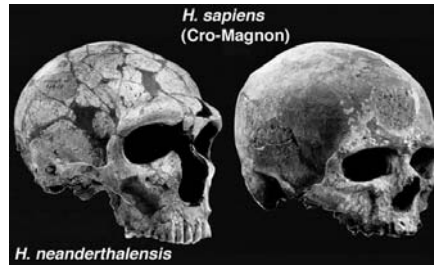
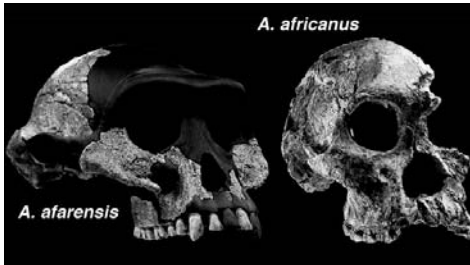
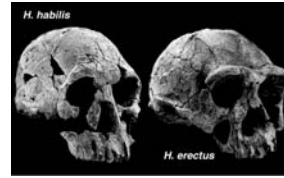
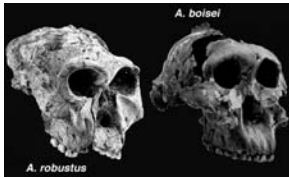


Evolution II The Evidence



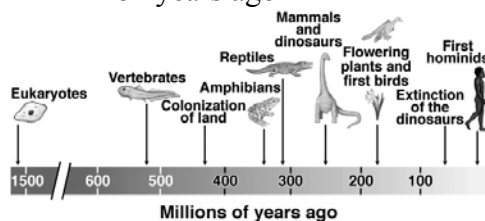
The evidence for evolution comes from geology, anatomy, developmental biology, molecular biology, laboratory experiments with selection, and studies of natural selection in natural populations.

1

Geology provides the most direct evidence for evolution.

We know a great deal from geology, including that

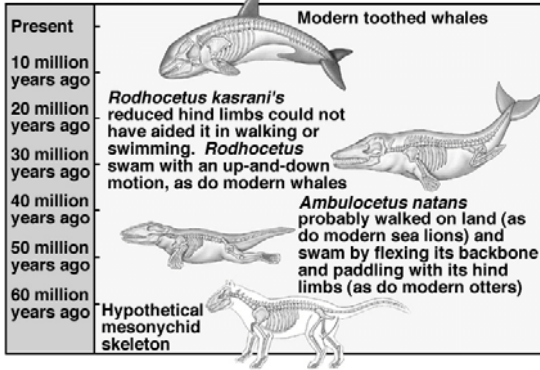
- the earth is about 4.5 billion years old,
- the earliest known cells are found in 3.5 billion year old rocks
- the earliest known eukaryotic cells date to 1.5 billion years
- the earliest multicellular animals date to 650 million years
- the earliest land animals date to about 450 million years
- the earliest mammals date to about 230 million years
- 65 m.y. ago there was a mass extinction of many living things
- the human family tree diverged from the other apes about 4.5 million years ago



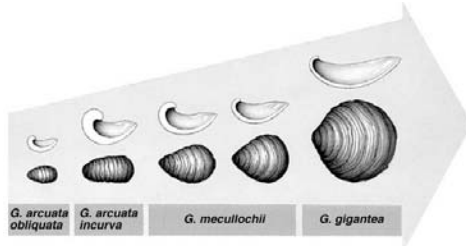
The record in the rocks indicates a gradual evolutionary progression from simpler to more complex

2

Ancestral Links



Fossils found in rocks have allowed paleontologists to track the evolution of many organisms, some in fine detail.

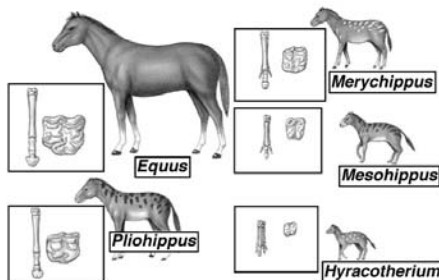
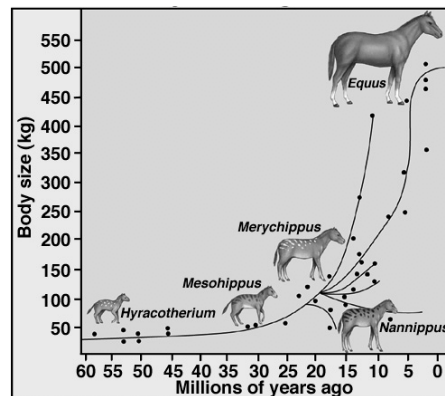


3

The family tree of horses is well documented in fossils.

