

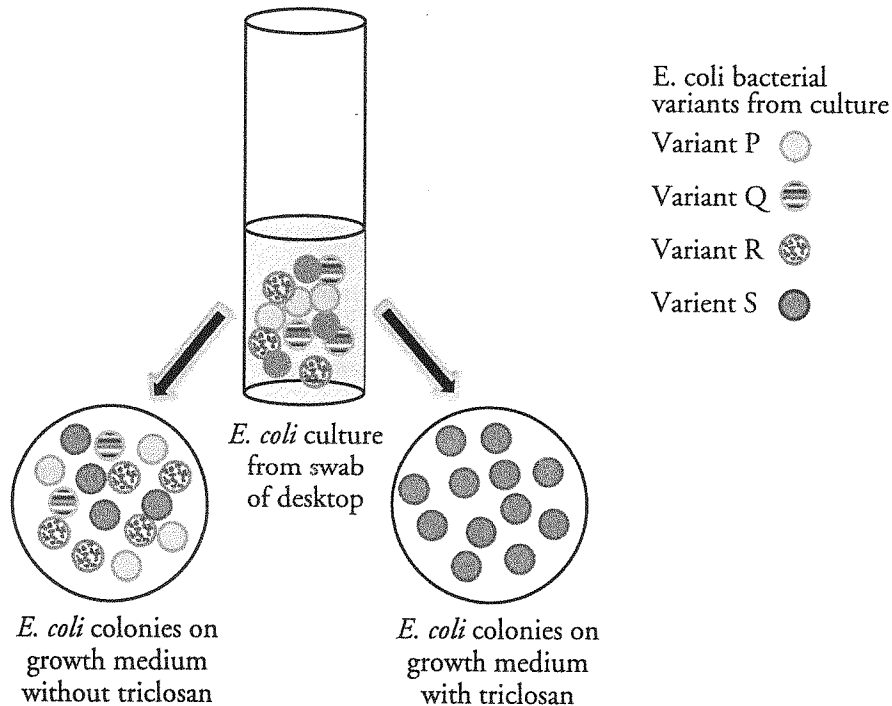
Evolution and Selection

What mechanisms lead to changes in the diversity of species on Earth?

Why?

People make choices by selecting options they like best. The natural world also “selects” (although not as a conscious decision) when environmental conditions allow organisms with a particular genetic trait to live healthier lives than other organisms. In this activity, we will explore how selection affects populations over time.

Model 1 – Desktop Swab Results



1. What is the source of the bacteria in the culture tube in Model 1?
The bacteria came from swabbing a desktop.
2. How many genetic variants of *E. coli* were present in the culture from the initial swab?
Four.
3. What variants of *E. coli* are found on the dish grown without triclosan?
Variants P, Q, R, and S are present on the dish that does not include triclosan.
4. Refer to the dish in Model 1 with the medium that included triclosan.
 - a. What variants of *E. coli* are found on the dish grown with triclosan?
The only variant present is S.
 - b. What likely happened to the other variants of *E. coli* on the dish with the medium containing triclosan?
They were killed by the triclosan.

