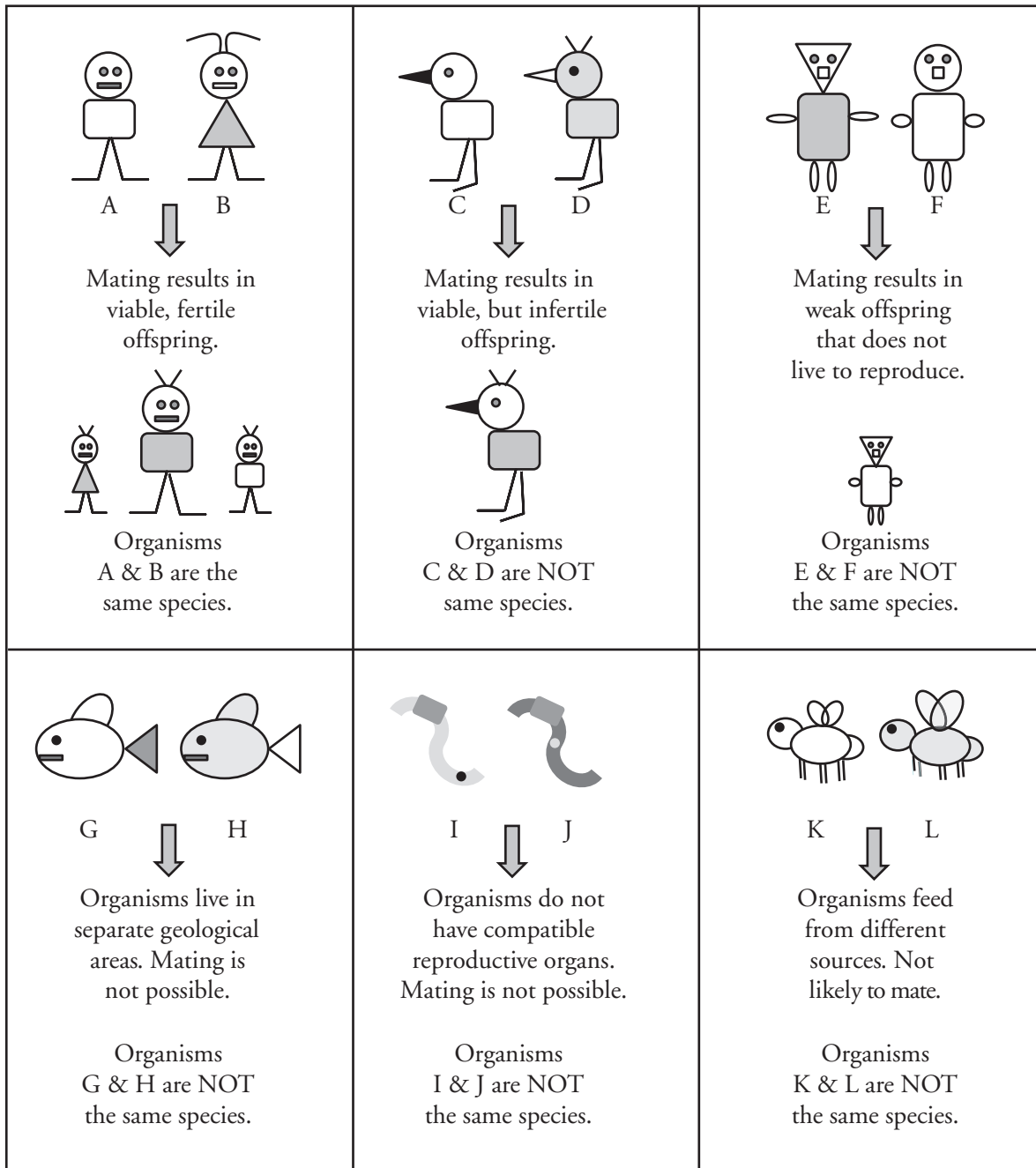
   a. Directional selection

   b. Disruptive selection

   c. Stabilizing selection

STOP

8. In each of the following examples, describe the likely outcome due to the environmental pressure and state the type of selection. Justify your choice.

   a. Finches with a small beak cannot crack open seeds.

   b. Human babies with very high or very low birth weights have a higher mortality rate.

   c. A population of seed cracker finches feeds on seeds available in two sizes, small or large.

   d. Overfishing occurs in two rivers in British Columbia, Canada, where larger salmon are preferentially caught.

