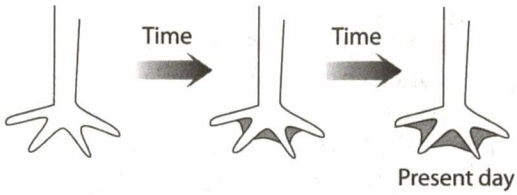
Review Questions

24. The changes in the foot structure in a bird population over many generations are shown in the diagram below.



These changes can best be explained by the concept of

(1) natural selection
(2) extinction
(3) stable gene frequencies
(4) cloning

25. Explain how the lack of genetic diversity found in populations of endangered species might hinder their recovery. [1]

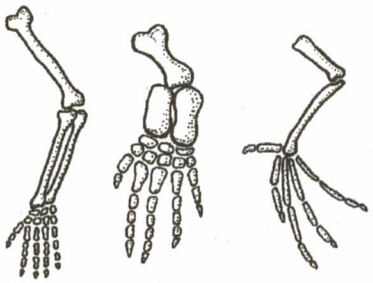
26. The Florida panther, a member of the cat family, has a population of fewer than 100 individuals and has limited genetic variation. Which inference based on this information is valid?

(1) These animals will begin to evolve rapidly.
(2) Over time, these animals will become less likely to survive in a changing environment.
(3) These animals are easily able to adapt to the environment.
(4) Over time, these animals will become more likely to be resistant to disease.

27. Which statement could be used as evidence to show that two different species of organisms most likely developed from a single, common ancestor?

(1) They eat the same types of food.
(2) They have different digestive enzymes.
(3) They lived during the same time period.
(4) They contain similar amino acid sequences.

28. The diagrams below show the bones in the forelimbs of three different organisms.



Differences in the bone arrangements support the hypothesis that these organisms

(1) are members of the same species
(2) may have descended from the same ancestor
(3) have adaptations to survive in different environments
(4) all contain the same genetic information

29. In most populations, the individuals that produce the greatest number of offspring are

(1) always the strongest
(2) usually the best adapted
(3) those that have only inheritable traits
(4) those that are the most intelligent

30. The best scientific explanation for differences in structure, function, and behavior found in different species of organisms is provided by

(1) carbohydrate electrophoresis
(2) population chromatography
(3) the theory of carrying capacity
(4) the theory of evolution

Patterns of Change

Evolution appears to follow certain patterns that appear repeatedly in the fossil record. For example:

- Changes in species are often related to environmental change.
- Species with short reproductive cycles that produce many offspring tend to evolve more quickly than species with long lifespans and few offspring.
- The failure to adapt to a changing environment may result in the death of the species.

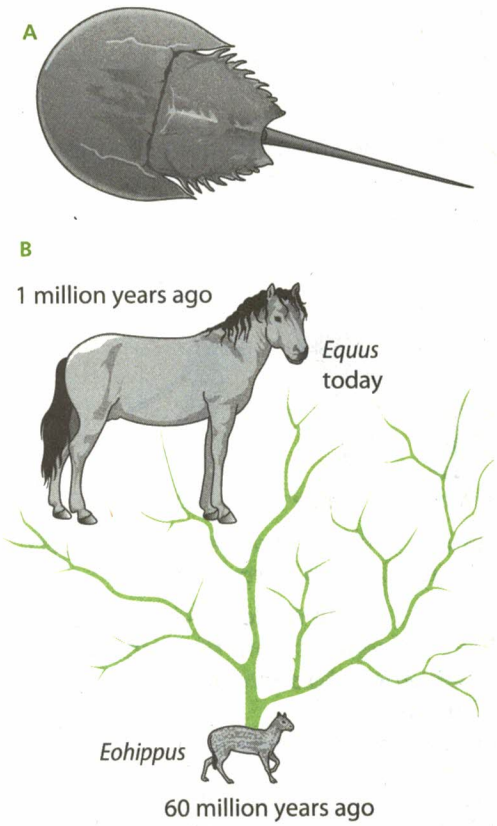


Figure 5-7. The rate of evolution: For some species, the rate of evolutionary change has been very slow. For example, the horseshoe crab (A) has shown little change from fossils of its ancestors that lived 300 million years ago. However, the horse (B) has evolved tremendously over the past 60 million years.

The Rate of Evolution

Most of the diversity of life on Earth today is believed to be the result of natural selection occurring over a vast period of geologic time. The amount of change seems to be linked to changes in the environment. Minimal environmental change often results in stable populations. Rapid environmental change often leads to rapid changes in species. However, for any species, it may take millions of years to accumulate enough differences from its ancestors to be classified as a new or different species. As shown in Figure 5-7, some species have hardly changed in many millions of years. Others have changed so much that the relationships may not be obvious.

