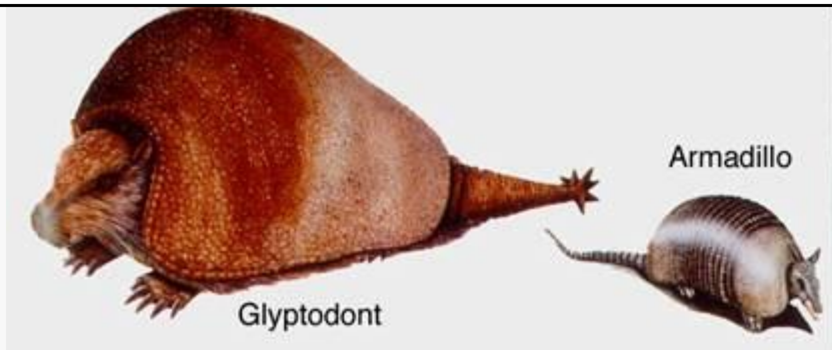
Evolution as Fact

Evolution is a fact.

Organisms descend from others with modification. **Phylogeny, the lineage of ancestors and descendants, is the scientific term to Darwin's phrase "descent with modification."** We can observe evolution. Peter and Rosemary Grant have observed the change in beak sizes in Darwin's finches on the Galapagos Islands. There are countless other examples of the **FACT of evolution (the change in a species over time)**. However, we don't have to rely solely on small-scale observations as evidence for evolution. Scientists use the principle of **uniformitarianism**, which states that **processes identical to those occurring today (e.g., geological uplift, erosion, volcanism, and evolution) also occurred in the distant past**.

Evidence of phylogeny/evolution

1. **Fossil record**



The **fossil record** reveals information about the past and **shows a succession of life forms over time**. Extinct species, such as the fossil glyptodont, most closely resemble extant (living) species, such as the armadillo, in the same area.

In rock strata (layers), changes in the characteristics of organisms can be seen in fossils from earlier strata. The picture at right is of an extinct oreodont, a distant relative of the modern day camel.

Transitional fossils also **reflect changes from ancestors to descendants**. There are many examples of transitional fossils linking one group to another. For example, ***Archaeopteryx*** is a transitional bird fossil that **has both avian/bird** (feathers, wings—with claws—a "wishbone") **and reptilian** (teeth, a tail, and unfused hand bones) **characteristics**. In fact, *Archaeopteryx* would have been classified as a dinosaur if it weren't for its feathers. This and other bird fossils demonstrate that birds descended from a lineage of reptiles. For more information on *Archaeopteryx* click here.

The figure below shows transitional fossils in the whale lineage.

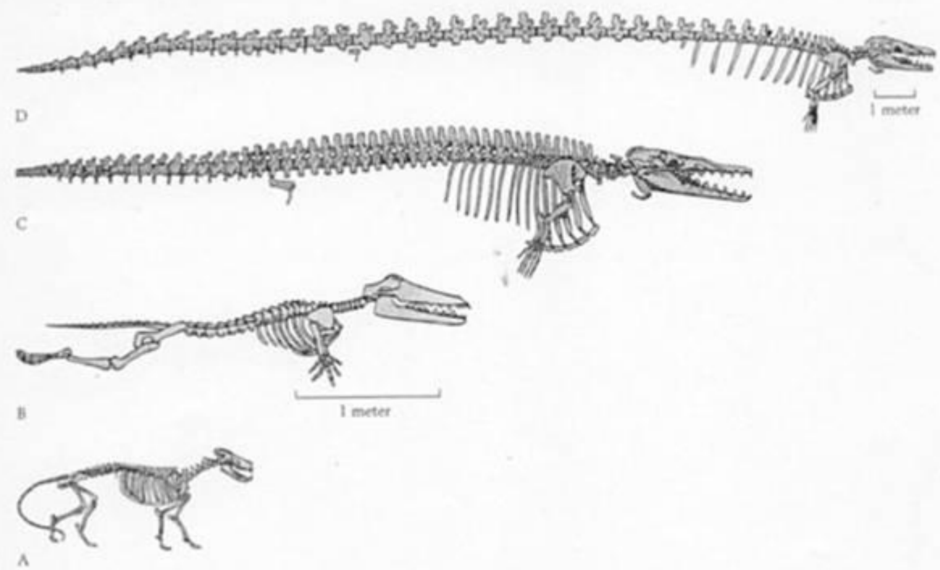
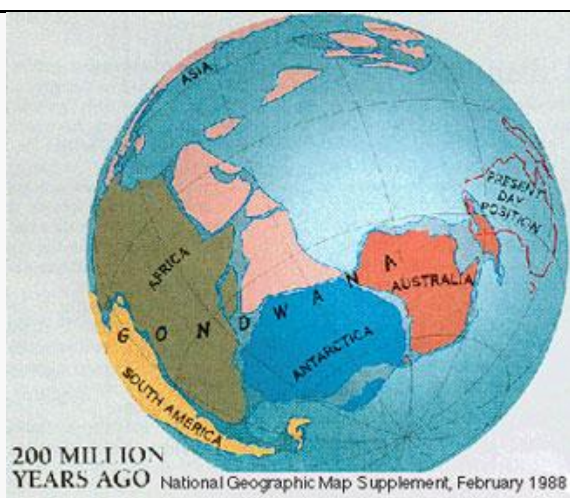