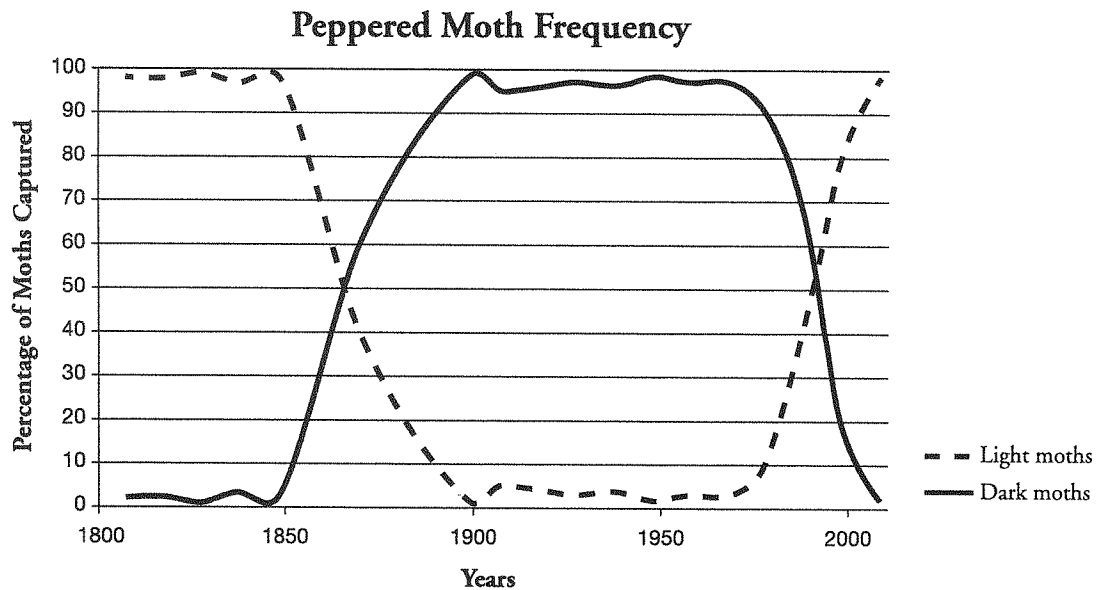
5. Based on its effect on *E.coli*, why is triclosan used as a cleaning agent?
It kills or prevents the growth of some types of bacteria.
6. Suppose the desktop swabbed earlier was cleaned with a solution containing triclosan. Would living *E.coli* remain? Support your answer.
Yes, variant S grew on the plates containing triclosan after the initial swab.
7. Suppose the desktop was swabbed again after cleaning it with triclosan over a 9-month school year. When the sample was cultured only variant S was seen.
- a. What characteristic does the variant S bacteria have that allows it to remain on the desktop even after several months of treatment with triclosan?
A trait that prevents the triclosan from affecting or killing the bacteria and allows them to grow even when triclosan is present.
- b. Is it likely that the bacteria in the new swab were on the desk 9-months ago, or are they offspring of the original bacteria?
They are the offspring of the original bacteria.
- c. Propose an explanation for the presence of only variant S on the desktop after so much time.
Only variant S would survive to reproduce in this environment. The triclosan-resistance trait would be passed on to the offspring. Other bacteria would be inhibited or killed by triclosan and would probably not reproduce, eventually dying out completely. Only bacteria that are resistant to triclosan and their offspring would remain.

Read This!

Populations of most living organisms exhibit genetic diversity among individuals. Certain traits in a population give some organisms a greater chance of survival than individuals that lack these traits. Because these traits tend to increase the chance of survival, these individuals may produce more offspring that will also have the trait that favors survival. Over time, the number of individuals within the population possessing the favorable trait increases while the number of offspring with the favorable trait decreases.



