HOMOLOGY VERSUS ANALOGY

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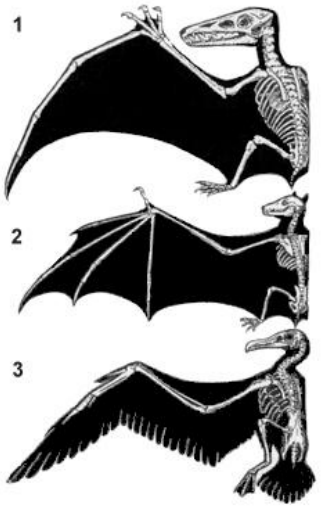
In comparing and contrasting certain traits in organisms, biologists often look at similarities in structure, function, and evolutionary ancestry. Features of animals that have similar structure are classified as homologous if they have a common evolutionary origin, even if they have different functions in different animals. A classic example of homologous structures is that of the wing of a bat and the arm of a human. Both have similar internal bone structure, and as mammals, the evolutionary origin is clearly similar. However, the wing of a bat is utilized for flying, whereas the arm of a person is used to carry items or to perform other tasks and is not suited for flight. Similarly, the leg of a dog, wing of a bird, and fin of a whale are also homologous to the human arm. Such structures are said to have diverged over time, indicating that at one time, they may have had the same function in the common ancestral organism.

Alternatively, many structures that are clearly similar have entirely different evolutionary ancestors. These have converged to have the same or comparable function despite differing origins and are known as analogous or homoplastic structures.Bird wings and insect wings; both features of these organisms allow for flight, but the development of wings on the bird and the insect evolved differently and subsequently converged to allow both to function similarly. By comparing gene sequences in these organisms, it can be shown that birds and insects have most certainly evolved from different parent species, yet gained a similar ability to fly. Observation of these two varying sets of wings would also show that, although they have similar functions, they are structurally different and thus physiologically divergent. In the same way, bird wings (3) are homologous to bat (2) and dinosaur wings (1), as shown in the diagram above.



Homology

The other classification of similar anatomical structures is called homology. In homology, the homologous structures did, in fact, evolve from a recent common ancestor. Organisms with homologous structures are more closely related to each other on the tree of life than those with analogous structures.

However, they are still closely related to a recent common ancestor and have most likely undergone divergent evolution.

Divergent evolution is where closely related species become less similar in structure and function due to the adaptations they acquire during the natural selection process. Migration to new climates, competition for niches with other species, and even microevolutionary changes like DNA mutations can contribute to divergent evolution.

An example of homology is the tailbone in humans with the tails of cats and dogs. While our coccyx or tailbone has become a vestigial structure, cats and dogs still have their tails intact. We may no longer have a visible tail, but the structure of the coccyx and the supporting bones are very similar to the tailbones of our household pets.

Plants can also have homology. The prickly spines on a cactus and the leaves on an oak tree look very dissimilar, but they are actually homologous structures. They even have very different functions. While cactus spines are primarily for protection and to prevent water loss in its hot and dry environment, the oak tree does not have those adaptations. Both structures do contribute to photosynthesis of their respective plants, however, so not all of the most recent common ancestor's functions have been lost. Oftentimes, organisms with homologous structures actually look very different from each other when compared to how close some species with analogous structures look to each other.

Analogy

Analogy, or analogous structures, is actually the one that does not indicate there is a recent common ancestor between two organisms. Even though the anatomical structures being studied look similar and maybe even perform the same functions, they are actually a product of convergent evolution. Just because they look and act alike does not mean they are related closely on the tree of life.

Convergent evolution is when two unrelated species undergo several changes and adaptations to become more similar. Usually, these two species live in similar climates and environments in different parts of the world that favor the same adaptations. The analogous features then help that species survive in the environment.

One example of analogous structures is the wings of bats, flying insects, and birds. All three organisms use their wings to fly, but bats are actually mammals and not related to birds or flying insects. In fact, birds are more closely related to dinosaurs than they are to bats or flying insects. Birds, flying insects, and bats all adapted to their niches in their environments by developing wings. However, their wings are not indicative of a close evolutionary relationship.

Another example is the fins on a shark and a dolphin. Sharks are classified within the fish family while dolphins are mammals. However, both live in similar environments in the ocean where fins are favorable adaptations for animals that need to swim and move in the water. If they are traced back far enough on the tree of life, eventually there will be a common ancestor for the two, but it would not be considered a recent common ancestor and therefore the fins of a shark and a dolphin are considered to be analogous structures.