

Natural Selection & Evolution

Essay Entry: Genetics and Heredity

All Living things contain DNA which is the basis for their structure.

Biology/Life Science

Standard

7. The frequency of an allele in a gene pool of a population depends on many factors, and may be stable or unstable over time. As a basis for understanding this concept, students know:

Concepts

- a. why natural selection acts on the phenotype rather than the genotypes of an organism.
- b. why alleles that are lethal in a homozygous individual may be carried in a heterozygote, and thus maintained in a gene pool.
- c. that new mutations are constantly being generated, and so harmful alleles can never be eliminated from a gene pool.
- d. variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.

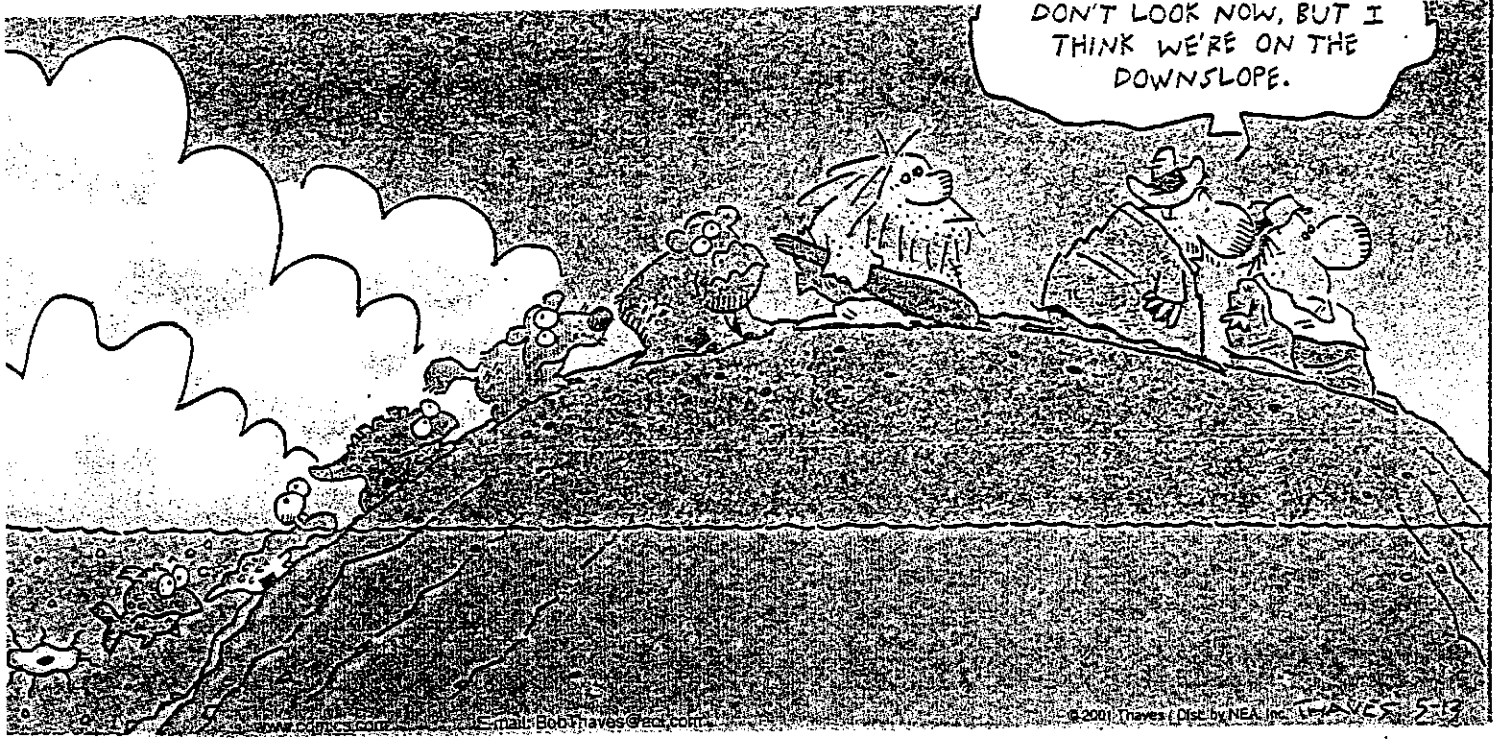
Standard

8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept, students know:

Concepts

- a. how natural selection determines the differential survival of groups of organisms.
- b. a great diversity of species increases the chance that at least some organisms survive large changes in the environment.
- d. reproductive or geographic isolation affects speciation.
- f. * how to analyze evidence from independent sources (including comparative embryology, and comparison of protein sequences), and summarize the probable evolutionary relationships among several organisms using a branching diagram.

