exaggeration. For example, during no stage of development does a gorilla look like an adult fish. In the early stages of development, all vertebrate embryos are similar, but those similarities fade as development proceeds. Nevertheless, the similarities in early embryonic stages of vertebrates can be taken as yet another indication that vertebrates share a common ancestry.

Similarities in Macromolecules

Darwin hypothesized that more-similar forms of organisms have a more recent common ancestor than do less-similar forms. He arrived at this hypothesis by observing anatomical features only. He could not have known how true this rule would prove at the molecular level—for homologous proteins, as well as RNA and DNA molecules. For example, many species have the red-blood-cell protein, hemoglobin. The amino acid sequences in the hemoglobin molecules of different species are similar, but not identical. The amino acid sequences in human hemoglobin and gorilla hemoglobin differ by one amino acid, while the hemoglobin molecules of humans and frogs differ by 67 amino acids. The number of amino acid differences in homologous proteins of two species is proportional to the length of time that has passed since the two species shared a common ancestor. Thus, the more-similar the homologous proteins are in different species, the more closely related the species are thought to be. Information provided by molecular biology can confirm the evolutionary histories suggested by fossils and anatomy.

FIGURE 15-9

This is a modernized version of Haeckel's drawings of embryological stages in different species. Although modern embryologists have discovered that Haeckel exaggerated some features in his drawings, it is true that early embryos of many different vertebrate species look remarkably similar.

PATTERNS OF EVOLUTION

There are several ways that species can change to adapt to their habitats. The pattern and speed of evolutionary change result from the changing requirements of the environment.

Coevolution

The change of two or more species in close association with each other is called **coevolution.** Predators and their prey sometimes coevolve, parasites and their hosts often coevolve, and plant-eating animals and the plants they feed on also coevolve. One example of coevolution is plants and the animals that pollinate them.

In tropical regions, some species of bats feed on the nectar of flowers, as shown in Figure 15-10. These bats have a slender muzzle and a long tongue with a brushlike tip, which aid them in feeding. The fur on the bat's face and neck picks up pollen, which the bat takes to the next flower. Flowers that have coevolved with these bats are light in color, enabling the bats, which are active at night, to easily locate them. The flowers also have a fruity odor that is attractive to bats.

FIGURE 15-10

Some species of bats, such as this long-nosed fruit bat, have coevolved with the flowers they feed on.

VISUAL LINK
Figure 15-9

Ask students to study the embryos shown in Figure 15-9. Ask them what characteristics the earliest stages of the embryos shown have in common (tail, skull, eyes, etc.). Ask them to infer what the common ancestor of the vertebrates looked like. (It probably had a skull and other bones, a tail, and prominent eyes, etc.)

CRITICAL THINKING
Cytochrome *c* Similarities

Human and chimpanzee cytochrome *c* proteins are identical in all 104 of their amino acids. How can you explain the lack of difference between these two animals' cytochrome *c*? (This protein is only one of thousands of proteins in each of these animals. Two animals are different from each other because of the sum of all their biochemical differences.)

TEACHING STRATEGY
Coevolutionary Relationships

Obtain a variety of pictures of flowering plants and the insect pollinators with which they have coevolved. First show the students the pictures of the flowers, and ask them to study them and predict what kind of insect might pollinate each. Then show students the pictures of the insect pollinators, and have them try to match up the flowers with their pollinators. (Some examples to include are bee orchids and their bee pollinators, wasp orchids and their wasp pollinators, carrion flowers and their fly pollinators, and figs and their fig-wasp pollinators. Botany and entomology textbooks would be good sources of these pictures.)