

Topic 4: Change Over Time

LS.11 The student will investigate and understand that populations of organisms can change over time. Key ideas include

- a) mutation, adaptation, natural selection, and extinction change populations;
- b) the fossil record, genetic information, and anatomical comparisons provide evidence for evolution; and
- c) environmental factors and genetic variation, influence survivability and diversity of organisms.

Mutations: One cause of change in organisms is mutations.

A **mutation** is any change in the sequence of DNA. Mutations can be caused by:
random errors during DNA replication, exposure to radiation, chemicals

Most mutations are harmful or have no effect on an organism.

In asexual reproduction, all mutations are passed on

In sexual reproduction:

- In a body cell - NOT passed onto offspring •
- In a sex cell - yes passed onto offspring!

HOWEVER! Sometimes this can be POSITIVE!

Natural Selection:

Natural selection = the survival and reproduction of individuals that have traits that best enable them to survive in their environment.

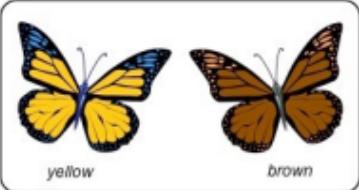
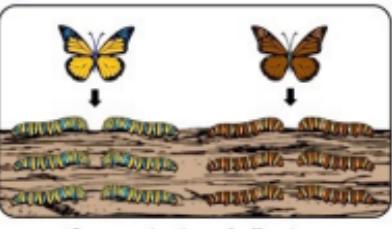
“Survival of the fittest” = Able to reproduce the most! (More babies = more with those parents’ traits) •

NOTE: This may not mean the strongest or longest living organisms.

Only reproduction matters! (You have to survive to reproduce, though)

Adaptation = An adaptation is a characteristic that improves an individual’s ability to **survive** and **reproduce** in a particular environment.

Summary of Natural Selection:

 <p>1. Variation There is genetic variation within a population which can be inherited.</p>	 <p>2. Competition Overproduction of offspring leads to competition for survival.</p>
 <p>3 Adaptations Individuals with beneficial adaptations are more likely to survive to pass on their genes.</p>	 <p>4 Selection Over many generations, there is a change in the allele frequency (evolution).</p>

Environmental Factors:

Factors in the environment can affect an organism's ability to survive. These can be naturally occurring or imposed by humans. Some examples include:

- amount of rainfall • temperature • fires • pollution • deforestation

EXTINCTION

NOTE: If a species does not possess traits that enable survival in its environment or adaptation to changes in the environment, then the species may become extinct!

- This especially happens when a habitat changes (e.g. climate changes or a new predator is introduced.)

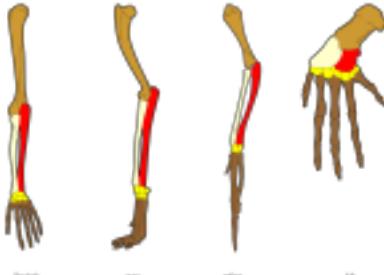
Evidence for Evolution:

What is Evolution? - Evolution is ANY change in the **heritable** characteristics in a population over time.

It is a theory which means that it is NOT a guess. As we learned, a theory must be supported by LOTS of evidence.

There are three main “buckets” of evidence:

Comparative Anatomy, Fossil Record, and DNA Evidence

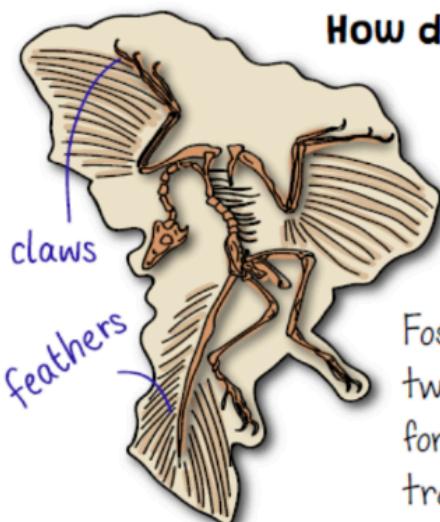
Comparative Anatomy		
<p>Shared Characteristics</p> <p>If organisms share anatomical characteristics, this can be evidence that they evolved from a common ancestor.</p> <p>Example: Mammals share a set of characteristics (e.g. giving live birth and producing milk for their babies), which suggest they may be evolutionarily related.</p>	<p>Homologous Structures</p>  <p>Homologous structures are similar structures found in different organisms, often despite being used for different functions.</p> <p>Example: The forelimb of many vertebrates has the same bone structure. This suggests that they may have evolved from a common ancestor.</p>	<p>Vestigial Structures</p>  <p>Vestigial structures are structures in an organism that have lost all or most of their original function.</p> <p>They suggest the organism evolved from something that DID have the full function of this structure.</p> <p>Example: The hind leg bones in a whale. These are NOT used for walking now (they have no legs), but it suggests that they evolved from an organism that did walk with hind legs.</p>

DNA Evidence:

1. The presence of DNA (with the same structure) in EVERY living organism from single-celled bacteria, all the way up to humans, is used as evidence for the claim that all living things evolved from a common ancestor.
2. Comparing the DNA sequences of different organisms, we can see how closely related they are.

(Example: In the image to the right, we can see that whales and hippos are most closely related as their DNA is the most similar. This suggests that they share a common ancestor.

PERCH	AGG CCG GCT CCA ACC AGG CCG
COW	AGG CCC AAA CCA ACC ATG CAC
HIPPOPOTAMUS	AGG CCC GCA CCA ACC GAT CAC
WHALE	AGG CCC CTT CCA ACC GAT CAC

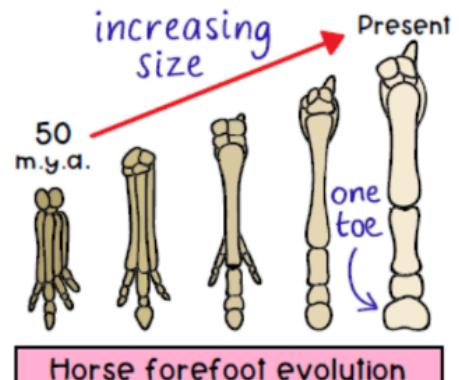


Archaeopteryx fossil

Fossils of organisms that are inbetween two species are called "transitional" forms. The Archaeopteryx fossil is a transitional form between a prehistoric reptile and a bird. There are many examples, but we do not have fossils of transitional forms for all living species.

How does the fossil record provide evidence of evolution?

Fossils show us evidence of evolution through the gradual change of physical structures over time. For example, we have fossils of early horses that had multiple toes, and we can see how this evolved over 50 million years to have a single toe or "hoof".



Horse forefoot evolution