

# Evidence for evolution factsheet

The theory of evolution by natural selection is supported by a great deal of evidence.

## Fossils

Fossils are formed when organisms become buried in sediments, causing little decomposition of the organism. As time progresses various sedimentary layers get deposited, with the oldest on the bottom and the youngest on the top.



Fossils are also formed through freezing, being embedded in amber, preserved in tar, or even footprints and imprints.

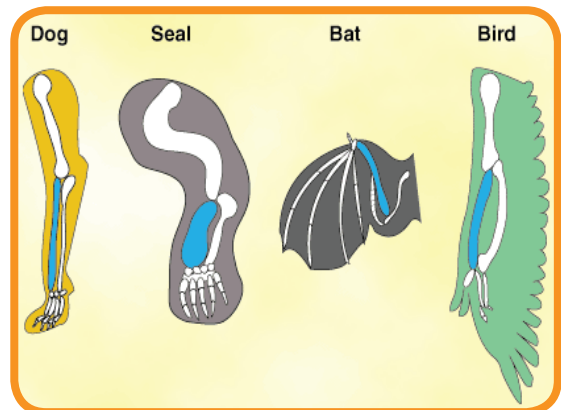
By observing the appearance, abundance and types of fossils in each of these layers we can understand the progression of the species that lived in that location over time.

Early fossils are fairly simple organisms, while later fossils become increasingly complex. This supports our more recent understanding of genetics and evolution: new alleles and genes develop from existing genes by mutation, and it seems unlikely that more complex organisms (those with many different genes) would develop first and then become more simple (having fewer genes).

Fossil records are both support and are supported by other evidence.

## Comparative anatomy

Comparative anatomy compares the structures of organisms of both living species and fossils. Comparisons of anatomical features in different organisms often provide evidence to support the theory of evolution. Organisms are often classed together according to similarities in their structures.



It was through comparing the anatomy of organisms that scientists discovered phylogeny, meaning the evolutionary history of a group of organisms.

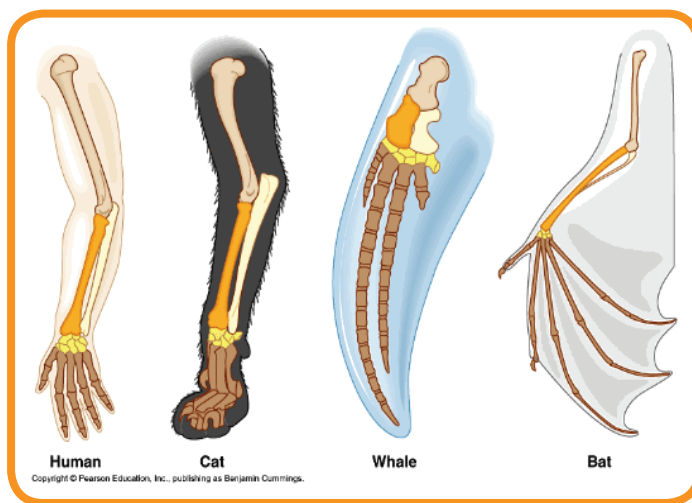
Comparative anatomy includes homologous and analogous structures as well as vestigial features.

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## Homologous structures

Homologous structures evolved from a common ancestor. Examples of homologous structures include the forelimbs of a variety of mammals. For example, human, cat, whale and bat. These species show the same skeletal elements in the humerus, radius and ulna as share a common origin. However these skeletal elements have been modified over time to suit the different functions suitable for the type of mammal.