DON'T LOOK NOW, BUT I
THINK WE'RE ON THE
DOWNSLOPE.



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Vocabulary: Natural Selection and Evolution

Word Part	Meaning	Vocabulary Word
Chemo	Liquid	chemosynthesis
Saprophyte	Rotten/ putrid	saprophyte
Phylo	Plant	
Di	Separate, apart	divergent
Co (n)	With, together	convergent
Vestigial	A trace or clue	vestigial
Pred	Prey	predation
Radi	A spoke or ray	radiation
-tion	Act of	variation
Grad, -a	Step or walk	Gradualism

Format

Word	Part of speech	Word parts
Definition		

Chemosynthesis		

Saprophyte		

Divergent		

Convergent		
Vestigial		
Predation		
Radiation		
Variation		
Gradualism		

Adaptation Artistry

Objectives: (1) identify and describe the advantages of bird adaptations; and (2) evaluate the importance of adaptations to birds.

Background: Birds have a variety of adaptations-including characteristics of beaks, feet, legs, wings, and coloration. These adaptations have evolved so that the bird is better suited to its environment and lifestyle. A variety of major adaptations are listed.

The major purpose of this activity is for you to realize that there are advantages for birds in looking the way they do, recognizing some of the ways in which birds are physically adapted to their environments.

Materials: construction paper, glue, or pencil and paper.

Procedure:

- You will have a chance to design your own original bird-one well adapted to its habitat. You should decide:
 - Where the bird will live
 - What it will eat
 - Its type of mobility
 - Its sex
- Based on these choices, you will decide the adaptations that are necessary for their bird, and write them down before proceeding further.
- Using the list of adaptations, create your original bird by drawing it
- In conjunction with creating a poster, you should include (on your poster) the name of the bird and its food sources, habitat and lifestyle. Include your list of adaptations, the reasons for adaptations, and the advantages provided by the adaptations.

5. Submit the poster

* you may make a mobile of the completed bird!!

Adaptation	Bird	Advantage	Adaptation	Bird	Advantage
Beaks	pouch-like pelican long, thin avocet	can hold fish, a food source can probe shallow water and mud for insects, a food source	Legs	flexor tendons long, powerful	chicken ostrich heron, crane eagle, hawk
	pointed wood-pecker curved hawk	can break and probe bark of trees, for insects, a food source can tear solid tissue, like meat, a food source can crack seeds and nuts, a food source	Wings	large	aid in perching, grasping aids running, transportation aids wading, transportation aids lifting, carrying prey, transportation
	short, stout slender, long	can probe flowers for nectar, a food source	Coloration	bright plumage	aids flying with prey, soaring while hunting attraction in courtship, mating rituals
Feet	webbed duck long toes crane, heron dawed hawk, grasping chicken	aids in walking on mud, transportation aids in walking on mud, transportation can grasp food when flapping prey, aids in sitting on branches, roosting, protection		female birds owl ptarmigan with seasons	aids in camouflage while nesting, protection in shelter provides camouflage protection (brown in summer, white in winter), protection in shelter

Adaptation Artistry Rubric

Name of Bird	2	1	0
Adaptations Are legible	2	1	0

Adaptations (labeled, described and justified)

Feet	2	1	0
Legs	2	1	0
Beaks	2	1	0
Color of bird	2	1	0
Wings	2	1	0

Ecosystem (habitat)

Colorful	2	1	0
Explained	2	1	0

Total: 18 x 2 = 36

(Cut rubric and paste on back of poster)

Natural Selection

Key Words

- species:** a group of closely related living things whose members can mate and produce young for generations.
- adaptation:** process by which a species becomes better suited to a change in its environment
- survival of the fittest:** another term for natural selection
- natural selection:** process by which the best adapted species survive and reproduce

KEY IDEAS

Many differences, or variations, exist among the individuals of any single species. Some variations may make an organism better suited to its environment. A species that is the best suited to its environment will survive and reproduce.

