Name_____ Class_____ Date_____

C. USE AND DISUSE. In the early 1800's the French scientist **Jean Lamarck** presented a theory of evolution called the **theory of use and disuse**. Lamarck thought that organisms were able to develop new structures because they *needed* to adapt to changes in the environment. He also believed that the size of an organ was determined by how much the organ was used. According to Lamarck's theory, ballet dancers have big strong muscles because they need strong muscles and when a dancer doesn't need a certain muscle the muscle becomes smaller and weaker.

Lamarck also believed in the **inheritance of acquired characteristics.** He stated that the useful traits an individual develops during its lifetime are passed on to its offspring. For example, according to Lamarck the children of dancers inherit their parent's strong muscles. An **acquired characteristic** is a trait that is produced during an individual's lifetime. Strong muscles in dancers is an example of an acquired characteristic.

Lamarck's theories were widely accepted for a long time. However, as time passed, scientists began to challenge his theories by showing that there was no data to support Lamarck's hypothesis. For example, scientific data proved that dancer's children are not born with big strong muscles and that strong muscles are acquired through excercise during an individual's lifetime.

Review Questions

1. Lamarck believed that organisms developed new structures because they _____ them.
2. An _____ is a trait that is produced during an individual's lifetime.

Name_____ Class_____ Date_____

D. DISPROVING LAMARCK'S THEORY. The idea that acquired traits are inherited was officially disproved in the late 1800s by the experiments of **August Weismann**. Weismann cut off the tails from mice. He then mated the tailless mice. He did this for many generations. The offspring of the tailless mice were always born with normal length tails (Figure 27-3). This experiment proved that acquired traits *are not* inherited by offspring.

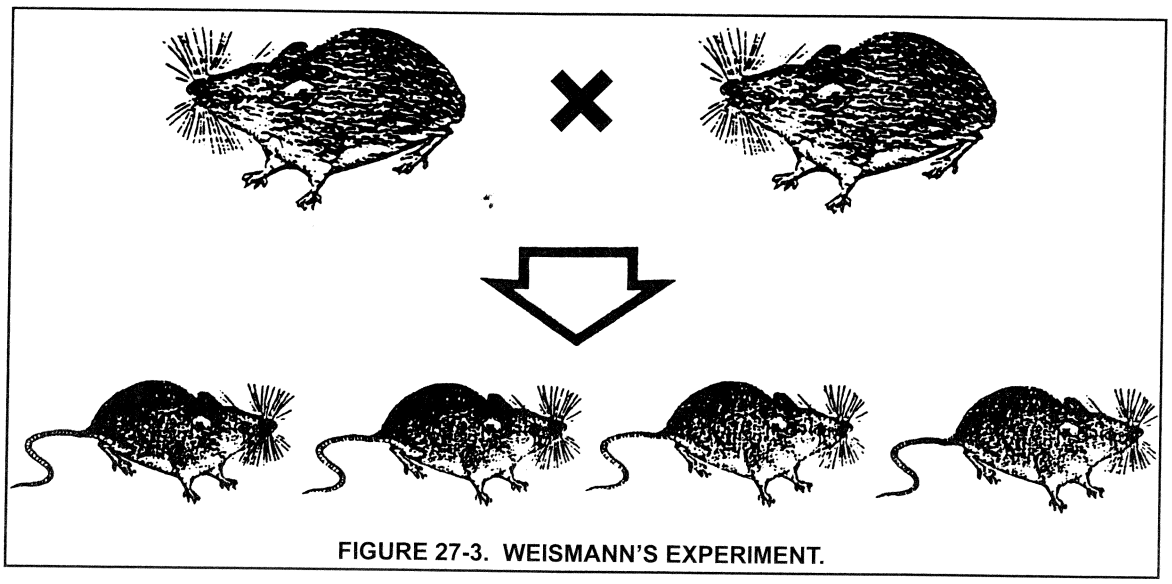


FIGURE 27-3. WEISMANN'S EXPERIMENT.

