

Recall that there are four parts of natural selection to take place.

A) Below is a series of pictures representing changes in a population of cacti. Pictures 1 and 2 show what happened when a deer came to eat, picture 3 shows the cacti a few weeks later (notice the flowers on the right-hand cactus), and picture 4 shows the situation a few months later.

- 1) What is overproduction?
- 2) Genetic Variation within the population: In picture 1, what is the main difference between the cactus on the left and the cactus on the right?
- 3) Struggle to survive: Why would a deer be more likely to eat the cactus on the left than the cactus on the right in picture 1?
- 4) Differential Successful Reproduction (fitness): What effect does the deer's behavior have on the survival and reproduction of these two types of cactus?
- 5) Do you think that evolution by natural selection is occurring in this cactus population? (Assume there is actually a large population of cacti, some look like each type of cacti shown above) Explain why or why not.

**B) Peppered Moth Background:**

Natural selection is the reproductive success of organisms that are best suited for an environment. It is the driving force of evolution. Natural selection occurs within populations, which are interbreeding groups of individuals of the same species. Genetic variation is one factor that influences natural selection. Genetic variation occurs when a population has multiple versions of a trait. For example, some organisms in a population of moths are dark colored, while some are light colored. Natural selection over time results in adaptations, where certain traits are favored due to their influence on survival. Adaptations over many generations can lead to evolution. Peppered moths have lived in the forests around Manchester, England for hundreds of years. There are two genetic variations for color in peppered moths- the moths can be dark with light spots OR light with dark spots.

Before the 1800s (figure 14.11a), the trees were light colored and the light colored moths were well camouflaged. After the 1800s, when England went through the Industrial Revolution, the pollution from factories made the trees darker (figure 14.11b). Now, the trees were dark colored and the dark colored moths were well camouflaged. Various birds eat both kinds of moths IF they are able to be seen. This phenomenon is called Industrial Melanism.

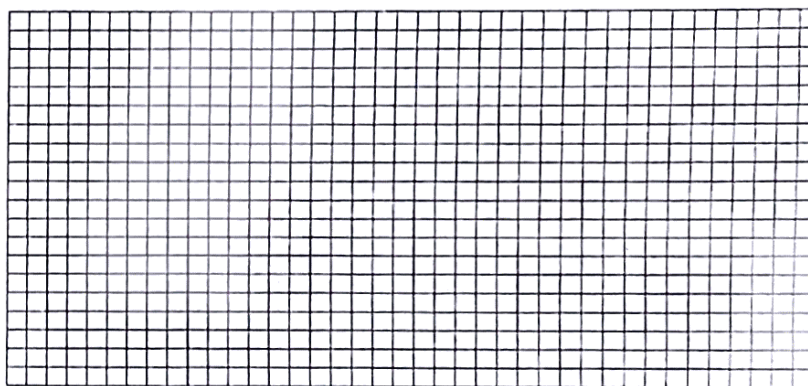
Data: The table below displays the Number of peppered moths of each color found over a ten year period. Graph the data below to show how the peppered moth populations changed in the 1800s. You should make a line graph with two lines. Years should be on the x axis and number of moths on the y axis. Assume year one was the start of the industrial revolution. Don't forget a legend. (two colors)

Peppered Moth Populations		
Year	Light Colored Population	Dark Colored Population
1	537	112
2	484	198
3	392	210
4	246	281
5	225	357
6	193	412
7	147	503
8	84	594
9	53	638
10	38	673



Figure 14.11 illustrates a moth population that has undergone directional selection. (a) illustrates the environment, light-colored tree trunks and dark-colored moths. (b) illustrates the environment, dark-colored tree trunks and dark-colored moths.

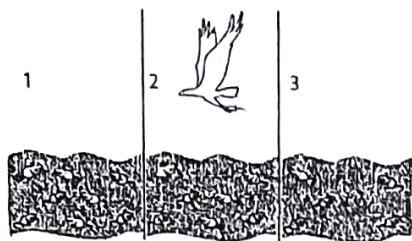
Line Graph:



Analysis Questions for B:

6. What changes occurred in both forms of the moth over these ten years?
7. Why do you think these changes occurred? (your explanation needs to include the FOUR parts natural selection from your notes, using these moths as an example for each part)
8. England has recently cleaned up their factories and now produces much less pollution. As a result, the trees are slowly becoming lighter. What might happen to the populations of each form of the moth in the next 10 years? Why?

9. Describe what is happening in figures 1-3 to the right. Is the population of mice different in figure 3 than in figure 1? Explain why.



10. Living things that are well adapted to their environment survive and reproduce. Those that are not well adapted don't survive and reproduce. An adaptation is any characteristic that increases fitness, which is defined as the ability to survive and reproduce. What characteristic of the mice is an adaptation that increased their fitness in #3?

11. The table below gives descriptions of four female mice that live in a beach area which is mostly tan sand with scattered plants. According to the definition given for fitness, which mouse would biologists consider the fittest? Explain why this mouse would be the fittest.

Color of fur →	Black	Tan	Tan and Black	Cream
Age at death	2 months	8 months	4 months	2 months
# pups produced by each female	0	11	3	0
Running speed	8 cm/sec.	6 cm/sec.	7 cm/sec.	5 cm/sec.

12. A more complete definition of fitness is the ability to survive and produce offspring who can also survive and reproduce. Below are descriptions of four male lions. According to this definition of fitness, which lion would biologists consider the "fittest"? Explain why.