Over time, scientists have realized how much can be learned from studying differences among species. One of the first people to see the importance of slight variations among species was Charles Darwin. Darwin was an English scientist who lived more than 100 years ago.

Darwin's Studies. On a long voyage around the world, Darwin stopped at several small islands in the Pacific Ocean. While there, he noticed slight variations in the traits of the animals that lived on each island.

Darwin observed that one type of bird, a finch, lived on all the islands. But the finches living on each island had slightly different beaks. On one island, the finches had heavy beaks. The finches on another island had thinner, more pointed beaks. Darwin also noticed differences among the islands themselves. Some islands were covered with trees and bushes. Others were rocky and had only a few plants. After careful study, Darwin concluded that the finches' beaks had adapted to the type of food available on each island.

A **species (SPEE-sheez)** is a group of closely related living things with a common ancestor. Members of the group can mate with one another and produce young for generations.

Darwin suggested that many slight variations in traits existed within any single species. For example, an individual bird might be slightly smaller or a bit lighter in color than other birds of the same species.

may be sudden, such as that caused by a fire or a volcanic eruption. Changes may be slow, such as the wearing down of mountains. If members of a species are not suited to the new, changed environment, the species may not survive. To survive, the species must either change or move away. But such changes occur slowly. They happen over long periods of time and over many generations.

Sometimes, an organism has a trait that allows it to survive. If this trait is passed on to its offspring, the offspring also have a better chance of survival. The process by which a species becomes better suited to a change in its environment is called **adaptation** (ad-uhp-TAY-shuhn).

1. What is adaptation?



Darwin wrote that the differences in the finches' beaks were variations. See Fig. 13-1. On an island that had many plants with large seeds, the finches had large, heavy beaks. This trait allowed them to crack open the seeds. Because these birds had plenty to eat, they would be healthy, and would be likely to find a mate and produce young.

In contrast, a finch with a smaller beak would have a hard time cracking open and eating the large seeds. This bird might not get enough to eat. As a result, it would not be as healthy as other well-fed finches. The hungry bird might not find a mate, and it might even die. Thus, it would not pass traits to a new generation of offspring.

Darwin suggested that only the better adapted finches would be healthy enough to survive and produce young. He called this process **survival of the fittest** (suh-VY-juh uhv thuh FIFIT-uhst). In this process, organisms that survived produced young that inherited the traits they needed to adapt to their environment. These helpful variations were passed from one generation to the next.

Natural Selection. Darwin realized that survival of the fittest also happened in species other than finches. He suggested that all species compete for survival. He also noted that species that are best adapted to their environment survive longer and reproduce more. Darwin called this process **natural selection** (NACH-uh-uhl suh-LEFIK-shuhn). The terms *survival of the fittest* and *natural selection* are both used to describe the process in which organisms with the best adaptations survive and reproduce.

2. What is natural selection?



Fig. 13-1



Small seed-eating finch



Insect-eating finch



Cactus-feeding finch

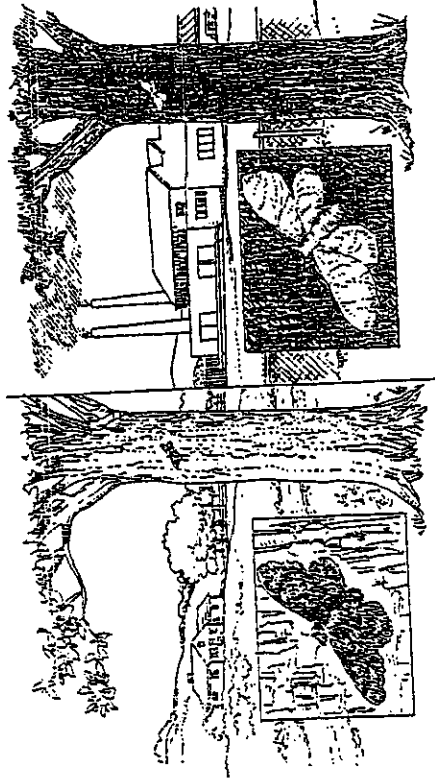


Large seed-eating finch

Fig. 13-2 shows an example of natural selection in moths. Imagine two different traits for wing color in moths. One trait is for light-colored wings. The second trait is for dark-colored wings. Because dark-colored moths are easy to see on tree trunks, predators capture many of them. Most of the moths that remain have light-colored wings.