REVIEW QUESTIONS

1. The theory of acquired characteristics was disproved by _____.
2. Describe Weismann's experiment. _____

_____

E. DARWIN'S THEORY. In the 1850's, the **theory of natural selection** was proposed by **Charles Darwin**. During his travels he noticed that a certain species in one geographic area was different from the same species in another area. His theory of evolution was developed to explain the gradual change in species. According to Darwin evolution occurs because of **natural selection.** That is, *nature (environment) acts as the selecting agent of an organism's traits*. Darwin believed organisms better adapted to the environment survive and reproduce more successfully than organisms not as well adapted. Natural selection suggests that traits that help an organism survive in a changing environment are passed on to the next generation. [Although Darwin is given credit for the theory of natural selection another scientist, Alfred Wallace, proposed a theory of evolution that was quite similar to Darwin's theory.]

The main ideas of Darwin's theory are listed on the next page. This theory is the basis for the modern theory of evolution. There were some questions that Darwin could not answer. For example, Darwin's theory of evolution did not include the genetic basis of variations. He did not know about genes, chromosomes, and mutations. He also did not know the difference between acquired variations and inherited variations.

Name_____ Class_____ Date_____

Darwin's Theory of Natural Selection

- **Overproduction:** A population generally produces more offspring than can survive in the environment. For example, a fish must lay millions of eggs to reproduce a small number of new fish.
- **Competition:** Because of overproduction there is competition, or a ***"struggle for survival,"*** between organisms for space, food, water, light, minerals, or other limited resources.
- **Variations:** Members of a population show variations (differences in traits) that make certain individuals better adapted to survive. Differences in structure, size, and color are examples of variations.
- **Natural Selection:** Since some variations are more helpful than others, there is a natural selection against organisms that cannot adapt. Organisms that cannot adapt, die.
- **Survival of the Fittest:** ***"Survival of the fittest"*** applies to those individuals that have variations that enable them to live and reproduce. In a woodland environment brown fur color would be a helpful variation and white fur color would not be helpful.
- **Inheritance of Variations:** Organisms with helpful variations are more likely to survive and to reproduce and pass these variations to their offspring.
- **Evolution of New Species:** Over long periods of time variations accumulate in a population. Eventually there are so many variations that the population becomes a new species.

Review Questions

1. Charles Darwin proposed the theory of _____.
2. Darwin did not know about _____, _____, and _____. He also did not know the difference between _____ and _____.
3. List the seven steps of Darwin's theory. _____

F. COMPARING LAMARCK AND DARWIN. It is a fact that the ancestor of the modern long-necked giraffe had a short neck. Lamarck would have explained the change in the giraffe's neck by saying that the giraffe's ancestor was a grass-eating, short-necked animal. When the grass became scarce the giraffes needed to stretch their necks to reach for food and each generation had to stretch

more and more to reach food. Because of this, each generation inherited a slightly longer neck. The longer neck was passed on to the next generation.

Darwin would have said that the giraffe's ancestors had different length necks. Through natural selection giraffes with longer necks could reach higher for food and they survived. Short-necked giraffes starved and died. Long-necked giraffes passed on their long-necked traits to their offspring (Table 27-1).