Figure 7-15 Stages in the evolution of whales. *A.* A member of the mesonychid group of terrestrial mammals, from which whales evolved. *B. Ambulocetus,* an early whale that lived about 50 million years ago and probably spent some time on land at the water's edge. C and *D.* Fully aquatic whales that lived about 35 million years ago. (Lower scale applies to *A, B,* and C.) *(A, B, and D. From R. L. Carroll, Vertebrate Paleontology and Evolution, W. H. Freeman and Company, New York, 1987; C. from G. M. Thewissen et al., Science 263:210–212, 1994.)*

2. Biogeography

Biogeography is the study of the distribution of species. Different geographic areas with similar climates, such as Australia, South Africa, and California, have unrelated plants and animals, indicating that biodiversity is not entirely influenced by climate and the environment. Before Darwin, most people thought that organisms would be found wherever there was suitable habitat for them. However, Darwin found no rabbits in South America, even though the habitat should have been able to support them. Biologists now know that species within a given geographical region tend to be related to one another because they share a common ancestry.

Marsupials ("pouched" mammals) are found primarily in Australia and South America. **Continental drift** has influenced their distribution.

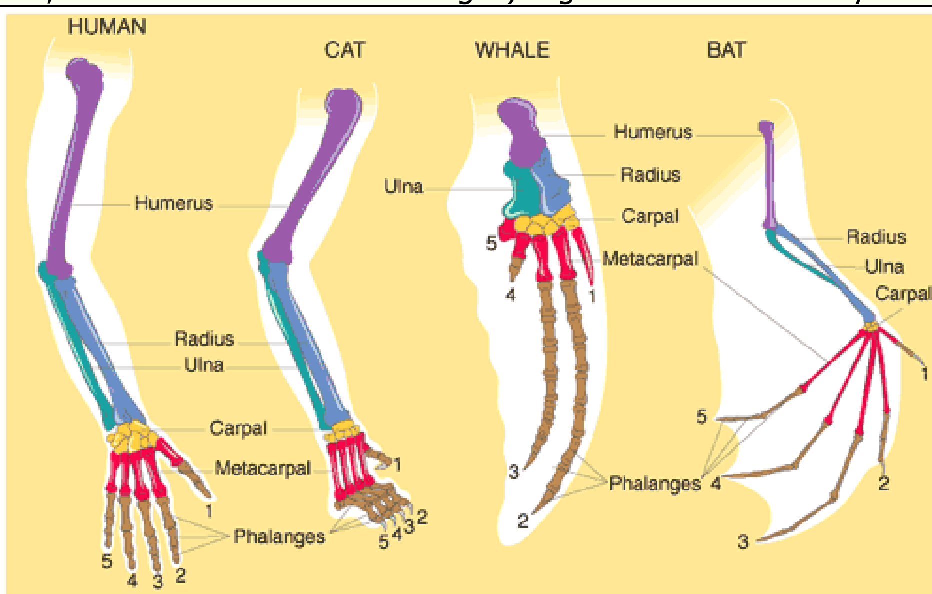


Australia, South America, and Antarctica were once connected with one another. Marsupials originated when the three continents were connected and spread throughout these regions. Incidentally, fossil marsupials have been found in Antarctica.

