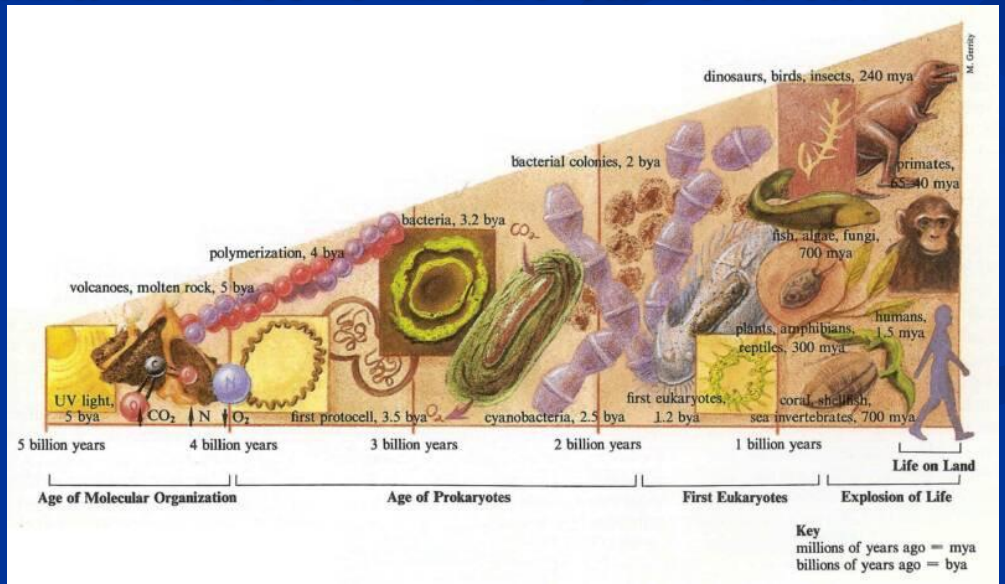
Evolution

Evolutionary Thought / Evidence

Video clip: Is evolution a theory? (mousetrap DVD)

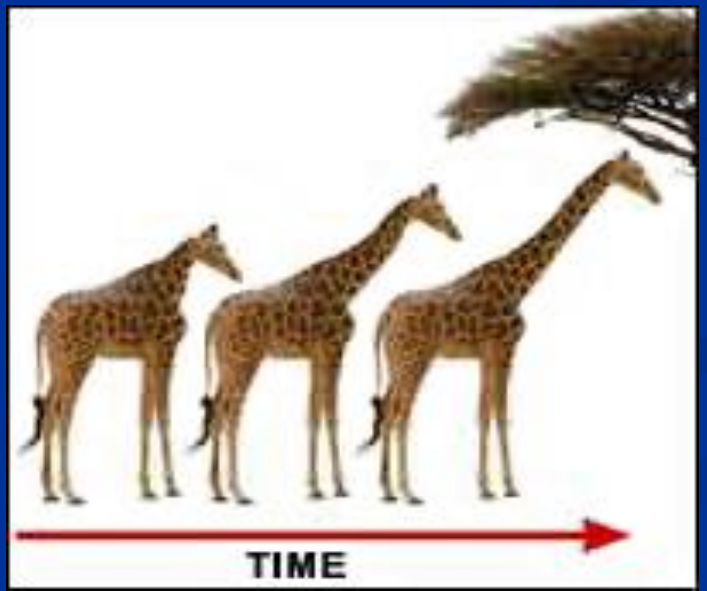
Theories of Evolution

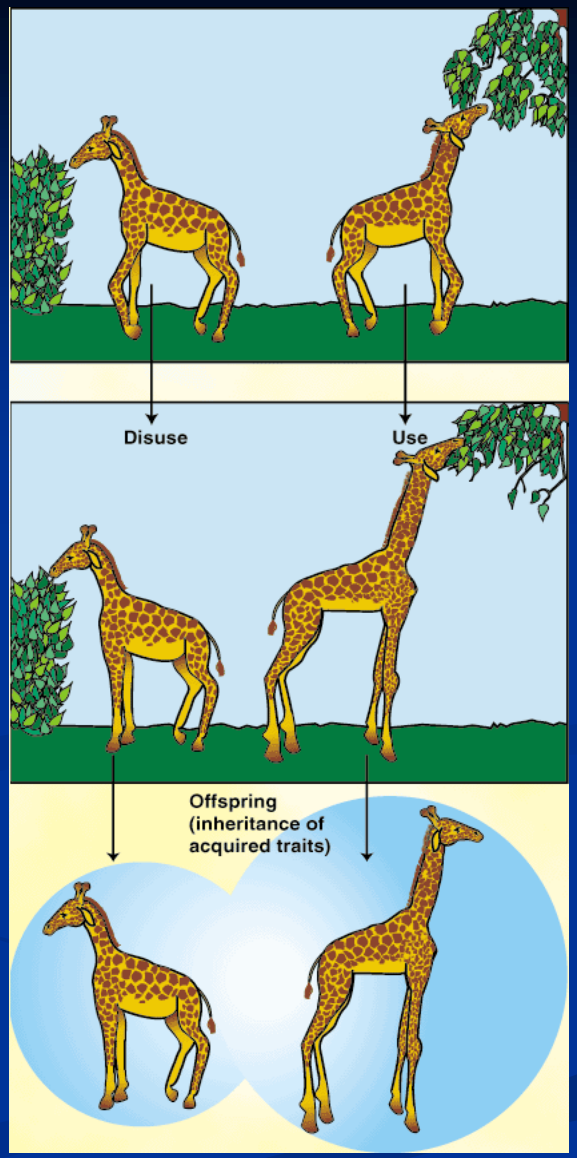
- **Evolution** - an orderly succession of changes
- Biological evolution - the *change of populations of organisms over generations*
  - New life-forms appeared to be *modifications* of life forms found in fossils in the same area.