Name →	George	Dwayne	Spot	Tyrone
Age at death	13 years	16 years	12 years	10 years
# cubs fathered	19	25	20	20
# cubs surviving to adulthood	15	14	14	19
Size	10 feet	8.5 feet	9 feet	9 feet

Explain:

C. Background:

Suppose that Tyrone had genes that he passed on to his cubs that helped his cubs to resist infections, so they were more likely to survive to adulthood. These genes would be more common in the next generation, since more of the cubs with these genes would survive to reproduce.

A characteristic which is influenced by genes and passed from parents to offspring is called heritable. Over many generations heritable adaptive characteristics become more common in a population. This process is called evolution by natural selection. Evolution by natural selection takes place over many, many generations.

Evolution by natural selection leads to adaptation within a population. The term evolution by natural selection does not refer to individuals changing, only to changes in the frequency of adaptive characteristics in the population as a whole. For example, for the mice that lived in the beach area with tan sand, none of the mice had a change in the color of their fur; however, due to natural selection, tan fur was more common for the pups than for the mother mice.

In summary, a heritable characteristic that helps an organism to have more offspring which survive to reproduce will tend to become more common in a population as a result of evolution by natural selection.

13. Explain why a characteristic which helps an animal to live longer will generally tend to become more common in the population as a result of evolution by natural selection.

14. Some times characteristics are not heritable but are environmentally influenced. Describe three characteristics that are not inherited but affect survival.

15. Not all heritable characteristics which contribute to longer life become more common in the population. Some characteristics contribute to long life, but not more offspring. For example, a female cat which is sterile and cannot have any offspring may live longer because she will not experience the biological stresses of repeated pregnancies. Explain why a characteristic like this which contributes to a long life, but with few or no offspring, would not become more common as a result of evolution by natural selection.

Read the following situations below and identify the 5 points of Darwin's natural selection.



1) There are 2 types of worms: worms that eat at night (nocturnal) and worms that eat during the day (diurnal). The birds eat during the day and seem to be eating ONLY the diurnal worms. The nocturnal worms are in their burrows during this time. Each spring when the worms reproduce, they have about 500 babies but only 100 of these 500 ever become old enough to reproduce.

a. What worm has natural selection selected AGAINST? \_\_\_\_\_ FOR? \_\_\_\_\_

Darwin's 5 points: Identify the 5 points in the scenario above.

- Population has variations. \_\_\_\_\_
- Some variations are favorable. \_\_\_\_\_
- More offspring are produced than survive. \_\_\_\_\_
- Those that survive have favorable traits. \_\_\_\_\_
- A population will change over time. \_\_\_\_\_

2) There are 3 types of polar bears: ones with thick coats, ones with thin coats and ones with medium coats. It is fall, soon to be winter. The temperatures are dropping rapidly and the bears must be kept warm, or they will freeze to death. Many of the bears have had ~2 cubs each but due to the extreme temperatures, many mothers only have one cub left.



a. What bear will natural selection select AGAINST? \_\_\_\_\_ FOR? \_\_\_\_\_

Darwin's 5 points: Identify the 5 points in the scenario above.

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- Those that survive have favorable traits. \_\_\_\_\_
- A population will change over time. \_\_\_\_\_



3) In ostriches, there are 2 types: ones that run fast and those that run slowly. The fast birds can reach up to 40 miles an hour. Jackals love to eat ostrich, and they can reach speeds of up to 35-40 miles per hour. A flock of ostrich will lay ~ 10 eggs (each mother only lays 1), but many rodents break into the eggs and eat the fetus before they hatch.

a. What ostrich will natural selection select AGAINST? \_\_\_\_\_ FOR? \_\_\_\_\_

Darwin's 5 points: Identify the 5 points in the scenario above.

- Population has variations. \_\_\_\_\_
- Some variations are favorable. \_\_\_\_\_
- More offspring are produced than survive. \_\_\_\_\_
- Those that survive have favorable traits. \_\_\_\_\_
- A population will change over time. \_\_\_\_\_

4) There are two types of rabbits: those that strictly eat grass and those that strictly eat berries and flowers. A drought occurs one year, and the plants have difficulty producing any extras (flowers, berries, etc.). They can only try and keep themselves green. The rabbits have had babies all year long but many are eaten by foxes or hawks. Due to the drought, many have starved to death.

a. What rabbit will natural selection select AGAINST? \_\_\_\_\_ FOR? \_\_\_\_\_

Darwin's 5 points: Identify the 5 points in the scenario above.

- Population has variations. \_\_\_\_\_
- Some variations are favorable. \_\_\_\_\_
- More offspring are produced than survive. \_\_\_\_\_
- Those that survive have favorable traits. \_\_\_\_\_
- A population will change over time. \_\_\_\_\_



5) Bob believes that giraffes have long necks because they have stretched their necks to try and reach food that is high in trees. Since the parent had stretched its neck, it passed the long neck on to its offspring.

Ryan believes that giraffes have long necks because the ones with long necks were able to reach the food, and those with short necks could not and died. The long necked giraffes reproduced, and soon all of the giraffes had long necks.

a. Who thinks like Lamarck? \_\_\_\_\_

b. Who thinks like Darwin? \_\_\_\_\_

c. Who disproved the idea of inheritance of acquired traits using tailless mice? \_\_\_\_\_