The ancestor of all horses was a small forest-dwelling leaf browser.

Many of the changes seen in horses through time correlated with environmental change.



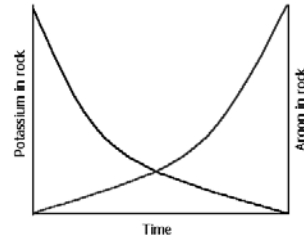
As grasses became more common, horses evolved to become better grazers of grasses and faster runners in open grasslands.

4

How are fossils dated?

The fossils themselves are seldom dated but layers of rock above and below the fossils sometimes provide rocks of a type that can be dated with radioisotopes. The rock dates bracket the fossil's age.

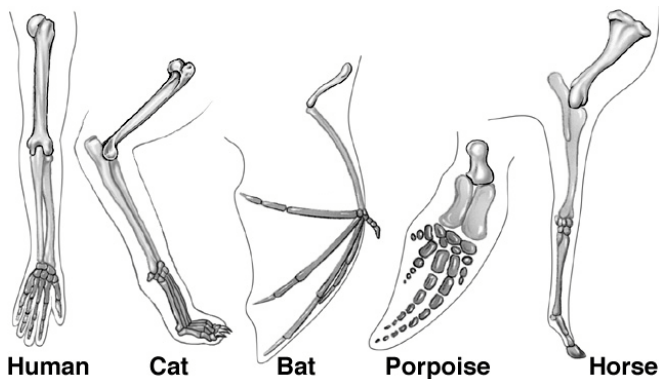
One type of radioisotope dating is K/Ar dating. Radioactive ^{40}K decays to ^{40}Ar at a known rate (one half-life = 1.26 billion years). Because ^{40}Ar is a volatile gas, any rock that was heated to a high temperature in the past would have had no ^{40}Ar in it when it cooled. So, any ^{40}Ar today would have been formed through the decay of ^{40}K .



The sum of the content of ^{40}K and ^{40}Ar in the rock today equals the total amount in the rock in the distant past. The relative amount of the two elements indicates how old the rock is.

5

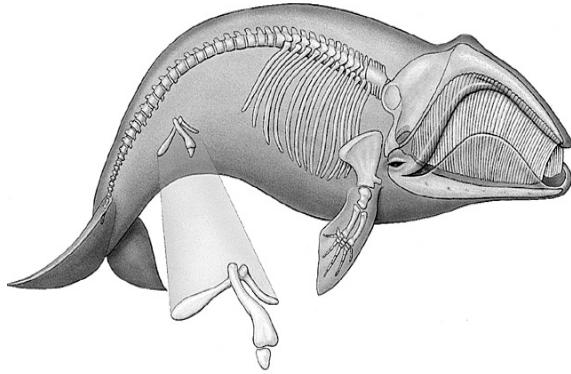
The anatomy of many organisms indicates they evolved from a common ancestor.



Body parts that develop from the same embryonic tissues are called **homologous**. The forelimbs of all vertebrates are all homologous structures and are modifications of the same assemblage of bones and muscles.

6

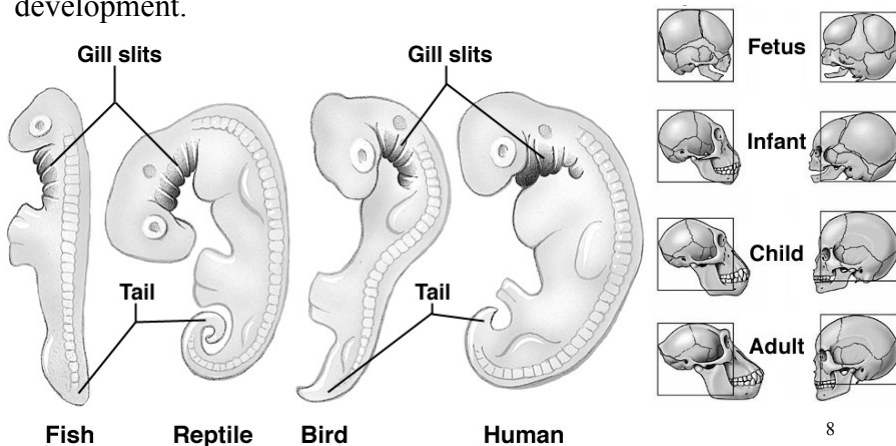
The anatomy of many organisms have **vestigial structures**. Vestigial structures have no function, but are derived from structures that did have a function in an ancestor of that organism.