The rate of evolutionary change may also be influenced by the number of offspring produced by a species. Those that have few offspring and live a long time generally evolve quite slowly. Those that have brief lifespans and numerous offspring can change so quickly that evolution may occur in just a few years.

One example of rapid change involves the evolution of antibiotic resistance by pathogenic bacteria. When a population of millions of bacteria is exposed to an antibiotic, there is a chance that a few might have a gene that makes them resistant to the antibiotic. (This gene probably occurred as a chance mutation at some earlier time. It was most likely present in some of the bacteria before the antibiotic was used, and its appearance was totally unrelated to the presence of the antibiotic.) The antibiotic could kill almost all of the bacteria except for a few that escape exposure to the antibiotic. The ones with the resistance gene would also survive.

Because the antibiotic eliminated most of the competition, the few survivors, including the resistant ones, reproduce quickly, giving rise to a new population of the bacteria. In this new population, a higher proportion of individuals is now resistant to the drug. When the same antibiotic is used on the descendants of this new population, even more resistant bacteria will survive. Now the proportion of resistant bacteria is even higher. In this case, the antibiotic has become an agent of selection. The antibiotic did not cause the original mutation that made the bacteria resistant to the antibiotic. It merely determined which bacteria would live to reproduce. Figure 5-8 shows the process.

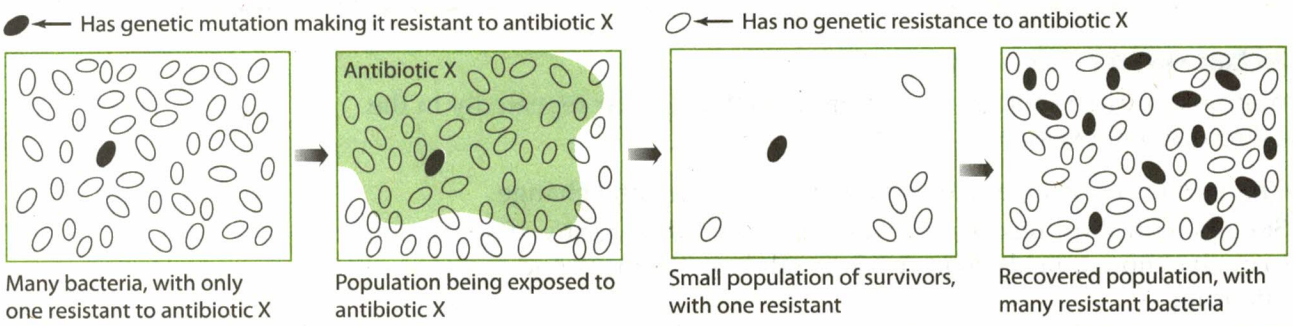


Figure 5-8. How resistance to antibiotics can develop

Insects also have short reproductive cycles and produce many offspring. Many insect species have changed significantly in response to pesticide use. For example, the widespread use of the pesticide DDT led to insect species becoming resistant in just a few years. As was the case with bacteria and antibiotics, there may have been a few DDT-resistant insects in the population before the chemical was ever used. They probably had a random mutation that had no adaptive value before the use of DDT. Once the DDT was sprayed, nearly all of the nonresistant insects were killed, leaving a high proportion of resistant insects to repopulate the area. Later, if DDT was sprayed again, it was less effective against the resistant offspring of the survivors of the earlier spraying.

As a result of these kinds of rapid evolutionary events, we are finding more and more bacteria that are resistant to antibiotics and more and more insect species that are resistant to our pesticides. This has created many problems in the fields of medicine and agriculture and will continue to be a problem in the future.

Extinction

Extinction is the disappearance of an entire species. Any time the death rate of individuals within a species is greater than the birth rate, extinction is a possibility. Generally, extinction occurs when the environment changes. Temperatures change; sea levels rise and fall. Grasslands become deserts; clear lakes become polluted. The variation of organisms within a species increases the likelihood that at least some members of the species will survive the changing environmental conditions. However, when the adaptive characteristics of a species are insufficient to allow its survival in a new environment, the species will become extinct.

The fossil record shows that throughout geologic time, millions of species have evolved, survived for a while, then failed to adapt successfully, and finally became extinct. It is a surprisingly common process. In fact, from the number of fossils of extinct organisms found, it is apparent that a majority of the species that ever lived on Earth is now extinct. Figure 5-9 shows a fossil of the extinct *Archaeopteryx*, an ancestor of modern birds.