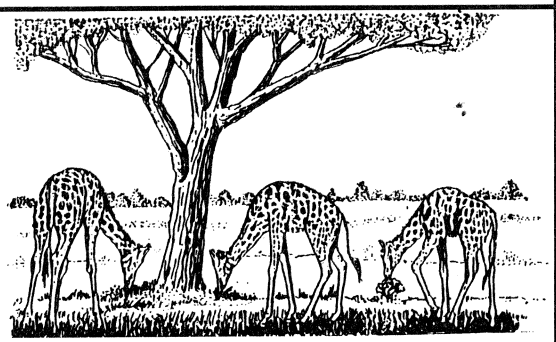
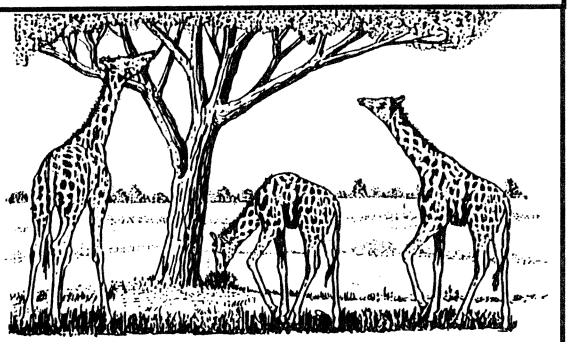
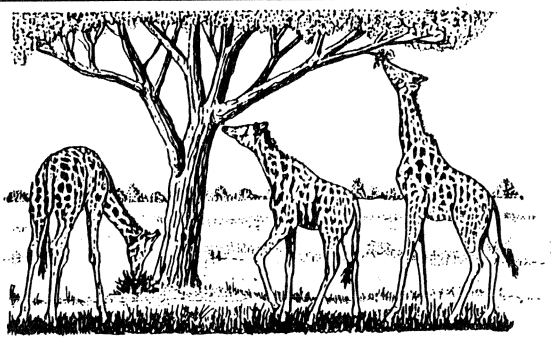
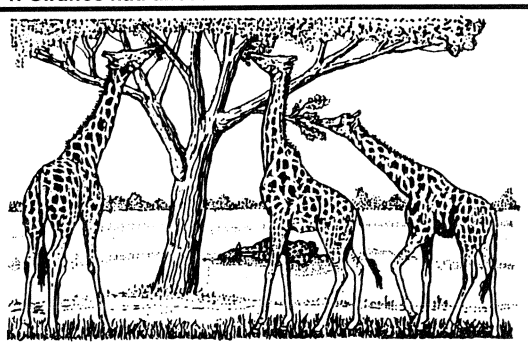
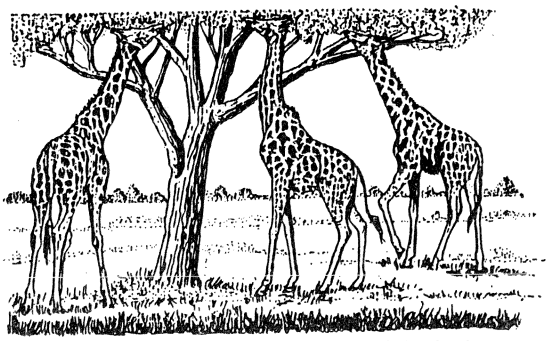
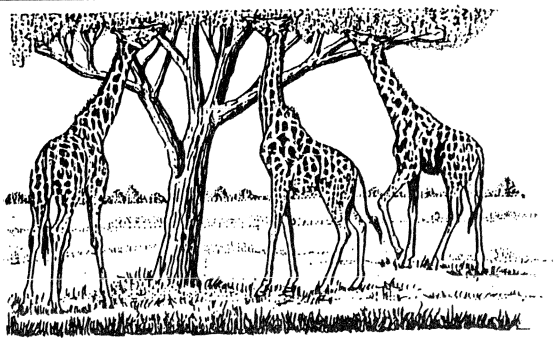
LAMARCK	DARWIN
 1. Giraffes had short-necked ancestors.	 1. Giraffes had ancestors with different sized necks.
 2. Giraffes stretched their necks because they needed to reach for food.	 2. Through natural selection long necked giraffes lived and short-necked giraffes died.
 3. Due to stretching, every generation inherited a slightly longer neck.	 3. Long-necked giraffes passed down the long-necked trait to their offspring.

TABLE 27-1. COMPARING THE THEORIES OF LAMARCK AND DARWIN.

Name _____ Class _____ Date _____

Review Questions

1. How would Lamarck explain the change in the length of the giraffe's neck?

_____

_____

_____

_____

_____

2. How would Darwin explain the change in the length of the giraffe's neck?

_____

_____

_____

_____

G. MUTATION THEORY. Darwin could not account for his observations that variations existed among organisms. In 1901, a scientist named **Hugo DeVries**, suggested that inherited mutations caused variations. He believed that mutations (changes in genetic material) occurred randomly and those mutations that were favorable were inherited by offspring. He would have said that the change in the length of the giraffe's neck was caused by a sudden mutation. Short-necked giraffes, according to DeVries, suddenly reproduced a mutant long-necked giraffe. It reproduced and produced more long-necked giraffes. When the ground food supply disappeared the long-necked giraffes could reach leaves in trees and were able to survive. The short-necked giraffes died and the long-necked giraffes lived, therefore, today we have a population of long-necked giraffes. DeVries based his theory on his reproduction experiments with the evening primrose plant.