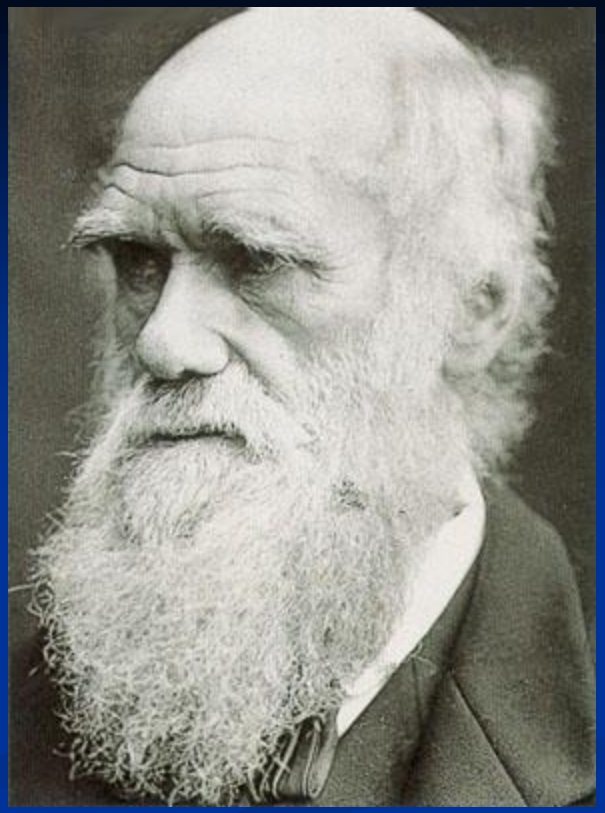
- Jean Baptiste de Lemarck hypothesized that **acquired traits** were passed on to offspring
- Acquired trait:
  - not determined by genes
  - arises during lifetime as a result of the organism's experience or behavior

- Ex. a giraffe stretching neck to reach higher food on a tree, the more it stretches the longer the neck
- Acquired traits get passed on to next generation
- Scientists disproved Lamarck's theories but his idea that *organisms change over time was* important

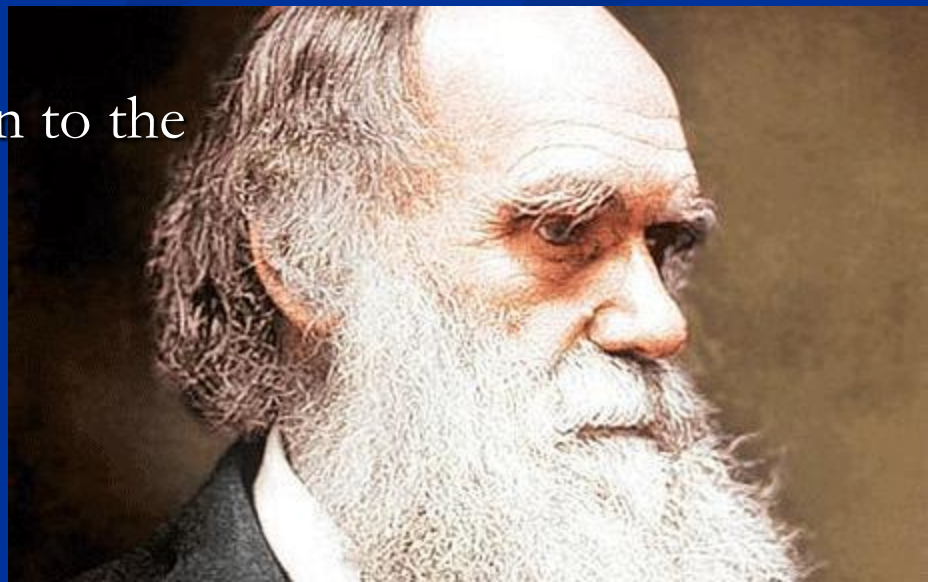




Charles Darwin



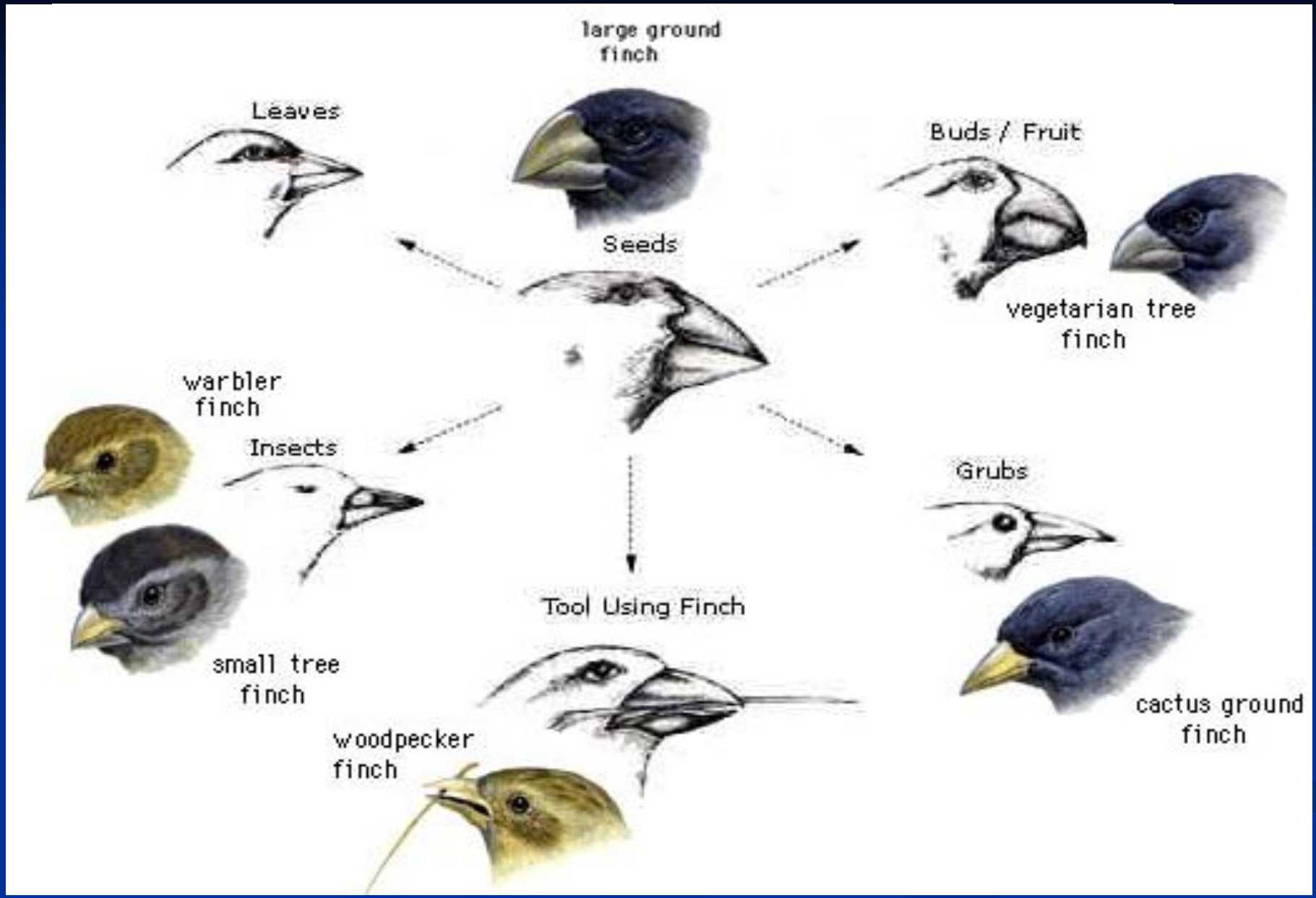
- Proposed the hypothesis that species were modified by natural selection
- **Natural selection** - organisms best suited to their environment reproduce more successfully than other organisms
  - Successful traits get passed on to the next generation