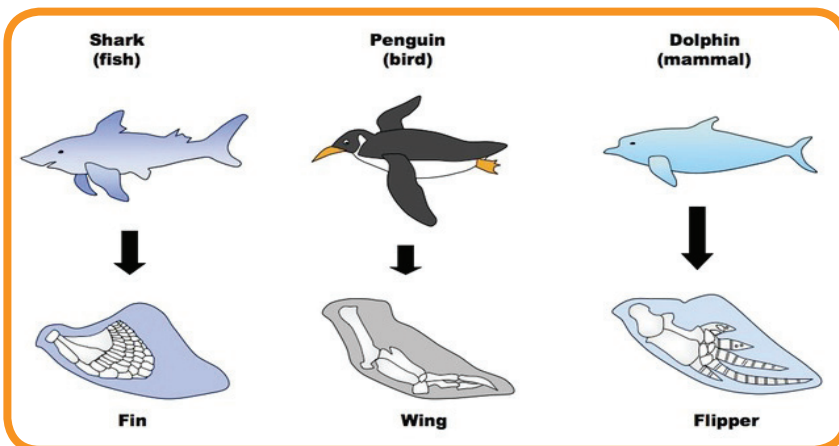
Homologous structures result from divergent evolution.



*Homologous structures - the arm of a human, the foreleg of a cat, the fin of a whale and the wing of a bat. All show the same skeletal elements.*

## Analogous structures

Analogous structures serve the same function between organisms but are different in internal anatomy. For example, the wings of birds and butterflies, and the eyes of lobsters and fish. These structures are of no use in classifying organisms or in working out their evolutionary relationships with each other.

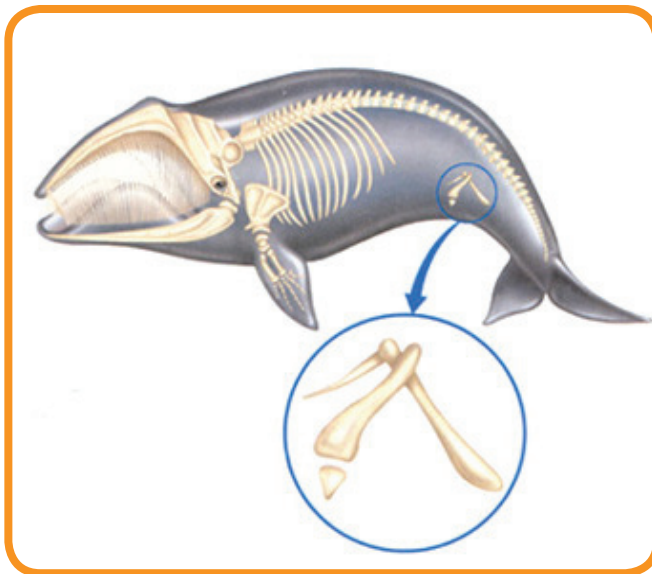


*Analogous structures - the fin of a shark, the wing of a penguin and the flipper of a dolphin serve the same function but have different internal anatomy..*

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## Vestigial structures

Vestigial structures are structures in an organism that has lost most or all of its function. Vestigial structures are usually dwarfed and useless to the organism. Sometimes vestigial structures may be adapted for new uses e.g. penguin wings can't be used for flight, yet they are adapted for swimming. Even though organisms have these structures there is no significant disadvantage to the organism. Examples of vestigial structures include the human appendix, the tail bone and wisdom teeth.



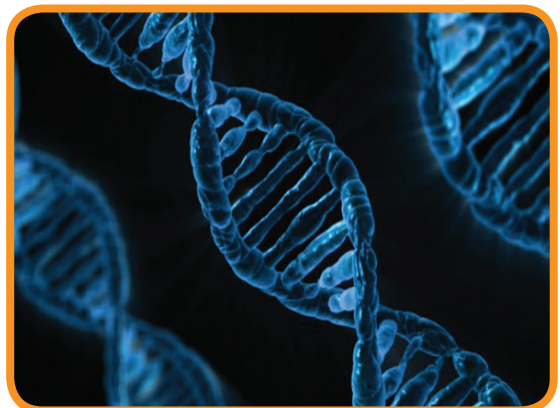
*Vestigial structures - One commonly cited example of a vestigial structure is the pelvic bone in the baleen whale.*

## DNA and protein structure

While Darwin, Wallace and Lamarck based their understanding of evolution on what they could see with the naked eye. More recently though, we have also been able to look at our DNA and protein structures, and by comparing DNA sequences of genes from one organism to another, we can learn an enormous amount about their relationships.