Review Questions

1. DeVries believed that _____ were responsible for variations in organisms.

H. MODERN THEORY. Modern evolutionary theory combines Darwin's ideas of variations and natural selection with studies of mutations, DNA, genes, chromosomes, and sexual reproduction and genetic recombination. The modern theory of natural selection states that:

Modern Theory of Natural Selection

- The genes of inherited variations that give an organism a better chance for survival tend to be passed on from parents to offspring.
- These favorable genes tend to increase in numbers within a population.
- Genes for traits with low survival value decrease in numbers from generation to generation.
- If the environment changes genes that previously were neutral or had low survival value may become favorable and increase in numbers.

Name_____ Class_____ Date_____

A scientist today might say that the evolution of the giraffe's neck started with the overproduction of short-necked, grass-eating giraffes. When the ground food supply disappeared there was no food for the short-necked giraffes. Due to random mutations some giraffes had longer necks and were able to eat tree leaves. The giraffes with the favorable long-necked mutations survived and produced more long-necked giraffes. The giraffes with short necks died. Over time other long-neck mutations occurred that had positive survival value. An accumulation of mutations with positive survival value resulted in a new long-necked giraffe species.

Review Questions

1. Modern evolutionary theory combines Darwin's ideas of _____ and _____ with studies of _____, _____, _____, _____, and _____, and _____.

2. List the four parts of the theory of natural selection. _____

_____

_____

_____

_____

_____

_____

I. EVOLUTION IN OUR TIME. In modern times there have been many opportunities for scientists to observe evolution in progress. For example in some areas, such as the Adirondack Mountains in New York State, DDT was sprayed to kill a black fly insect pest. DDT is an **insecticide**–a chemical that kills insects. After a few sprayings most of the black flies disappeared but some black flies had genes that made them resistant to DDT. When the environment was free of DDT, these resistant genes did not have positive survival value. However, when the environment changed (was sprayed with DDT), the DDT-resistant gene suddenly had positive survival value. Since most of the black flies that had no resistant gene had been killed, there was little competition for food. The black flies with resistant genes rapidly increased in numbers. Within a couple of years the DDT-resistant black flies had reproduced in such large numbers that they were again pests to the inhabitants of the Adirondacks. *(DDT spraying has since been banned in New York State and a black fly population with no resistance to DDT is reappearing.)*

Another organism that evolved during modern times is the *Staphylococcus* bacteria. When antibiotics were first used some *Staphylococcus* bacteria had genes that made them resistant to antibiotics. When the use of antibiotics became widespread the bacteria with resistant genes increased in numbers producing a population of bacteria that was not killed by antibiotics. Even today scientists continuously develop new antibiotics because the bacteria population mutates and produces new antibiotic-resistant strains. ***Remember that mutations are not caused by environmental change. Mutations occur randomly.*** Mutations with positive survival value allow

organisms to be better adapted to their environment. The *environment selects* those variations, or adaptations, that may have survival value. You learned in a previous chapter that an adaptation is a structure or function that enables an organism to live and successfully reproduce in a particular environment.

The **English peppered moth** is an example of an organism that adapted to a changed environment. The evolution of English peppered moth has been observed for over 100 years in Manchester, England. Peppered moths have two basic colors–light color with dark markings or dark color with light markings. Before the industrial revolution most peppered moths were light colored. This enabled them to blend with their light-colored environment such as the trunks of trees and the sides of buildings (Figure 27-4). When they blended with the environment, the light-colored moths were almost invisible and insect-eating birds could not see them.