H.M.S. Beagle

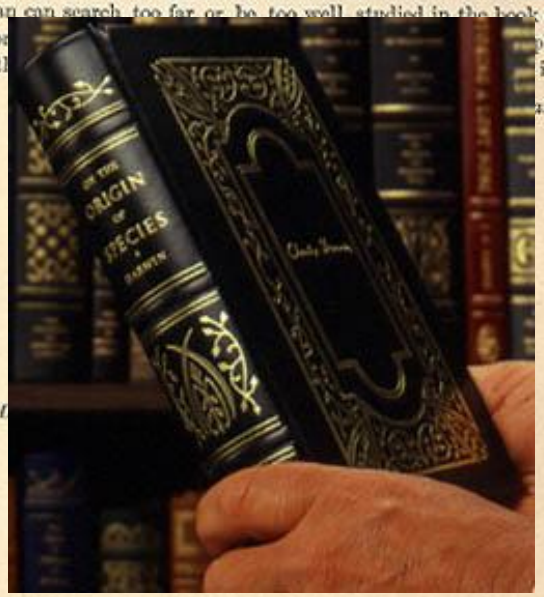
- Darwin was on H.M.S. Beagle (ship) for 5 yrs
- Collected specimens and kept records on trips to South America and the South Pacific
- Observed many fossils on many different countries

- Darwin found several types of modified finches on the Galapagos Islands, different than finches in S. America.
- They had large differences in their beaks and ate many different things rather than only seeds



Darwin's Finches

- Darwin published his book, ***The Origin of Species***
- He said in populations of organisms there is some natural variation between individual organisms

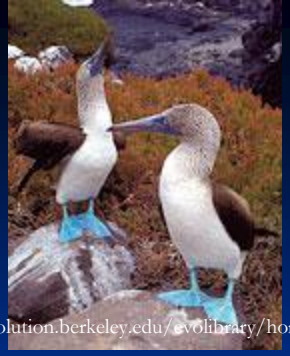


ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE



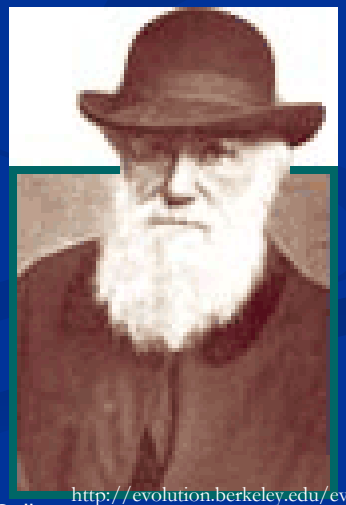
http://evolution.berkeley.edu/evolibrary/home.php

www.darwinday.org/englishL/life/beagle.ht

Celebration (at DarwinDay.org), 2006

I have called this principle, by which each slight variation, if useful, is preserved, by the term Natural Selection.

—Charles Darwin from "The Origin of Species"



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Darwin's Theories

- Darwin's ideas about evolution and natural selection can be summed up in two theories
  1. Descent with Modification
     - Newer forms in the fossil record are modified descendents of older species
       - All species descended from one or a few common ancestors
     - Fossils of transitional species show evidence
       - Transitional species - a species which has features that are intermediate between those of hypothesized ancestors and later descendant species

FIGURE 15-7

The fossil skeletons below form a sequence of transitional forms that support the hypothesis that whales evolved from four-legged, land-dwelling mammals.

1 *Pakicetus* (pak-uh-SEE-tuhs)
Scientists think that whales evolved from land-dwelling mammals. One of these ancestors may have belonged to the genus *Pakicetus*, which lived about 50 million years ago. The fossil skeleton of a pakicetid is shown here.

2 *Ambulocetus* (am-byoo-loh-SEE-tuhs)
This genus of mammal lived in coastal waters about 49 million years ago. It could swim by kicking its legs and using its tail for balance. It could also waddle on land with its short legs.

3 *Dorudon* (DOH-roo-don)
This genus of mammal lived in the oceans about 40 million years ago. It resembled a giant dolphin and propelled itself with a massive tail. It had forelimbs that were flippers and tiny hind limbs that could not have been used for walking or swimming.

4 Modern toothed whales
Modern whales have forelimbs that are flippers. They also have tiny, nonfunctioning hip bones at the rear of their bodies.

Darwin's Theories

2. Modification by Natural Selection
   - States how evolution occurs
   - The environment affects organisms
   - If a trait is beneficial and is inherited, it will be passed on
   - Organisms **adapt** to their environment as favorable genes keep getting passed through many generations
   - A single organism's contribution to the next generation is called **fitness**, and produces more offspring