All living cells have the same basic DNA structure and use the same genetic code. Proteins produced from genes all come from the same set of amino acids.

Comparing sections of DNA in different species has shown that even organisms that seem to be different, actually have large sections of identical DNA.



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Organisms that seem fairly similar on the basis of comparative anatomy, show more genes in common than organisms that aren't much alike. For example, 96% of the genes in humans and chimpanzees are identical. That two species and their common ancestor have similar DNA is strong evidence supporting evolution.

Protein amino acid sequences can also be used to compare similarities between species. Proteins are made from amino acids and the sequence of these amino acids is controlled by genes. Comparing how many of the amino acids are in the same positions on the protein chain can provide some idea of how closely related two species are.

For example, humans and chimpanzees only have one position where they are different on the amino chain, while humans and moths have 31 different positions.

## Species distribution

All the places where species live is known as species distribution. When looking closely at distributions it is clear that many unique species occur in isolated pockets or islands. When looking at these unique species through the lens of evolution, we would expect unusual species in isolated areas because isolation is necessary before speciation can occur.

The theory of the movement of the Earth's tectonic plates was supported by the distribution of the fossils of particular species. Moving continents also explains why Australia has most of the world's marsupials and the only two monotremes; the platypus and the echidna.



*The platypus and the echidna are the only two living monotremes in the world. They evolved at a time when Australia became an isolated continent after being separated from Antarctica.*

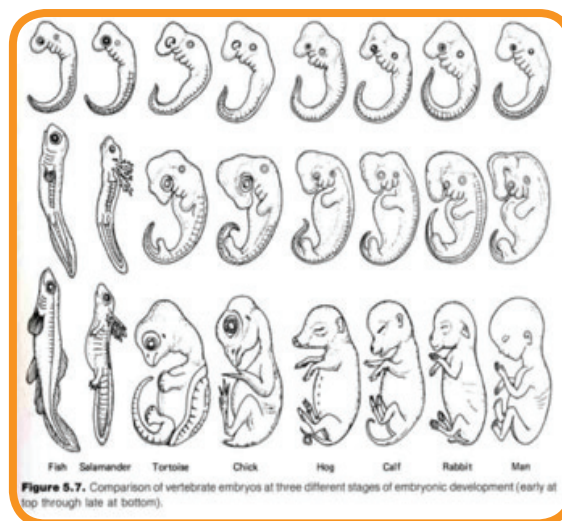
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## Embryology

Embryology is the study of the development, structure and function of embryos. When comparing vertebrate embryos in the early stages of development, you will see striking similarities. Even species that bear little resemblance in their adult form may have strikingly similar embryonic stages.

For example, when looking at humans we see that the embryo passes through a stage in which it has gill structures like those of the fish from which all terrestrial animals evolved. For a large portion of its development the human embryo also has a tail, much like those of our close primate relatives. This tail is usually reabsorbed before birth. Gills could be considered homologous traits between humans and fish: in humans the parathyroid glands (endocrine glands in your neck) develop from the branchial arches. In fish, a gene called Gcm-2 controls the development of branchial arches into gills. If the gene mutates (or if scientists prevent it from working) then the gills fail to develop.

The development of mammals, fish, reptiles and birds are linked to the branchial arteries. Biologists long ago proposed that fish evolved into amphibians, which evolved into reptiles, which evolved into birds. More recent studies of embryonic development support this idea.



## Key points

- The layers of fossils in sedimentary rock shows the progression of organisms through time.
- Homologous structures are structures that are similar in appearance but not in function.
- Analogous structures are structures that are similar in function but not in appearance.
- Vestigial structures are those features that still remain in animals, but that serve no function or purpose in the organism.
- Distribution - isolation islands have unusually high proportions of unusual species.
- Comparing sections of DNA in different species has shown that even organisms that seem to be different, actually have large sections of identical DNA.
- Embryology shows the similarities that organisms have at a very early stage of development.

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