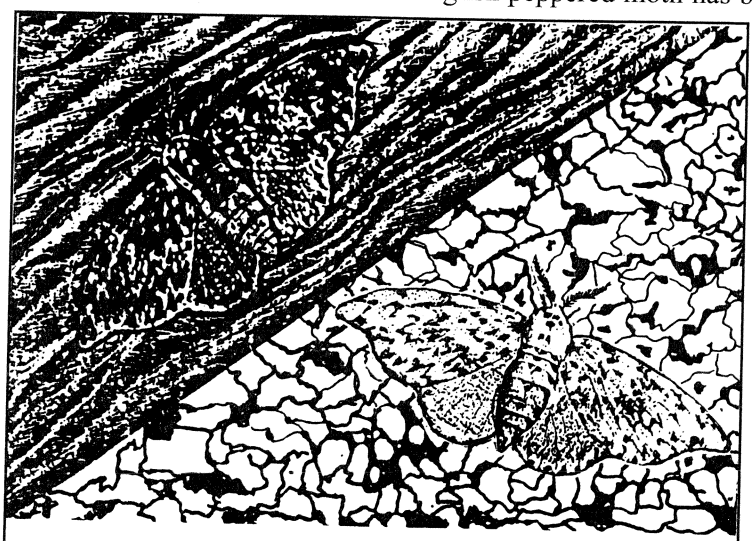


FIGURE 27-4. ENGLISH PEPPERED MOTH.

The soot and other air pollutants from the industrial revolution gradually changed the environment from light to dark. The light-colored moths became visible and were eaten by birds. The dark-colored moths could not be seen against the dark background. These moths reproduced more dark moths and the population shifted from light to dark-colored. Recently, as a result of environmental pollution laws, the moth population is slowly changing back to light-colored moths.

Sometimes plant and animal breeders purposely modify organisms by mating plants and animals that have certain desirable traits. This process is called artificial selection. **Artificial selection** involves the mating of organisms with a particular desirable trait to produce offspring with this trait. For example, racehorses and greyhounds have been produced that are faster than their predecessors. By selective breeding, man may cause evolution. In natural selection, *nature* acts as the selecting agent. In artificial selection, *humans* are the selecting agents.

Review Questions

1. Name three organisms that have evolved in modern times. _____

   _____

2. Describe the process of artificial selection. _____

   _____

   _____

   _____

Name_____ Class_____ Date_____

J. GEOGRAPHIC ISOLATION. Geographic isolation occurs when a population is physically separated into smaller populations by geographic barriers. **Geographic barriers** could be mountain ranges, deserts, oceans, rivers, or other bodies of water (Figure 27-5). Even humans make geographic barriers when they construct big expressways and shopping malls.

Changes may occur in these separated populations that, over a long period of time, may result in the production of different species. The production of a new species is known as **speciation.** Speciation occurs when members of the isolated population and the main populations can no longer interbreed even when the barriers are removed. This is known as **reproductive isolation**. Geographic isolation may result in reproductive isolation.