Then the environment changes. Pollution darkens most of the tree trunks. Now dark-colored moths have the advantage because they are hard to find. They become more common as predators capture more of the light-colored moths.

Fig. 13-2



Check Your Understanding

Write a sentence explaining the connection between each pair of words.

3. adaptation, trait _____
4. natural selection, survival _____
5. survival of the fittest, reproduce _____

Complete the concept map shown in Fig. 13-3. Use the following terms:
young more away adapts

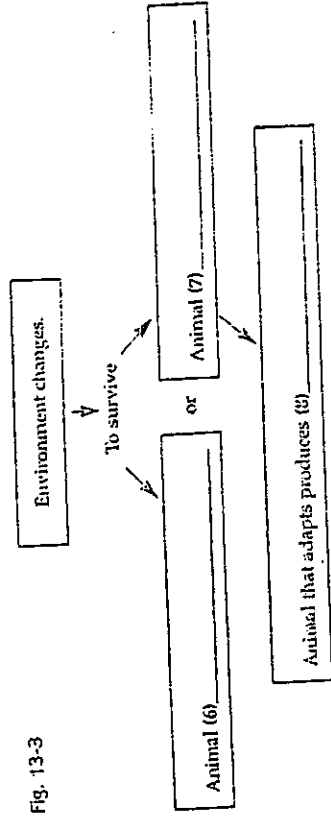


Fig. 13-3

Fill in the blanks.

9. Another term for natural selection is _____.
10. Species that are best _____ to their environment survive longer and produce more young.
11. The process by which a species with the best adaptations survive and reproduce is called _____.

