Developmental and Anatomical Evidence

At a very early stage, and before homeobox genes begin to make differences in body form, many seemingly different animals show striking similarities. As a general rule, organisms that resemble each other in their development are more closely related than others with different patterns of development. Even after an embryo begins to take on its adult form, many organisms share anatomical features with each other. Scientists use developmental and anatomical features to make inferences about evolutionary relationships among species.

Developmental Similarities

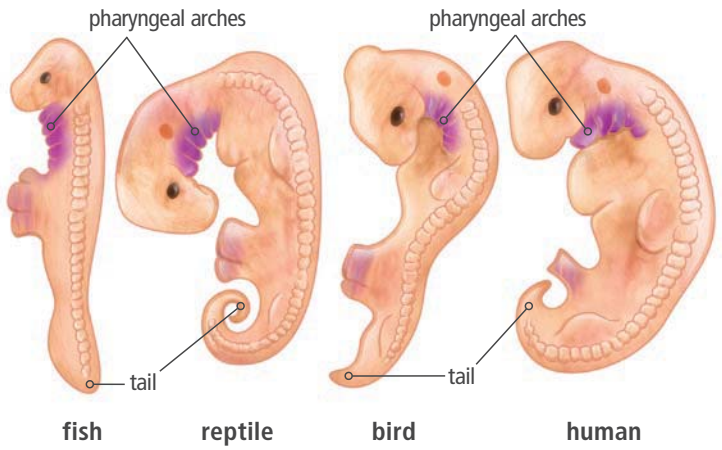
Language Arts Connection

Evolutionary developmental biology is a field of science that compares developmental processes in different organisms. Use library and Internet resources to research some of the latest advances in this field. Choose a study to focus on and make an informational guide to explain how this research has added to our knowledge of development and evolution. Discuss the evidence used to support the researchers' claims and explain how it supports their conclusions.

Invertebrates have an initial larval stage in which many organisms look quite similar, suggesting an evolutionary connectedness. At an early stage, some of these animals look exactly the same to the untrained eye. For example, barnacles and crabs show striking similarities as larvae even though as adults they take on very different body forms and behaviors. Barnacles become stationary animals, attaching to solid structures or larger animals. They must rely on their food to come to them. Crabs, on the other hand, use their legs to move around and capture food.

All vertebrates have three basic body features as embryos—a tail, limb buds, and pharyngeal arches. Note these common features in all four vertebrate embryos shown in Figure 5. Human embryos have a tail and pharyngeal arches, just as fish do. Homeobox genes direct the future development of these structures. Structures that once appeared very similar eventually differentiate in both structure and function. For example, pharyngeal arches become gills in adult fish. In mammals, however, pharyngeal arches develop into ear and throat structures. Biologists use shared developmental patterns as evidence of common ancestry.

FIGURE 5: All vertebrates go through a stage of development with common features.

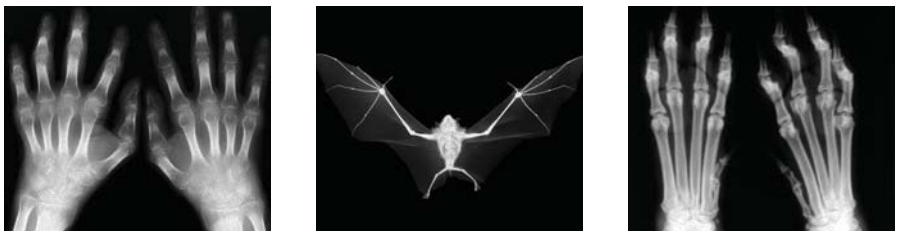


Analyze What similarities do the vertebrate embryos in Figure 5 share? How does this pattern of similarities help support common ancestry?

Anatomical Evidence

Homologous structures are features found in different organisms that share structural similarities but may have very different functions. Their appearance across different species offers strong evidence for common descent. It would be unlikely for many species to have such similar anatomy if each species evolved independently. For example, all four-limbed vertebrates, or tetrapods, share homologous bones in their forelimbs. Figure 6 compares the forelimbs of humans, bats, and dogs. In all of these animals, the forelimbs have several bones that are very similar to each other in appearance despite their different functions.