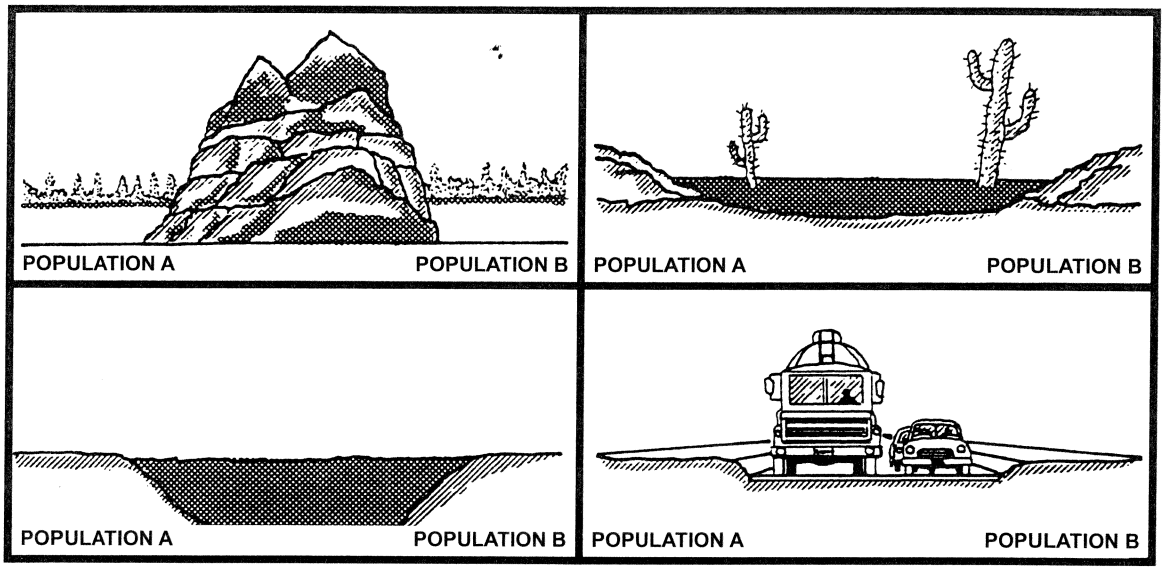


FIGURE 27-5. TYPES OF GEOGRAPHIC ISOLATION.

A common example of geographic isolation is that of the Kaibab and Abert squirrels that live in the Grand Canyon. Scientists believe that these two squirrel species developed from a single ancestral species that was separated geographically. The Kaibab squirrel lives on one side of the canyon and has a white tail, long ears, and a dark-colored body. The Abert squirrel lives on the other side of the canyon. It has a gray tail, long ears and a light-colored abdomen. The canyon is thought to be the geographic barrier that divided one squirrel species into two separate groups. One group of squirrels became isolated from the other. Over time different mutations occurred on either side of the canyon. Today the squirrels are so genetically different that they can not interbreed.

REVIEW QUESTIONS

1. Geographic isolation occurs when _____

_____

2. Name three geographic barriers. _____

_____

3. The production of a new species is called _____.

4. _____ occurs when population can no longer interbreed.

K. ADAPTIVE RADIATION. Adaptive radiation is the process by which many new species of organisms evolve from a common ancestor. The new species evolve and fill different environmental niches where there is less competition. A **niche** is the role an organism plays in a particular environment. A niche includes an organism's feeding habits, where it lives, how it reproduces, and its other life activities. Organisms may move into new niches in the environment because of chance mutations that prove to have positive adaptive value. A positive adaptation is one that allows an organism to live successfully in a new niche. If there is little competition in the new niche the organism has a better chance to survive and reproduce.

During his travels to the Galapagos Islands, a group of islands that are isolated from the mainland of South America, Darwin saw may different and unusual animal species. One of the populations that he observed was a finch (a small bird) population. He wrote that there were 13 different finch species living on the islands. He noticed that their beak shapes were very different (Figure 27-6). The beak differences allowed the birds to live in different niches based on the type