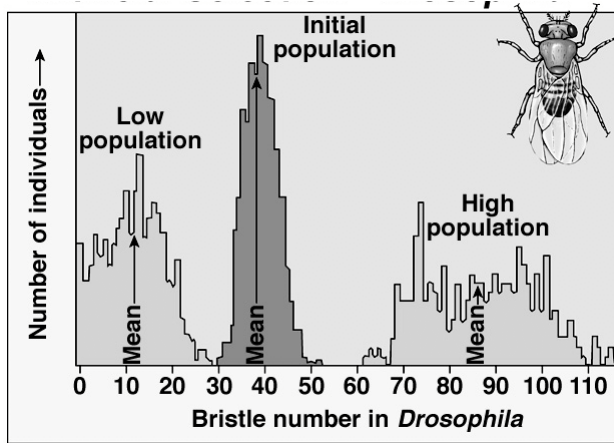
The pelvic girdle of whales and snakes do not support limbs and thus perform no function.

The appendix of humans is derived from a distant ancestor that ate more vegetation.

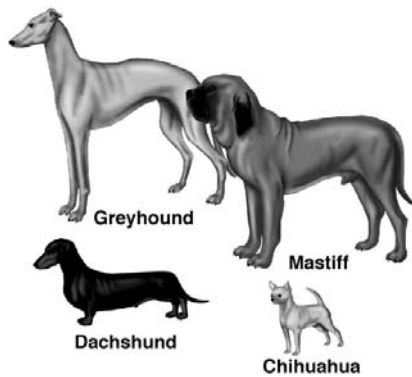
Developmental sequences of organisms indicate common ancestry. All vertebrates go through the same stages in early development. As development proceeds, there is greater and greater divergence in form, but closely related forms, like humans and chimpanzees, share nearly identical developmental sequences until very late in development.



In the laboratory, experiments with selection have confirmed that organisms can change greatly in form through selective breeding.

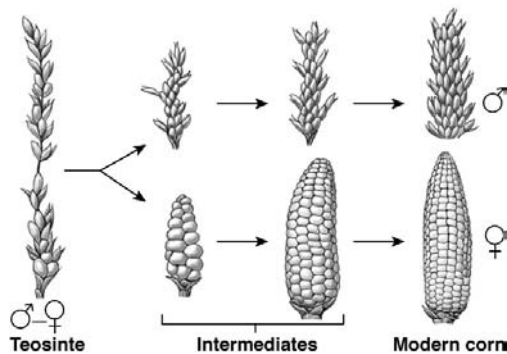


9



Selective breeding of domesticated plants and animals have results that are similar to laboratory experiments and sometimes go beyond what is seen in nature.

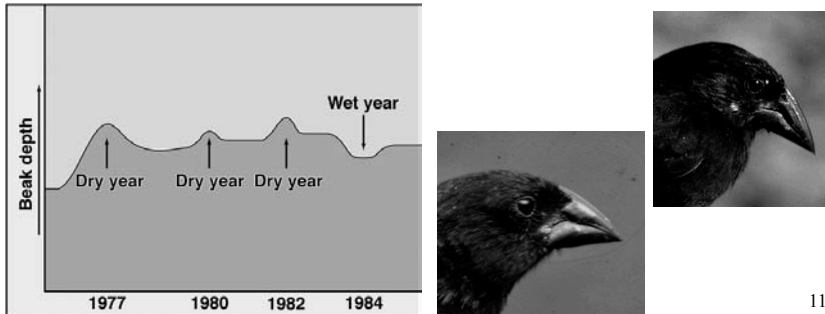
The gradual evolution of corn through selective breeding by Native Americans is recorded in archeological sites, in a fashion similar to the record of the evolution horses, etc., recorded in fossils.



10

Natural selection has been documented in nature many times.

In Galapagos finches, available seed sizes change with different amounts of rainfall. Dry years result in more large seeds. Wet years result in more smaller seeds. Studies of reproductive success in finches indicate that large-billed birds have higher fitness in dry years, and small-billed birds have higher fitness in wet years. Fitness is reflected in the offspring produced during wet and dry years. The pattern is repeatable and predictable.



Molecular studies of genetic similarity support estimates of evolutionary relationship from the fossil record and anatomical studies. Many independent lines of evidence all support the conclusion that all living things share common ancestors.