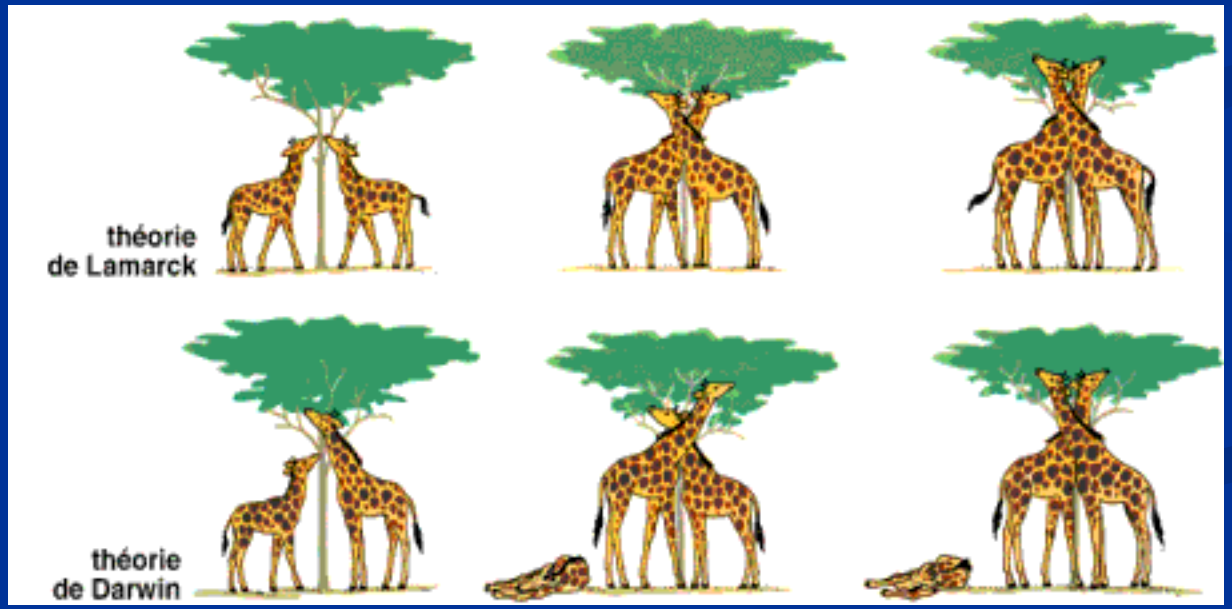
Lamarck

- Acquired skills are passed on to offspring
- Use and disuse
- first with idea
- Based on fossil record

vs.

Darwin

- Came up with the idea of natural selection
- Survival of the fittest
- Galapagos Islands



The Fossil Record

- Video clip "Fossils and Living Species" (mousetrap DVD)

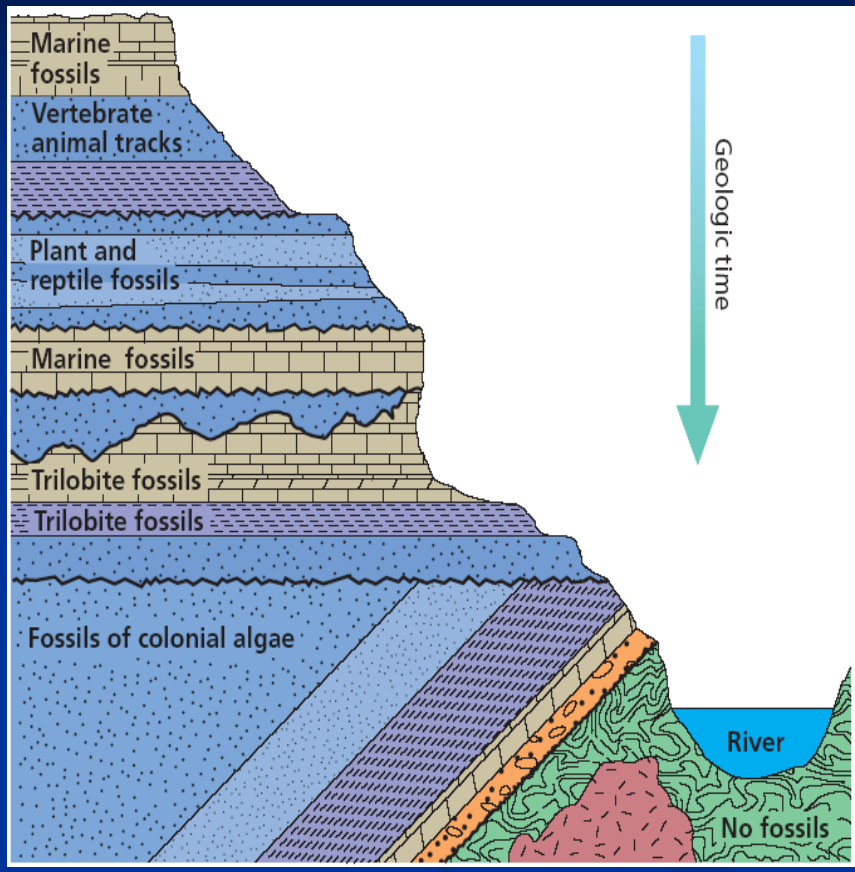
- Shows history of life on Earth – provides evidence of organisms that existed at different periods of time
- Species appeared, existed, then became extinct
- Shows evidence of several mass extinctions
- Most likely, mass extinctions resulted from drastic changes in the environment

Trilobite Fossil

A collision with an asteroid may have led to a mass extinction

The Fossil Record

- Nicolaus Steno proposed the principle of superposition - if layers of rock go undisturbed, the lower layers of rock are older than those on the top
- Can be used to find relative age.
  - Relative age - age of a fossil compared to the age of other fossils (older or younger)

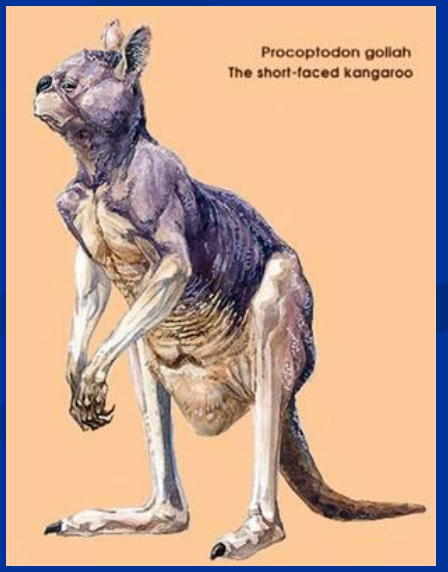


- Radiometric dating give an absolute age
  - Absolute age- the numeric age of an object or event usually stated in years before the present

Biogeography

- The study of the geographical distribution of fossils and of living organisms is called biogeography
- A comparison of recent fossils of organisms in the same area shows that new organisms arise in areas where similar organisms once lived

Modern kangaroos appeared only in Australia, where the now-extinct giant kangaroo once lived