FIGURE 6: Homologous structures are different in detail but similar to each other in structure and relative location.



a Human hands **b** Bat wings **c** Dog feet

Gather Evidence What patterns do you notice in these structures in terms of similarities? How do the similarities support common ancestry?

Analogous Structures

Homologous structures such as the bat wing and human hand are based on the same underlying body plan, but have diverged into distinct structures because of their use. We do not use our arms and hands the same way that a bat uses its wing. In contrast, analogous structures are structures that perform a similar function but are not similar in origin. Think about the wings of a parrot and those of a dragonfly. Both bird and insect wings have similar shapes and structures because they are both used for flight. However, wings develop differently in birds and insects, and they are made of different tissues. For example, bird wings have bones. In contrast, insect wings do not have bones, only membranes. The similar function of wings in birds and flying insects evolved separately.

FIGURE 7: Bird wings and dragonfly wings are examples of analogous structures.

a Parrot wings **b** Dragonfly wings

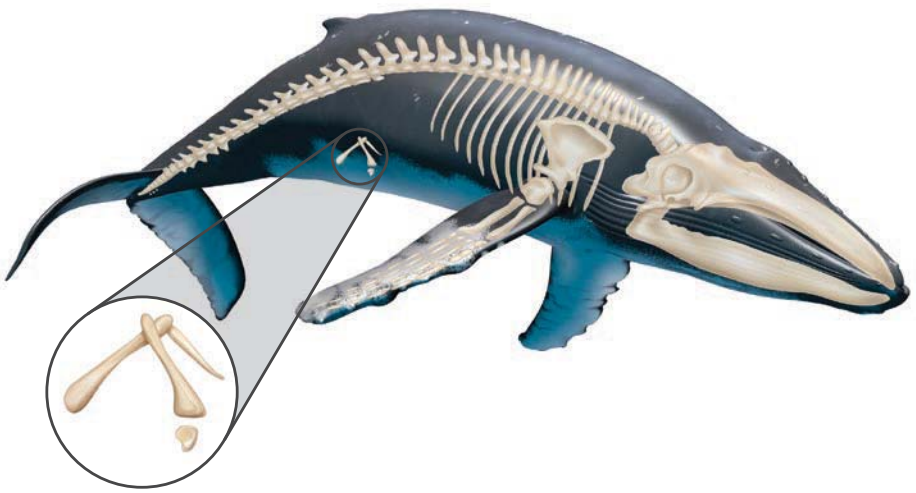
Explain What is the difference between homologous and analogous structures? Which type of structure indicates common ancestry? Explain your answer.

Image Credits: (tl) ©domin_domin/iStockPhoto.com; (tc) ©Nick Veasey/Getty Images; (tr) ©Irina Alyakina/Fotolia; (bl) ©Peter Schoen/Moment/Getty Images; (br) ©asfloro/Fotolia

Vestigial Structures

Anatomical comparisons can shed light on evolutionary relationships between species. Common body structures can become more similar or less similar over time. But what about structures which seem to serve no function at all? Early scientists had trouble explaining why flightless birds have wings or why humans have a tail bone. What we now know is that these vestigial structures are remnants of once-important structures that gradually have lost all or most of their function over time. Vestigial structures provide clues to an organism's evolutionary past. Consider the traces of pelvic bones present in the humpback whale shown in Figure 8. The pelvis normally sits near leg bones, such as the femur in humans.

FIGURE 8: Many whale species have vestigial pelvic and leg bones.



Analyze How does the evidence in Figure 8 support the idea that whales evolved from land mammals?

An example of a vestigial structure in humans is the arrector pili muscle, which makes your hair stand up when you are cold or scared. Goose bumps are caused by this muscle contracting and pulling the hair upward. This process normally creates air pockets to trap air and insulate the body. It also helps animals fluff up their fur to frighten off possible attackers. Humans still have this response, because we share a common ancestor with other mammals. However, we do not have enough hair for the response to serve its original function.

Explain What similarities in anatomical structures provide evidence of a link between the chicken and the *Archaeopteryx*? What additional evidence would help support the claim that these organisms share a common ancestor?