Model 2 – Color Variations in Moths in Great Britain

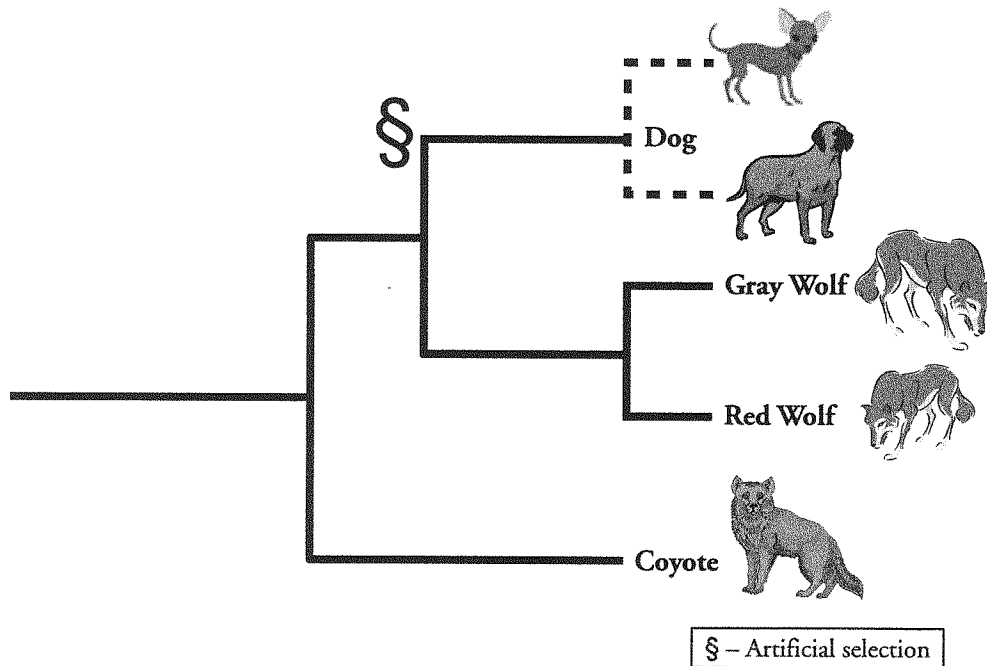


8. Refer to the graph of Peppered Moth Frequency in Model 2.
- Which moth color was more prevalent before 1850?
Light moths were more prevalent before 1850.
 - Which color was more prevalent between 1900 and 1950?
Dark moths were more prevalent between 1900 and 1950.
9. Describe the change in the percentage of light-colored moths and dark-colored moths between 1850 and 1900.
The number of light-colored moths decreased while the number of dark-colored moths increased.
10. Describe the change in the percentage of light-colored moths and dark-colored moths between 1950 and 2000.
The number of dark-colored moths decreased rapidly while the number of light-colored moths increased rapidly.
11. During the Industrial Revolution through the mid-20th century, factories and power plants, which burned coal, produced large quantities of soot and smog. Near industrialized areas, black powder covered surfaces, including the moth habitat.
- Which color moth would have a better chance of surviving predation (better camouflage to hide from predators) on this dark surface?
The dark moths would be less likely to be seen by predators.
 - How does this help explain the change in the colors of the moth population shown in Model 2?
Because the light-colored moths were easier to see on the dark surfaces, they were easier prey and could not have as many offspring as the dark-colored moths that were harder to see and could survive longer.

12. Clean Air Acts were passed by governments of industrialized nations beginning in the mid-1950s. Use this information to explain why the color of the moth population shifted again.

Because the factories were not producing the black powder, the moth habitat began to change into a lighter color. When this happened, the darker moths became easier to see and left fewer offspring than the better camouflaged light-colored moths.

Model 3 – Natural vs. Artificial Selection




13. Model 3 traces the lineage of what organisms?
Coyote, gray wolf, red wolf, and dog.
14. How does Model 3 indicate that all three types of organisms came from a common ancestor?
All branch from one line (seen on the left).
15. According to Model 3, wolves (gray and red) are more closely related to what other group—dogs or coyotes? Explain your answer.
Wolves are more closely related to dogs. They share a common ancestor that coyotes do not have.
16. Think about the characteristics of the organisms above.
- What are some differences that you note between wolves and dogs?
Differences include many various shapes and kinds of dogs, coat characteristics (smooth or rough), relationship with humans, temperament (ferocious vs. mild); accept other reasonable differences.
 - What similarities can you identify?
Similarities include being pack animals, body form and shape of wolves is similar to some dog breeds, barking/howling, carnivorous; accept other reasonable similarities.

17. Modern domesticated dogs arose from wolves through selective breeding by humans.
- What traits might humans have selected in the common ancestor of dogs and wolves that would account for the differences between dogs and wolves?
Tolerating humans, gentleness, and ability to be trained.
 - According to Model 3, what is the name of this type of selection?
Artificial selection.



Read This!