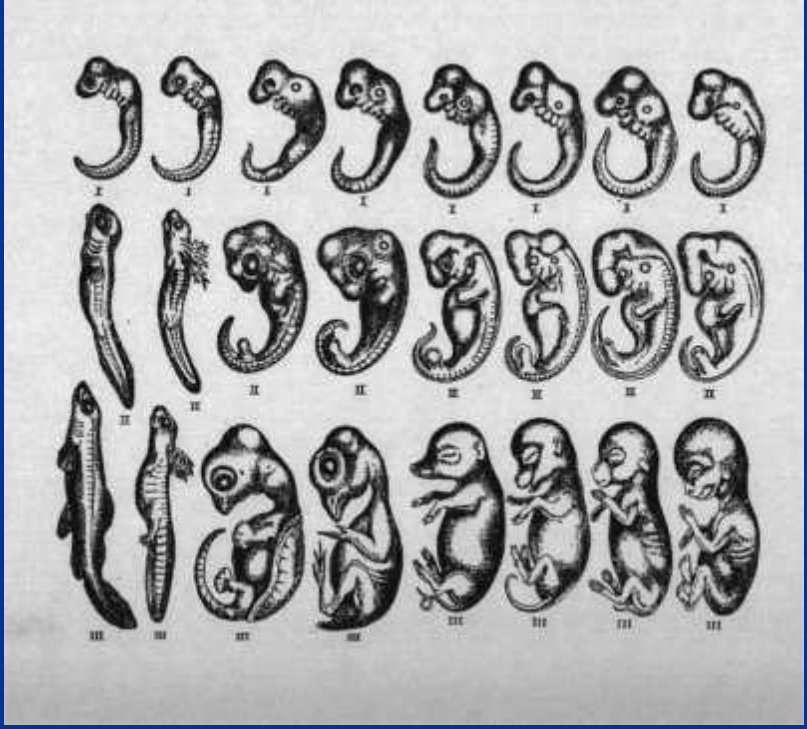


- Fossils often allow scientists to reconst the organism
- What is this skeleton?

How about this one?

Similarities in Embryonic Development

- Many animals with backbones have a similar appearance as developing embryos during certain stages, this suggests common ancestry



(a) dogfish, *Squalus acanthias*

(b) chicken, *Gallus gallus*

(c) cat, *Felis catus*

EVIDENCE OF EVOLUTION

- **Structural adaptations**
  - Mimicry
  - Camouflage

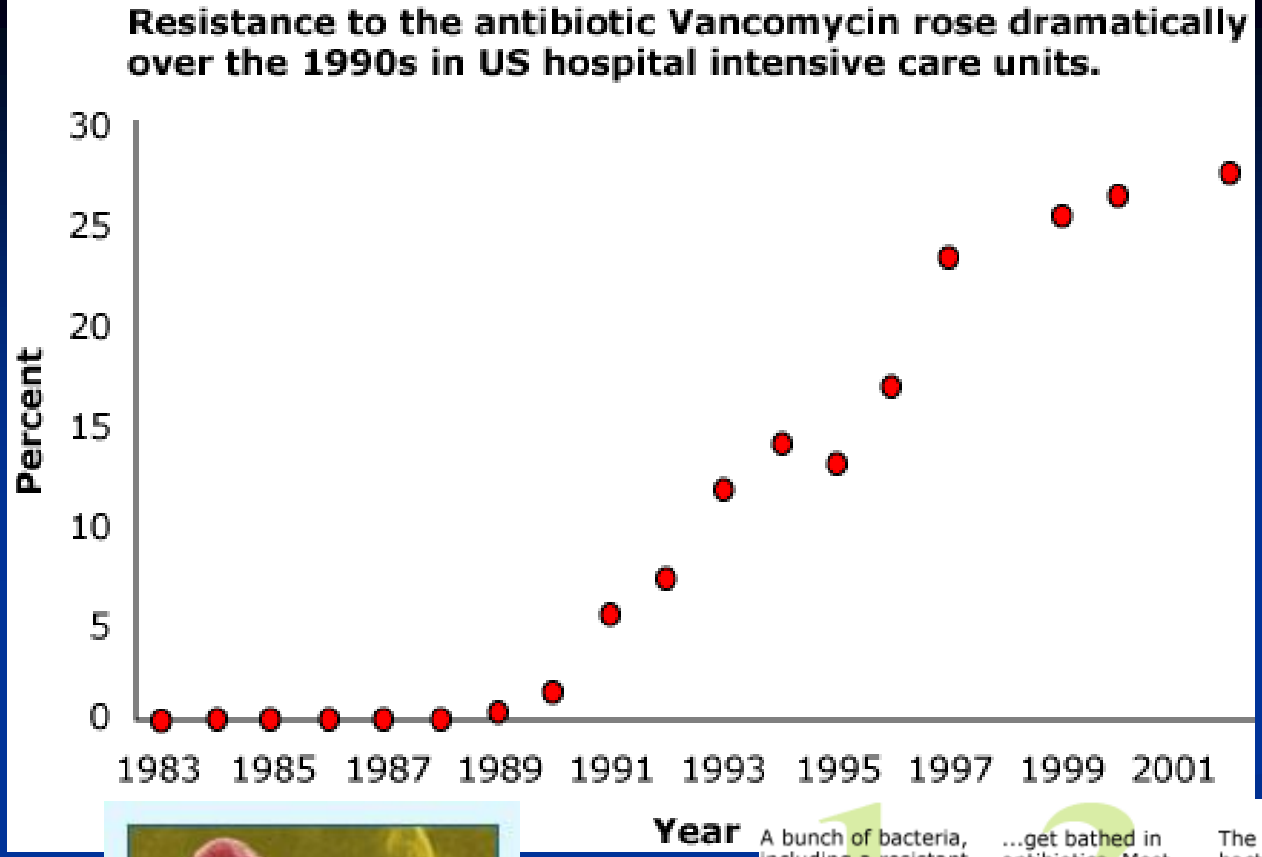
Millions of years

http://science.howstuffworks.com/animal-camouflage2.htm

Adaptation = inherited trait that improves chance of survival & reproduction

EVIDENCE OF EVOLUTION

- Physiological adaptations
  - Change in a metabolic process
  - What do you hear about in the news about some bacteria?