12. Within any group of species, there are variations of traits. How are these variations helpful to the group? _____

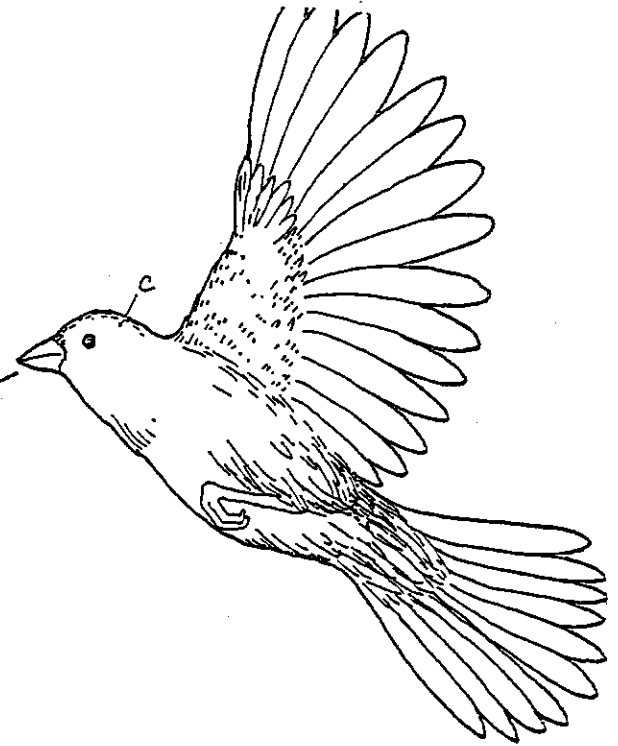
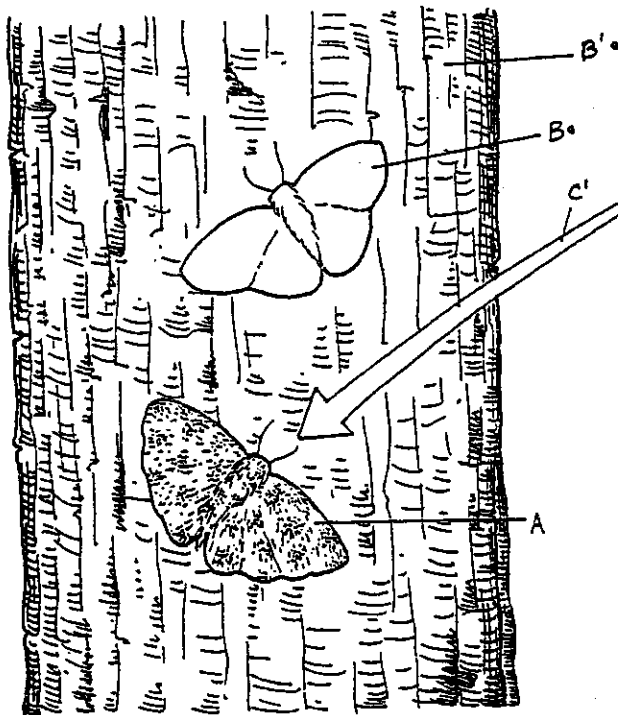
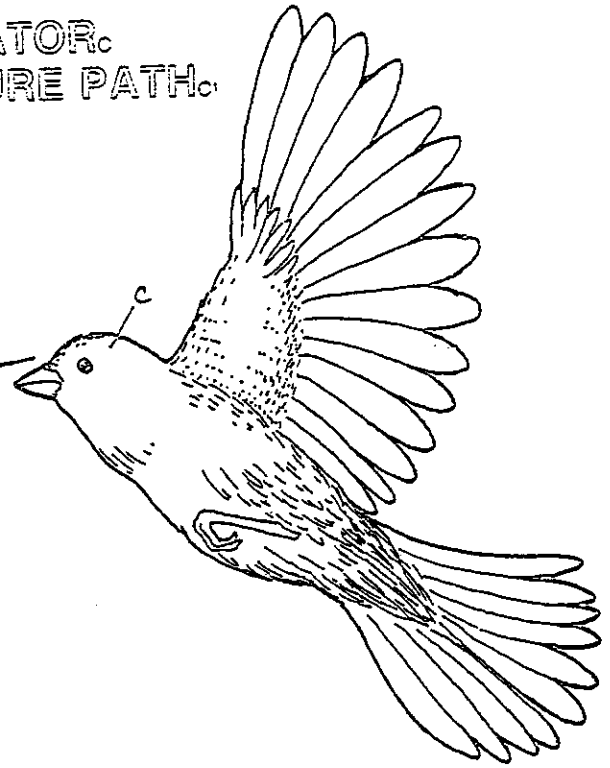
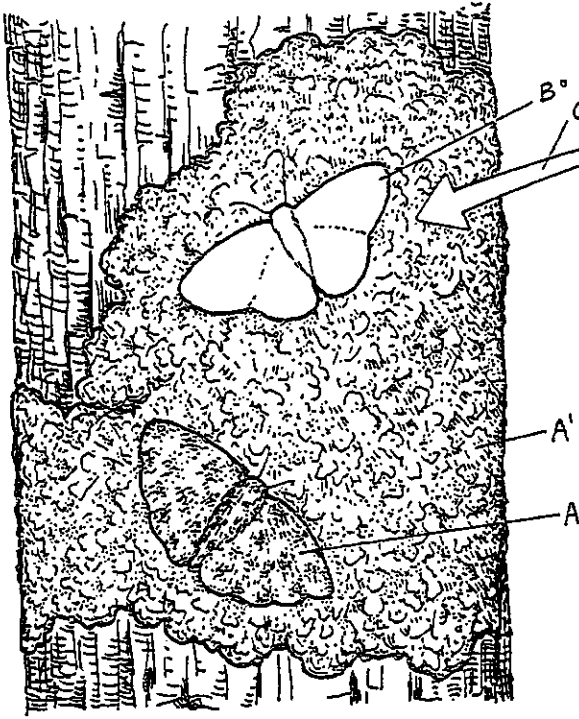
13. How did Darwin's finches adapt to the different environments of the islands? _____

14. Are all different types of traits the result of adaptation? Explain. _____

NATURAL SELECTION WE CAN SEE.

PEPPERED MOTH_A
BLACK MOTH_B
LICHEN_{A'}
SOOT-COVERED TRUNK_{B'}

PREDATOR_C
CAPTURE PATH_C



Natural Selection We Can See

Since Darwin's exposition of the principles of natural selection, biologists have found numerous examples of natural selection occurring in periods of time much shorter than the many thousands of years usually required. One outstanding example of this is what is known as industrial melanism (Greek: *melas* = black), the turning black of certain species in areas that were blackened with the soot of the coal-burning factories that sprang up in great numbers during the Industrial Revolution.