Figure 5-9. An artist's conception of how the extinct *Archaeopteryx* might have looked, and the fossilized skeleton of this animal.

Review Questions

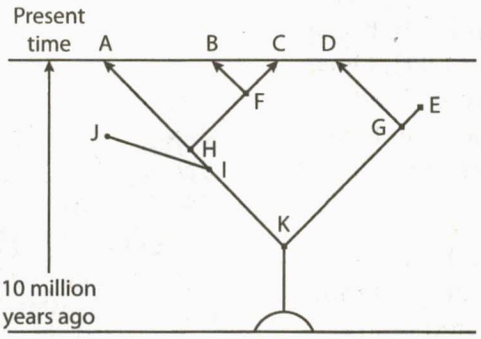
31. The shark has changed very little in the last 50 million years. Which statement best explains why this is the case?

(1) The shark is well adapted to its relatively unchanged environment.
(2) Sharks have a high reproductive rate and show little change in their genetic makeup from one generation to the next.
(3) Sharks need to change only if humans are present in their environment.
(4) Sharks have a high mutation and genetic recombination rate.

32. Many animals exist today in a form that is almost identical to the form they had a million years ago. What is the most probable explanation for this lack of evolutionary change?

(1) Genetic mutations have occurred among these animals.
(2) The environment of these animals remained about the same.
(3) These animals reproduce by sexual reproduction.
(4) Complex organisms evolved into simpler ones.

Base your answers to questions 33 through 35 on the diagram below and on your knowledge of biology. The diagram shows an interpretation of relationships based on evolutionary theory. The letters represent different species.



33. Explain why species B and C are more closely related than species A and C are.

34. The diagram indicates that a common ancestor for species C and E is species

(1) F (2) G (3) H (4) K

35. Which species are least likely to be vital parts of a present-day ecosystem?

(1) A and E
(2) C and D
(3) E and J
(4) B and F

Base your answers to questions 36 and 37 on the information below and on your knowledge of biology.

Joshua Lederberg discovered that, in a large population of Escherichia coli (E. coli) about 1 in 10 million of the offspring was naturally resistant to the antibiotic streptomycin. When these naturally resistant bacteria were isolated and grown separately, they soon formed a larger population. The entire population so formed was also naturally resistant to streptomycin.

36. The formation of the large streptomycin-resistant population is based on

(1) variations and survival of the fittest
(2) mutations and asexual reproduction
(3) sexual reproduction and no mutations
(4) survival of the fittest and cloning

37. According to modern evolutionary theory, the resistance to streptomycin probably resulted directly from

(1) culturing the *E. coli*
(2) changes in temperature under which *E. coli* are grown
(3) a change in the DNA of *E. coli*
(4) the presence of streptomycin in the environment of *E. coli*

38. A large population of cockroaches was sprayed with a newly developed, fast-acting insecticide. The appearance of some cockroaches that are resistant to this insecticide supports the concept that

(1) species traits tend to remain constant
(2) variation exists within a species
(3) insecticides cause mutations
(4) the environment does not change

39. Compounds like the pesticide DDT may bring about the evolution of new strains of organisms by

(1) destroying food producers
(2) acting as a natural selecting agent
(3) mixing two different sets of genes
(4) creating new ecological niches

40. A population of mosquitoes is sprayed with a new insecticide. Most of the mosquitoes are killed, but a few survive. In the next generation, the spraying continues, but still more mosquitoes hatch that are immune to the insecticide.

How could these results be explained according to the present concept of evolution?

(1) The insecticide caused a mutation in the mosquitoes.
(2) The mosquitoes learned how to fight the insecticide.
(3) A few mosquitoes in the first population were resistant and transmitted this resistance to their offspring.
(4) The insecticide caused the mosquitoes to develop an immune response, which was inherited.

41. Throughout the history of Earth, which factor has probably been the chief cause of the extinction of various species?

(1) people's interference with nature
(2) failure to adapt to environmental changes
(3) warfare within the species
(4) volcanic eruptions

42. Fossil evidence indicates that many species have existed for relatively brief periods of time and have then become extinct. Which statement best explains the reason for their short existence?

(1) These organisms lacked the energy to produce mutations.
(2) Humans modify plant and animal species through the knowledge of genetics.
(3) These organisms lacked variations having adaptive value.
(4) Within these species, increasing complexity reduced their chances of survival.