Oceanic islands generally contain organisms that most closely resemble those on the nearest mainland. For example, birds on the Galapagos Islands resemble those on the South America mainland. Ancestors from South America colonized the islands and evolved different traits.

3. Comparative anatomy

Comparative anatomy shows similar anatomical features among certain organisms. Vertebrate tetrapods, meaning animals with 4 legs like amphibians, reptiles, birds, and mammals, have forelimbs used for flying (birds), swimming (whales), running (horses), climbing (chameleons), burrowing (moles), and swinging (monkeys), yet they all contain the same kinds of bones (one upper arm bone, two middle arm bones, a group of wrist bones, and a variable number of digits) organized in similar ways.



The above forelimbs are an example of homology. **Homologous structures are those structures that are similar between species because the species inherited the traits from a common ancestor.**

Another example of a homologous structure is the amniotic sac, which protects the developing embryo, in mammals and birds. This trait is homologous between the two groups because it was inherited from the reptilian ancestors from which birds and mammals arose (reptiles also have amniotic sacs).

Analogous structures are those structures that are similar between species, but the traits evolved separately from one another through convergent evolution. Birds and insects (below) both fly, but their wings are very different from one another (one has feathers and the other chitin). Therefore, birds and insects did not inherit flight from an immediate common ancestor; rather each lineage evolved the trait separately (called convergent evolution or simply convergence). See Convergent Evolution for more examples.

Vestigial structures are those structures that **have no function but are "leftover" traits inherited from ancestors**. Whales and snakes retain a rudimentary femur (leg bone), even though they have no hind limbs (below). Humans retain a rudimentary tail bone, yet we have no functional tail. Organisms have vestigial structures because they inherit traits from their ancestors.

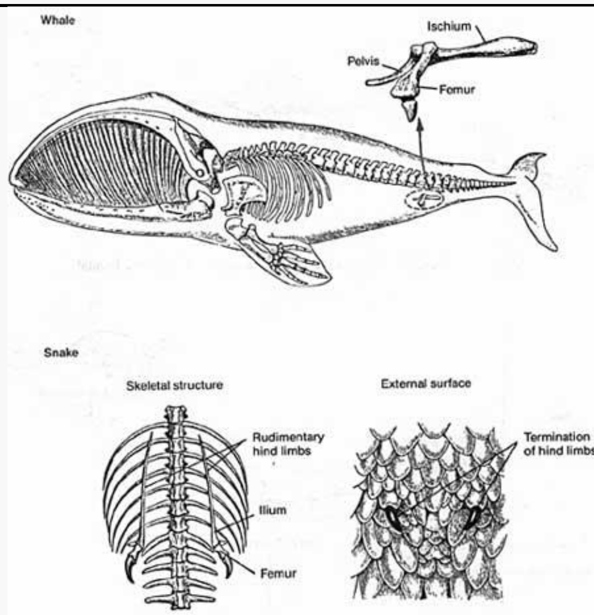


Figure 3-8

Rudimentary hind limbs in the Greenland whale and python snake. (From Romanes.)

4. Comparative embryology

Comparative embryology shows similar embryological features among certain organisms. Adult vertebrates look very different from one another, but during their embryological development, they look similar.

All vertebrate embryos at some time during their development have a notochord (which is replaced by the vertebral column), "gill slits" (which develop into tonsils, the thyroid gland, and the parathyroid glands in terrestrial vertebrates), and a tail. Related organisms inherit the developmental stages of their ancestors. Click here for a brief video on the similarities of vertebrate embryos.

5. Molecular evidence

Molecular evidence also supports common ancestry. Almost all organisms, from bacteria to mammals, use the same basic biochemicals (ATP, DNA, a variety of enzymes, etc.) and have the same genetic code, indicating a common ancestor to all living things (see The Common Genetic Code for more information). Additionally, **the more closely related species are, the more similar their DNA and proteins are**. The above figure shows the number of amino acid differences in the hemoglobin (blood) molecule between humans and other vertebrates. Humans and macaques differ by just 8 amino acids, whereas humans and frogs differ by 67. Thus, humans and macaques are more closely related to one another.