1. Predict the consequence of a light-colored organism turning darker due to the soot.

One of the best-studied cases of industrial melanism is the change in color of the peppered moths in the vicinity of Manchester, England. Nature study has been popular for centuries in England, so there are records of observations and insect collections going back several hundred years. In the vicinity of Manchester, a certain rather large moth was well known. It was called the peppered moth because it resembled a white moth on which pepper had been sprinkled. It was nocturnal in its habits and spent all the daylight hours resting on the trunks of trees, where it blended in almost perfectly with the lichens covering the tree trunks, since the lichens had the same "peppered" coloration. Only occasionally was a rare black member of this species spotted.

2. Explain how the peppered moth camouflaged with its environment.

In the second half of the nineteenth century, however, more and more black moths began to show up. That change in the moths corresponded exactly with the progress of the Industrial Revolution. In the coal-burning part of England, the amount of soot put into the air by factories was so great that it covered the tree trunks in industrial areas, killing the lichens and turning the tree trunks black. Under those conditions, of course, the black moths were as well camouflaged as the peppered ones had been on the lichen-covered trunks. Eventually 98% of the moths of this species in industrial areas were black. The same change was observed in many dozens of other species of moths in similar industrial areas in England and the United States, wherever forest became polluted with soot. In unpolluted forests, the moths retained their light coloration.

3. Explain the changes in the peppered moth population due to the increase in soot.

The English biologist H.B.D. Kettlewell decided to go out into the first to investigate how this change was occurring. Kettlewell captured equal numbers of black and peppered moths, put identifying paint marks on their undersides where the marks wouldn't show when the moths were resting on a trunk. He then released

one set in an area with blackened tree trunks and another in an unpolluted area with trunks still covered with lichens. When he came back to recapture the moths, he recovered only half as many of the peppered moths, as he did black moths in the soot-blackened forest, and in the light-colored forest he recovered only half as many black moths as he did peppered moths. He also examined the stomach contents of birds known to feed on the moths and found that in blackened forests they ate a disproportionately large number of light-colored moths and in light-colored forests that reverse was true. He also set up movie cameras and captured on film what is summarized in the coloring page. When a bird is zooming in toward a tree trunk looking for lunch, it is much more likely to see and therefore capture a black moth of a lichen-covered tree trunk or a peppered moth on a blackened tree trunk.

4. List Kettlewell's problem:

5. Why did the black moth population proliferate in the soot covered trees?

6. What would Kettlewell have to do in order to make his experiment more credible?

Kettlewell also found that geneticists had already established that the coloration of these moths was determined by a single pair of genes, with the peppered coloration (*r*) recessive to black (*R*). Clearly, then, this was a case of natural selection in action. There was no "battle for survival" according to the "law of the jungle," as is sometimes mistakenly assumed to be a requirement for evolution. Survival or nonsurvival may depend on something as simple as the color of the background. Evolution, then, is simply the process of heredity, with all its lottery-like characteristics, extended over a long period of time, with the environment selecting which survive and which do not.

7. Cross two heterozygous black moths and provide the phenotypic and genotypic ratios.

8. Is competition a requirement for natural selection? Explain.

BACK TO THE SEAS

Paleoworld: Produced by: New Dominion Pictures for The Learning Channel :

1994

1. Where did whale ancestors come from?
2. Who was the first to suggest this idea and on what evidence was this based?
3. How do paleontologists of today think evolution usually happens.
4. What was special about the bacillisaurus that was found in the the Egyptian desert in 1989 that was different from the ones found in the past?
5. When and where did the first big break come in solving the puzzle?
6. What made this area a good one for sea animals?
7. What did Philip Gingerich find?
8. What do paleontologists think whales evolved from?
9. What physical structure do they compare?
10. What different structures did Pakicetes have?
11. The next skeleton Philip Gingerich found had what additional structures?
12. What happened in 1994?

13. What was found next?

14. How many years do the paleontologists think it took the whales to return to the sea?

Characteristics of the ancient whales.

Masonichids -

Pakicetes -

Ambliocetes -

Rodocetes -

Bacillisaurus -

Name _____ Date _____
 Class _____ Use after Section 7-3.

Chapter 7 Mechanisms of Evolution

Bird Adaptations

Bird beaks come in all shapes and sizes. For example, some beaks are long and narrow while others are short and wide. Beaks are modified jaws that are hard but light in weight. Birds use their beaks to pick up objects, to communicate, and to defend themselves.