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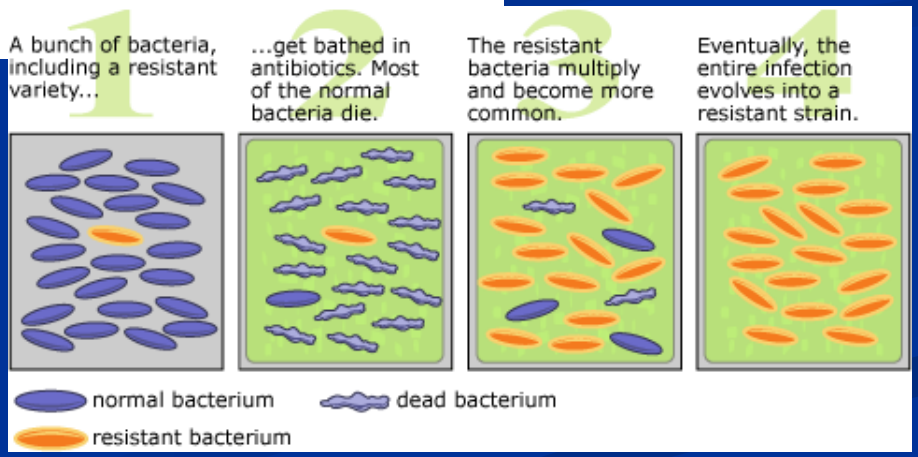
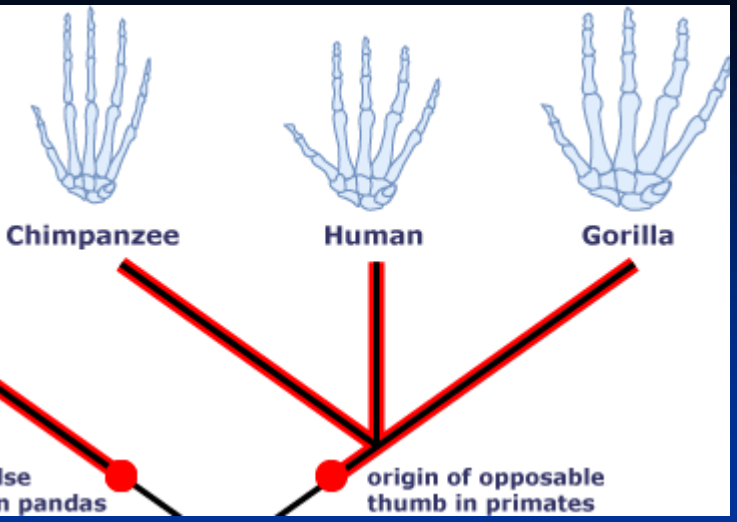
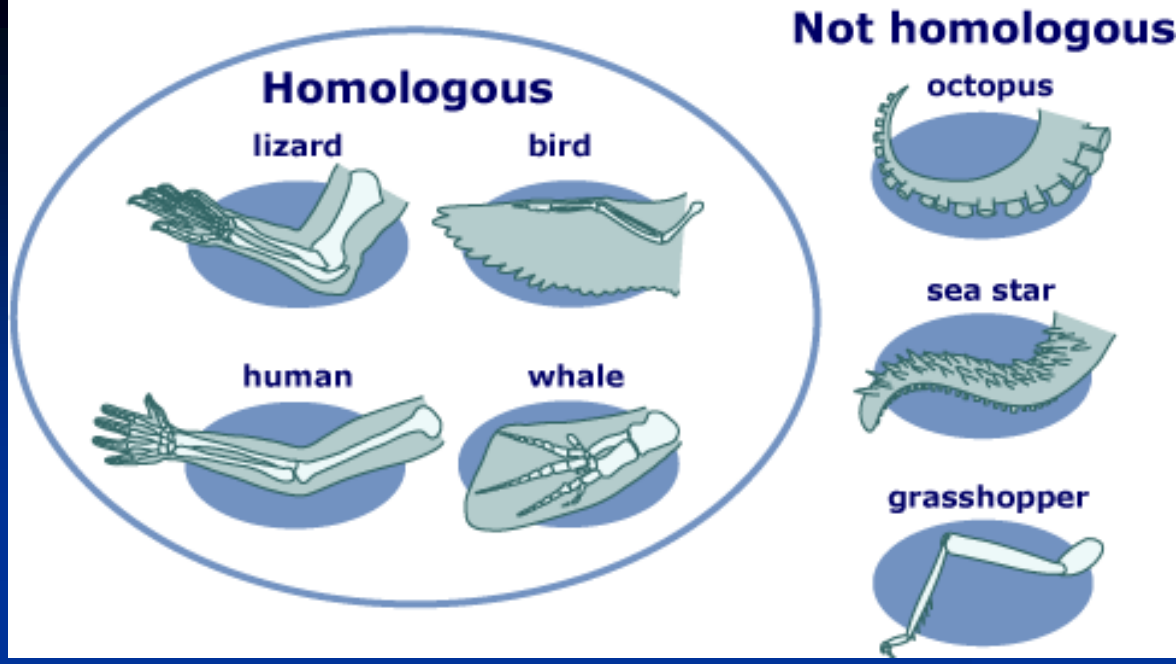


WHAT OTHER INDUSTRIES WOULD BE WORRIED ABOUT RESISTANCE?

EVIDENCE OF EVOLUTION cont.
Homologous Structures

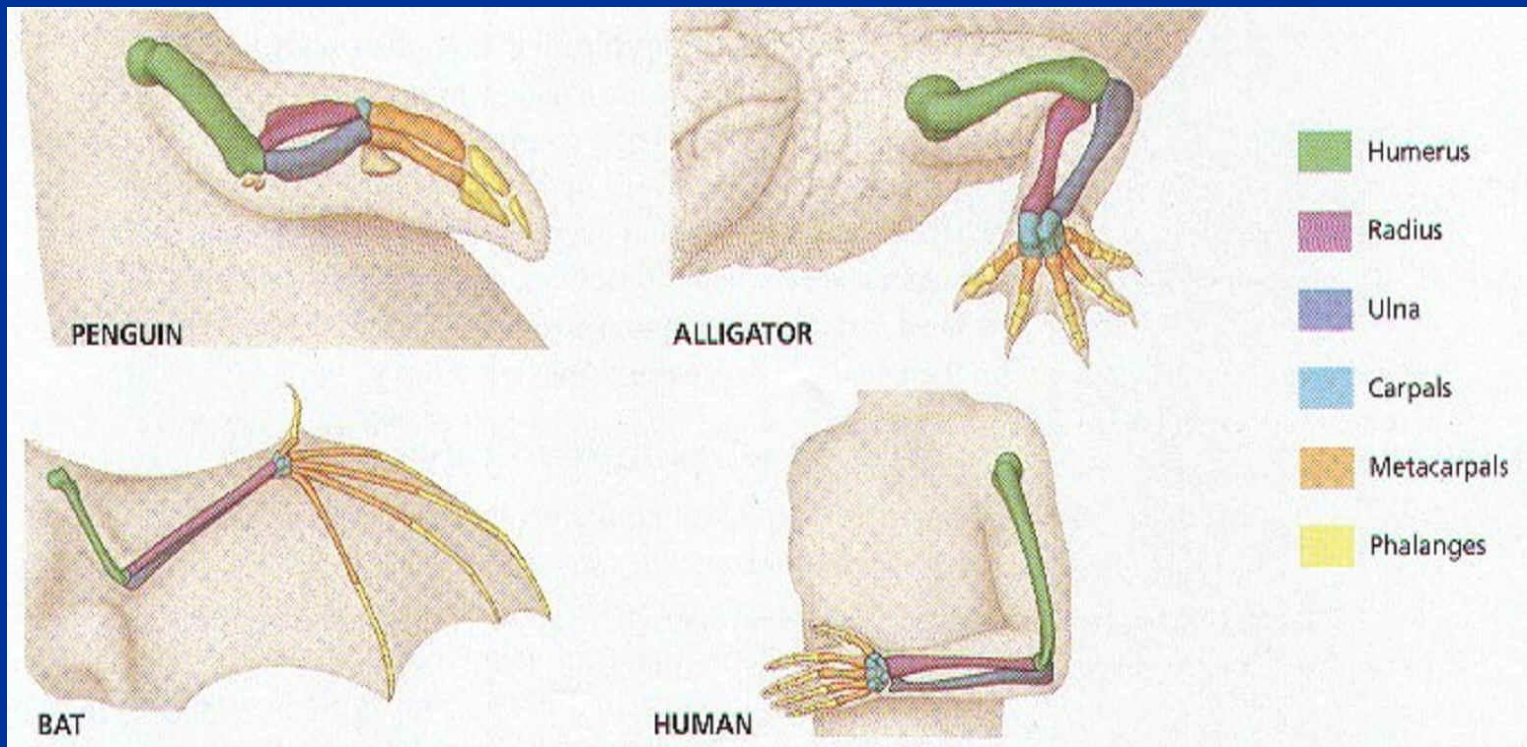
- Similar features that originated from a shared ancestor are described as **homologous structures**
  - ex. different beaks on Darwin's finches
  - The forelimbs of the penguin, alligator, bat and human all derive from the same structures within the embryo
  - They can result from modifications that change an original feature to two extremely different types
    - ex. Wing of a bat and a human arm