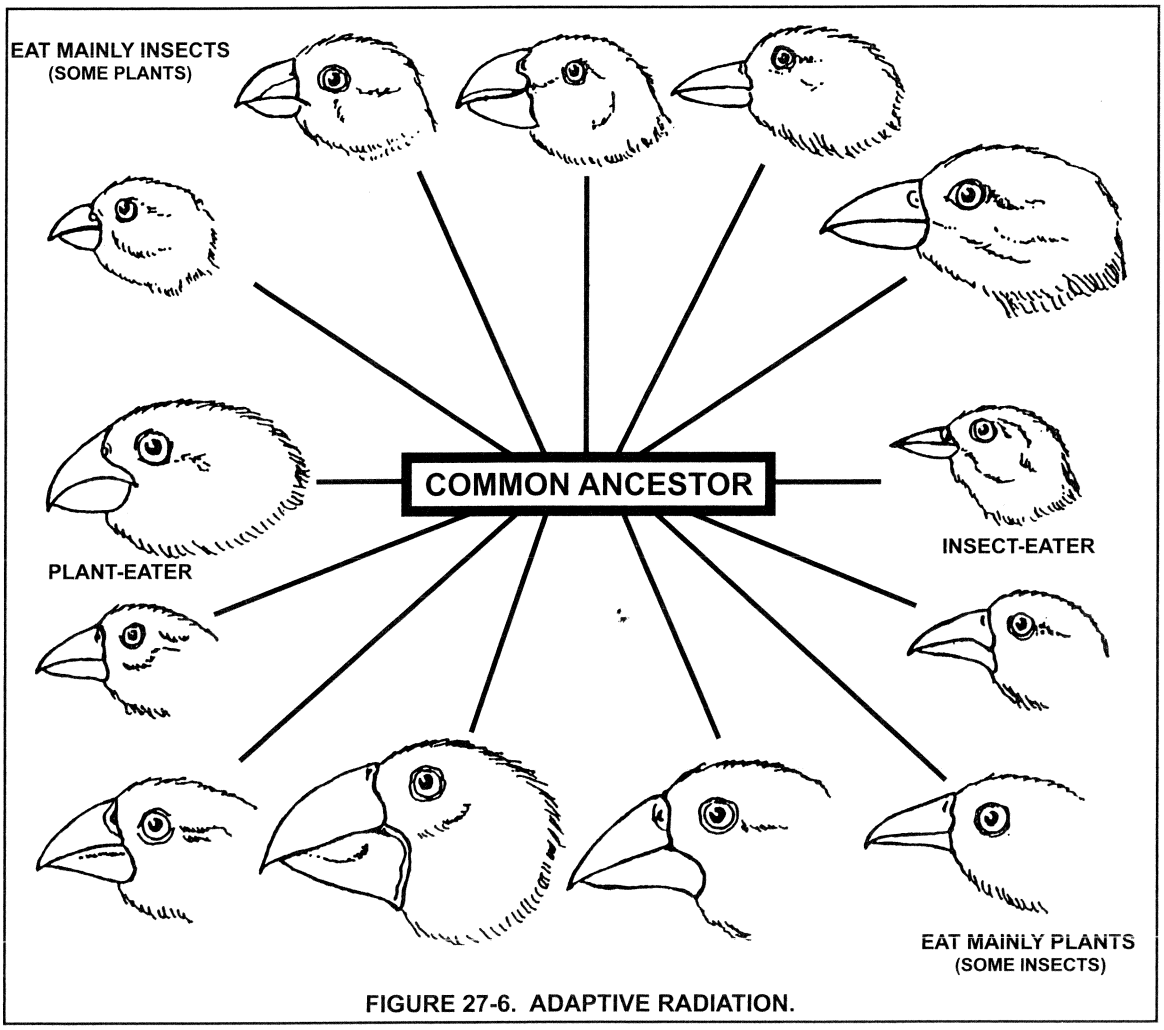


FIGURE 27-6. ADAPTIVE RADIATION.

of food they ate. Darwin thought the finches had evolved from one common ancestor. Darwin did not know why birds with beaks that were different from their parents were produced. He guessed that the new beaks gave the finches new feeding niches where there was less competition for food. For example, he saw a large ground finch with a blunt powerful beak for breaking open hard seeds. Because it could eat bigger seeds than other ground finches, it was not in direct competition with smaller birds. Therefore, the smaller birds could successfully inhabit one niche and the large birds inhabited another niche. Over time other mutations occurred and eventually many different finch species were produced.

Review Questions

1. Adaptive radiation is the process by which _____
_____
2. Darwin's finches are an example of _____.
3. A _____ is the role an organism plays in a particular environment.

L. RATE OF CHANGE. Although most scientists agree with the current facts of modern evolution theory, they do not agree on the time frame for evolutionary change–whether it was a slow, gradual, and continuous process or whether there were stable times interrupted by major disturbances.

The theories of **gradualism** and **punctuated equilibrium** are attempts by scientists to answer the question of the evolution rate.

Time Frame For Evolutionary Change

- **Gradualism.** A theory that proposes that evolutionary change is slow, gradual, and continuous. New species arise by the very gradual collection of minor changes in a population.
- **Punctuated Equilibrium.** A theory that proposes that species are relatively stable for long periods of time (several million years). This stability is interrupted by brief periods during which major changes occur. These changes result in the evolution of new species. According to this theory, the minor changes that occur in a population over time might produce new varieties of an existing species but not a new species.

Review Questions

1. Scientists do not agree on the _____ for evolution.

Name_____ Class_____ Date_____

2. Explain the differences between gradualism and punctuated equilibrium.