The drawings below show the beaks of different kinds of birds. The shape of each beak is an adaptation for obtaining food in a certain way. Some methods by which birds obtain food are listed below the drawings. Look closely at the different kinds of beaks and match each beak with one method of obtaining food. Write the name of the bird next to the feeding description.



Goosander



Crossbill



Skimmer



Woodpecker



Hawk



Grosbeak



Nighthawk



Heron

1. Scoops up fish while flying over water _____
2. Tears the flesh of small animals _____
3. Drills holes in trees to find insects _____
4. Grabs fish from the water and holds on to them _____
5. Cracks open seeds _____
6. Spears fish in water _____
7. Catches insects in its mouth while flying through the air _____
8. Pries open pine cones to eat the seeds _____

Evidence of Change

The Useless Appendix

The appendix in humans is a vestigial structure. About the size of the little finger, it hangs like a small pouch at the point where the small intestine and large intestine meet, on the right side of the body. Some animals, including rodents and rabbits, have a functional appendix. In humans, these animals contain bacteria that break down the cellulose in plant foods. In humans, the appendix has no known function. The ancestors of humans probably had a functional appendix that also aided in the digestion of cellulose. Some scientists predict that the useless appendix will eventually disappear as we continue to evolve.

The useless appendix can occasionally cause problems. The muscular wall of the appendix normally squeezes out mucus or fluid that sometimes works its way into the appendix from the small intestine. Sometimes, however, the opening of the appendix becomes blocked with digestive wastes or other kinds of matter. The blockage causes fluids to build up in the appendix. The appendix swells and may become infected by bacteria.

The swelling of the appendix, called appendicitis, is usually accompanied by severe pain, loss of appetite, nausea, and vomiting. Appendicitis is generally treated surgically by removing the appendix—the sooner, the better. Left untreated, the appendix may burst open and spread life-threatening infection to other organs or the abdominal wall.

1. Why is the appendix in humans considered to be a vestigial structure?

2. What is the function of the appendix in rodents and rabbits?

3. What is appendicitis and how is it caused?

4. Why is appendicitis dangerous?

5. Some other vestigial structures in humans include certain ear muscles and some bones at the end of the spinal column, or backbone. What characteristics must these structures have to be considered vestigial?

The Theory of Evolution, continued

Section 15.2 Mechanisms of Evolution

In your textbook, read about population genetics and evolution. Examine if the statement is true. If it is not, rewrite the italicized part to make it true.

Adaptations of species are determined by the genes contained in the DNA code. When Charles Mendel developed the theory of natural selection in the 1800s, he did not include a genetic explanation. Natural selection can act upon an individual's genotype, the external expression of genes.

1. Natural selection operates on an individual over many generations.

5. The entire collection of genes among a population is its gene frequency.

6. If you know the phenotypes of all the organisms in a population, you can calculate the allelic frequency of the population.

7. A population in which frequency of alleles changes from generation to generation is said to be in genetic equilibrium.

8. A population that is in genetic equilibrium is not evolving.

9. Any factor that affects phenotype can change allelic frequencies, thereby disrupting the genetic equilibrium of populations.

10. Many migrations are caused by factors in the environment, such as radiation or chemicals, but others happen by chance.

11. Mutations are important in evolution because they result in genetic changes in the gene pool.

12. Genetic equilibrium is the alteration of allelic frequencies by chance processes.

13. Genetic drift is more likely to occur in large populations.

14. The factor that causes the greatest change in gene pools is mutation.

15. The type of natural selection by which one of the extreme forms of a trait is favored is called disruptive selection.

The Theory of Evolution, continued

Section 15.2 Mechanisms of Evolution, continued

In your textbook, read about the evolution of species.

Complete each statement.

16. _____ can occur only when either interbreeding or the production of fertile offspring is prevented among members of a population.

17. _____ occurs when formerly interbreeding organisms are prevented from producing fertile offspring.

18. Polyploid speciation is perhaps the fastest form of speciation because it results in immediate _____.

19. The hypothesis that species originate through a slow buildup of new adaptations is known as _____.

20. This hypothesis is supported by evidence from the _____ record.

21. The hypothesis of _____ states that speciation may occur rapidly.

In your textbook, read about patterns of evolution. Answer the following questions.

22. What happened to the ancestor of the honey creeper when it left the mainland and encountered the diverse niches of Hawaii?