-Similar in structure, different function

-Evidence of a common ancestor



Analogous Structures

- **Analogous structures** are features that have evolved to *serve the same function* but have *different embryonic development*
  - ex. insect wings vs. bird wings

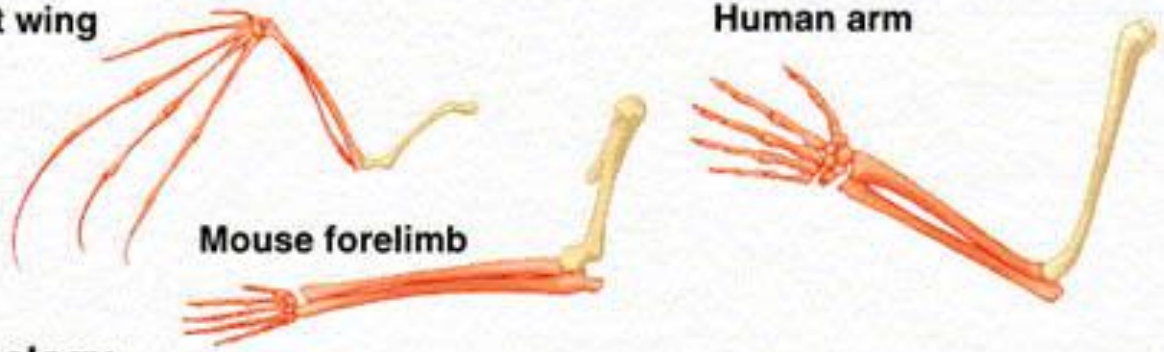
Homology and analogy

Homology

Bat wing

Human arm

Mouse forelimb



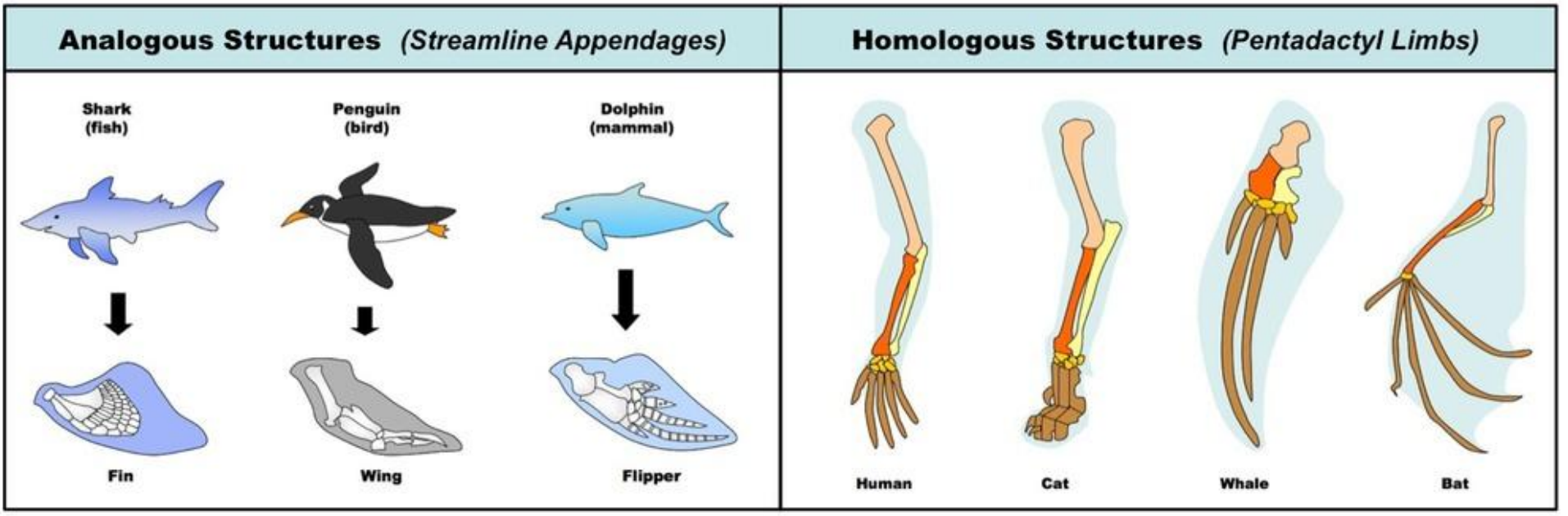
Analogy

Bat wing

Butterfly wing

Bird wing

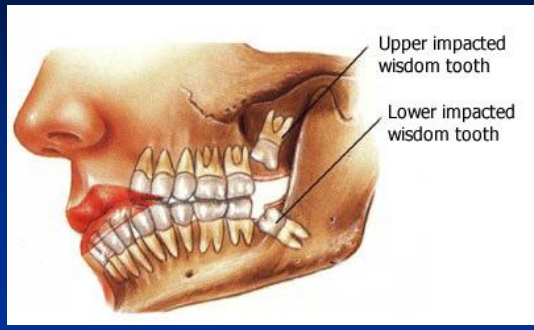
Analogous Structures



Analogous Structures	Homologous Structures
Same function	Different function
Differ in fundamental structure	Similar in fundamental structure
Different ancestry (convergent evolution)	Common ancestry (divergent evolution)
Example: Wings in bats, birds, insects	Example: Pentadactyl limb in vertebrates