The events that lead to changes in groups of organisms are called **selection** by evolutionary biologists. Charles Darwin (1809–1882) is the person credited with carefully outlining how various changes in populations of organisms might occur through time. He called this process **natural selection**. Humans participate in selection through selective breeding of plants and animals. This is referred to as **artificial selection**.

18. Is the selection that led to the development of wolves and coyotes an example of natural selection or artificial selection? Explain your choice.
Natural selection—humans were not involved in these changes.
19. Refer to Model 1. Is the selection leading to changes in the *E. coli* variants natural or artificial selection? Explain your choice.
This is artificial selection because humans are treating the bacteria with a chemical that kills some but not all of them.
20. Two differences between red and gray wolves is their color and size. What environmental conditions might have resulted in selection for red wolves and gray wolves?
Color of vegetation or earth, amount and duration of sunlight, amount and duration of snowy conditions, size and availability of prey, etc.
-  21. Refer to Model 2. Is the selection of moths that blend in to their environment an example of natural or artificial selection? Explain your choice.
It is an example of natural selection because the environment and predators caused the change in population. Some students might identify it as artificial selection since humans caused the changes in the environment, but the direct selection on the moths is natural selection.

Extension Questions

22. For the past 10 to 25 years, farmers have planted crop seeds that have been genetically modified to withstand treatment with a common weed killer called Roundup®. This allows the farmers to spray their fields to get rid of weeds without harming their crops. Recently, more and more farmers have discovered that their fields have Roundup-resistant pigweed growing along with their crop. Use what you've learned in this activity to explain how this came about.

Farmers spraying Roundup killed all the weeds except a few that were resistant to it. These weeds produced seeds and over time, more and more of these naturally-resistant weeds survived.

23. Many popular products from hand soap to clothing advertise that they have antibacterial qualities. Most microbiologists recommend against their routine use in our daily lives. How can you explain this using your knowledge from this activity?

When a person uses these products in everyday situations, they kill or control only part of the bacteria. Resistant bacteria will become more and more common over time and will be the only bacteria remaining after a while.

Teacher Resources – Evolution and Selection

Learning Objectives

1. Explain how populations of organisms can change over a period of time.
2. Distinguish between selection that is the result of human choices and selection that is the result of environmental changes (natural and artificial selection).

Prerequisites

1. Students should understand that populations are groups of organisms of the same species interacting in the same place and time.
2. Students should have knowledge of heritable traits and some familiarity with pedigrees.
3. Students should have an understanding of predator-prey relationships.
4. Students should have some familiarity with phylogenetic trees.

Assessment Questions

1. Which of the following could cause changes in populations of organisms over time?
 - a. The environment
 - b. Geographic separation
 - c. Human choices
 - d. All of these.
2. Which of the following explains why selection can cause populations of organisms to change?
 - a. It teaches organisms how to survive better in their environments.
 - b. It allows some organisms to survive and produce offspring while others do not.
 - c. It causes changes in organisms to help them in their everyday lives.
 - d. It chooses certain organisms with good traits over other organisms with bad traits.
3. People who are prescribed an antibiotic for a bacterial infection are supposed to use all of the prescription even if they feel better quickly. Use your knowledge of artificial selection to explain why.

Assessment Target Responses

1. *d.*
2. *b.*
3. *Finishing all of an antibiotic should kill the nonresistant bacteria so that the body can more effectively fight off the resistant bacteria. If a person stops too soon, some potentially resistant bacteria will remain and could begin to grow again, causing a worse infection.*

Teacher Tips

- A common misconception that students may have is that some traits are good while others are bad. When applied in evolution, the word favorable only means that a trait gives an organism a greater chance at survival.
- Two other misconceptions to help students overcome are the ideas that selection “chooses” traits and that more complex traits are “better” than less complex traits.
- The Flinn Scientific activity kit, *Natural Selection*, Catalog No. FB1989, uses a paper simulation of the peppered moth natural selection study to demonstrate the effects of environmental conditions on survival and population changes.