23. What is adaptive radiation?

24. Adaptive radiation is one example of divergent evolution. When does divergent evolution occur?

25. When will convergent evolution occur?

Name _____ Date _____ Class _____

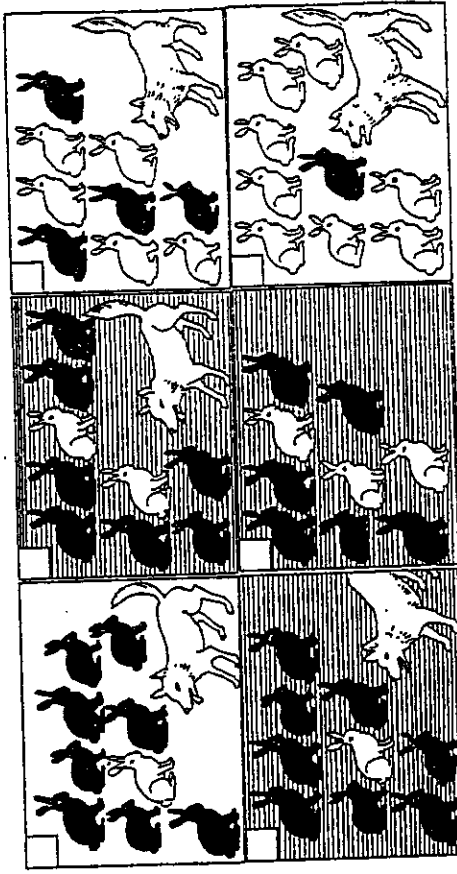
Use after Section 7.3.

Chapter 7 Mechanisms of Evolution

Natural Selection

Darwin's theory of evolution was based on two main points. First, variations appear naturally among members of the same species. Second, certain conditions in the environment determine which variations have survival value. Thus the individual with a variation that has survival value will survive in its environment and live to reproduce. Some of the offspring will also have the variation. The individuals that do not have this variation are less likely to survive and reproduce. Over time, the variation becomes a characteristic of the species. In this process of natural selection, "nature," or the environment, "selects" which traits have a survival value.

The diagrams below show the effects of natural selection on a population of rabbits living in a forest. At first, the climate of the forest was temperate. Over time, the climate changed to a more frigid one, with snow covering the forest floor most of the time. Number the boxes in the correct sequence in which natural selection occurred.



1. What variations did the rabbit population exhibit?

2. How did natural selection affect the rabbit population when the forest was not covered with snow?

11

3. How did natural selection affect the rabbit population when the forest became snow covered?

Name _____ Date _____ Class _____

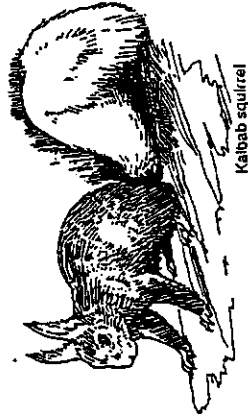
Use after Section 7-2.

Chapter 7 Mechanisms of Evolution

Squirrels of the Grand Canyon

Along the north rim of the Grand Canyon lives the black Kaibab squirrel. Across the canyon—only a few kilometers from rim to rim—lives the Abert squirrel. Both species have big, tufted ears. However, the Kaibab has a flashy white tail, and the Abert has a gray tail and body and a white belly. Scientists believe these two different species of squirrels were once one population that was divided as the Grand Canyon developed. Through natural selection, the squirrels on each side of the canyon developed different characteristics.

You might wonder how a canyon a few kilometers wide could separate a population and lead to the development of two species. What isolates these squirrels is more than a canyon, however. They are also separated by an environment that is totally different from the one found on both rims of the canyon. The temperature on the rims is cool. In the canyon it is much warmer and drier. Furthermore, the vegetation in the canyon is unlike that on the rims. Some of the squirrels may, indeed, visit the canyon from time to time, but are turned back by the very uncomfortable conditions in the canyon. The squirrels quickly return to their familiar, agreeable surroundings. The ecological barrier of the canyon is far wider and harder to cross than the deep chasm carved through the rocks.



Kaibab squirrel



Abert squirrel

1. What species of squirrel lives on the Grand Canyon's north rim?

2. What species of squirrel lives on the Grand Canyon's south rim?

3. How does the Kaibab squirrel differ from the Abert squirrel?

12

4. Since either species of squirrel can easily cross the canyon and climb up the canyon walls, what isolates these two different species?