Vestigial Structures

- **Vestigial structures** seem to serve no useful function
  - ex. Human tailbone, Human appendix, and pelvic bones in whales
- An organism with structures like these, share common ancestry with an organism that has a functional version of the same feature
  - Whales probably had an ancestor that lived on land



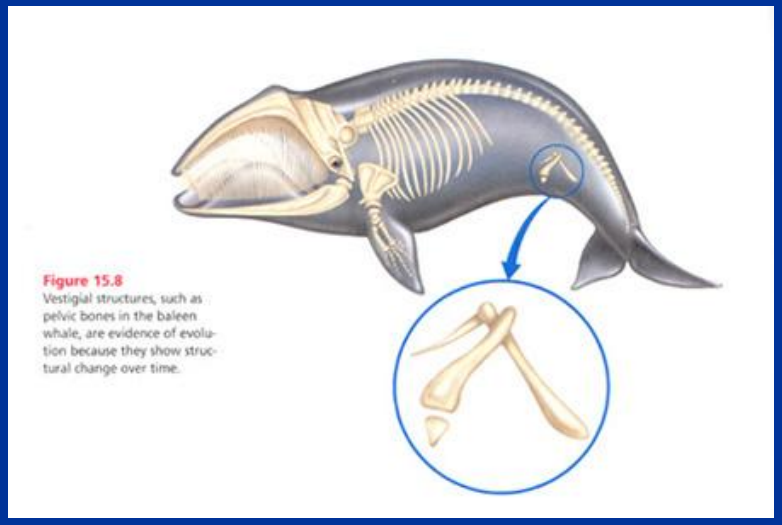
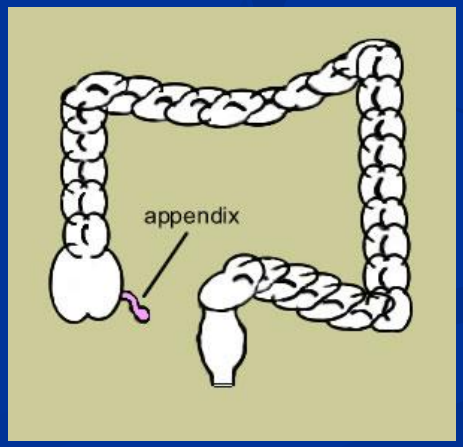


Figure 15.8
Vestigial structures, such as pelvic bones in the baleen whale, are evidence of evolution because they show structural change over time.



Ancestral Links

Present

10 million years ago

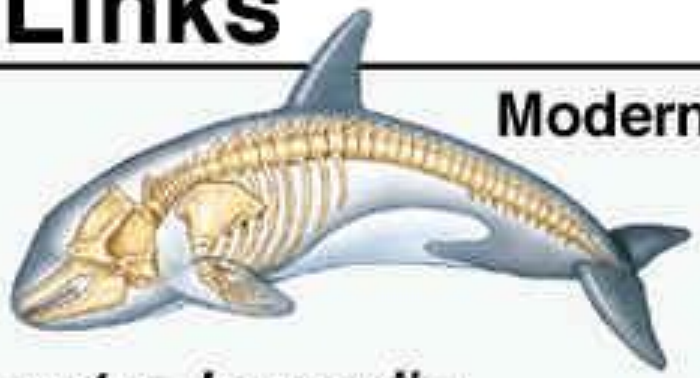
20 million years ago

30 million years ago

40 million years ago

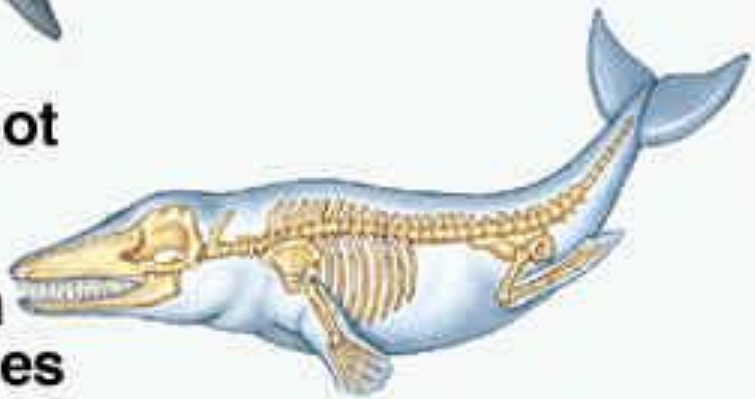
50 million years ago

60 million years ago

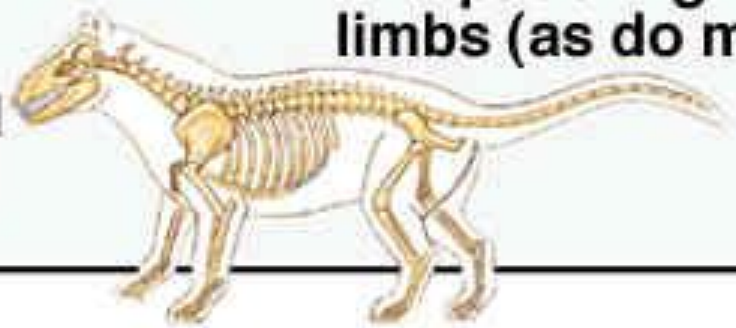


Modern toothed whales

Rodhocetus kasrani's reduced hind limbs could not have aided it in walking or swimming. *Rodhocetus* swam with an up-and-down motion, as do modern whales



Ambulocetus natans probably walked on land (as do modern sea lions) and swam by flexing its backbone and paddling with its hind limbs (as do modern otters)



Hypothetical mesonychid skeleton

Biological Molecules

- In all species, DNA and RNA are the molecular basis for inheritance of traits
- The more similarities in DNA and RNA between any two species, the more closely related the two species are through a common ancestor