Read This!

Natural selection, the improved fitness of certain individuals in the population that allows for survival and reproduction, is the primary mechanism by which populations change over time. Other mechanisms include the introduction of a mutation in the population and **artificial selection** (the effect of humans purposefully breeding animals to select for desirable traits). But at what point does a change in the population develop a new species? Data have been collected showing that the average height of an American adult is increasing, but that does not mean the American population has evolved into a new species.

Model 2 – Reproductive Isolation

A B	C D	E F
Mating results in viable, fertile offspring.	Mating results in viable, but infertile offspring.	Mating results in weak offspring that does not live to reproduce.
Organisms A & B are the same species.	Organisms C & D are NOT same species.	Organisms E & F are NOT the same species.
G H	I J	K L
Organisms live in separate geological areas. Mating is not possible.	Organisms do not have compatible reproductive organs. Mating is not possible.	Organisms feed from different sources. Not likely to mate.
Organisms G & H are NOT the same species.	Organisms I & J are NOT the same species.	Organisms K & L are NOT the same species.

9. Refer to Model 2. Identify the pairs of organisms that are able to produce offspring.

10. Which pair of organisms in Model 2 are members of the same species?

🔑11. Consider all of the pairs of organisms in Model 2 that are not of the same species. What criterion are missing in all cases that could be used to define a species?

Read This!

The primary criteria for animals to be classified as different species is that there must be **reproductive isolation**, meaning for some reason organisms from the two populations cannot pass on their genetic code through reproduction for several generations. Other criteria such as differing morphology (appearance and body structure) and how much DNA the organisms share are also used to make a final determination when comparing two similar organisms.

12. A common farming practice is to breed a female horse with a male donkey. The result is a very robust animal – the mule. Most mules however are sterile, and therefore cannot reproduce. Are horses and donkeys members of the same species? Justify your answer with a specific example from Model 2.

13. Many species of birds have elaborate mating rituals that include bird calls, nest construction, and courtship displays. A researcher is comparing two populations of birds with similar morphology that live in similar niches. Male birds in one population build a nest before attempting to court a female, while males in the other population build the nest in cooperation with the female. Is it likely the researcher will classify these birds as the same species? Justify your reasoning.

14. Could directional selection lead to the creation of a new species? Justify your reasoning using what you've learned from Models 1 and 2.
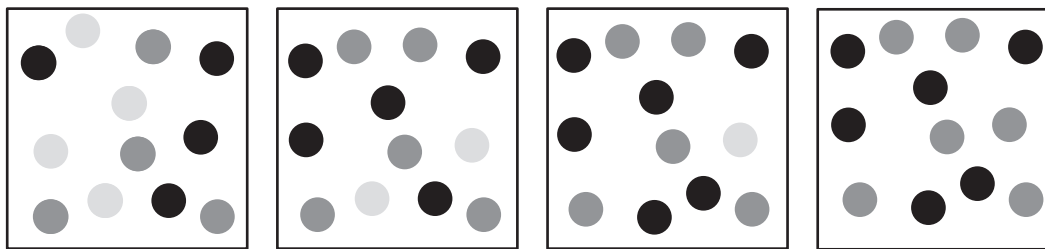
15. Could disruptive selection lead to the creation of a new species? Justify your reasoning using what you've learned from Model 2.

16. Could stabilizing selection lead to the creation of a new species? Justify your reasoning using what you've learned from Model 2.

Extension Questions

Model 3 – Genetic Drift

1st Generation   2nd Generation   3rd Generation   4th Generation

17. Refer to Model 3. Fill in the table below with the number of alleles of each type in each generation.

	1st Generation	2nd Generation	3rd Generation	4th Generation
Light				
Medium				
Dark				

18. Compare the frequency of the three alleles in the 1st generation of the small population illustrated in Model 3.

19. In the scenario illustrated in Model 3 two of the light alleles were lost (through the death of the individual who had these two alleles) before reproduction occurred in the 1st generation. How did this affect the distribution of the three alleles in this small population?

20. The phenomenon illustrated in Model 3 is called genetic drift. It mainly occurs in small, isolated populations. Propose an explanation for why the light allele disappears from the population by the fourth generation.

21. Will the light allele ever reappear in this population? If yes, describe the circumstances that would need to occur for the light allele to reappear.

22. If the population in Model 3 had been very large (hundreds of organisms), would the loss of two alleles from that population have led to the disappearance of that allele? Justify your reasoning.