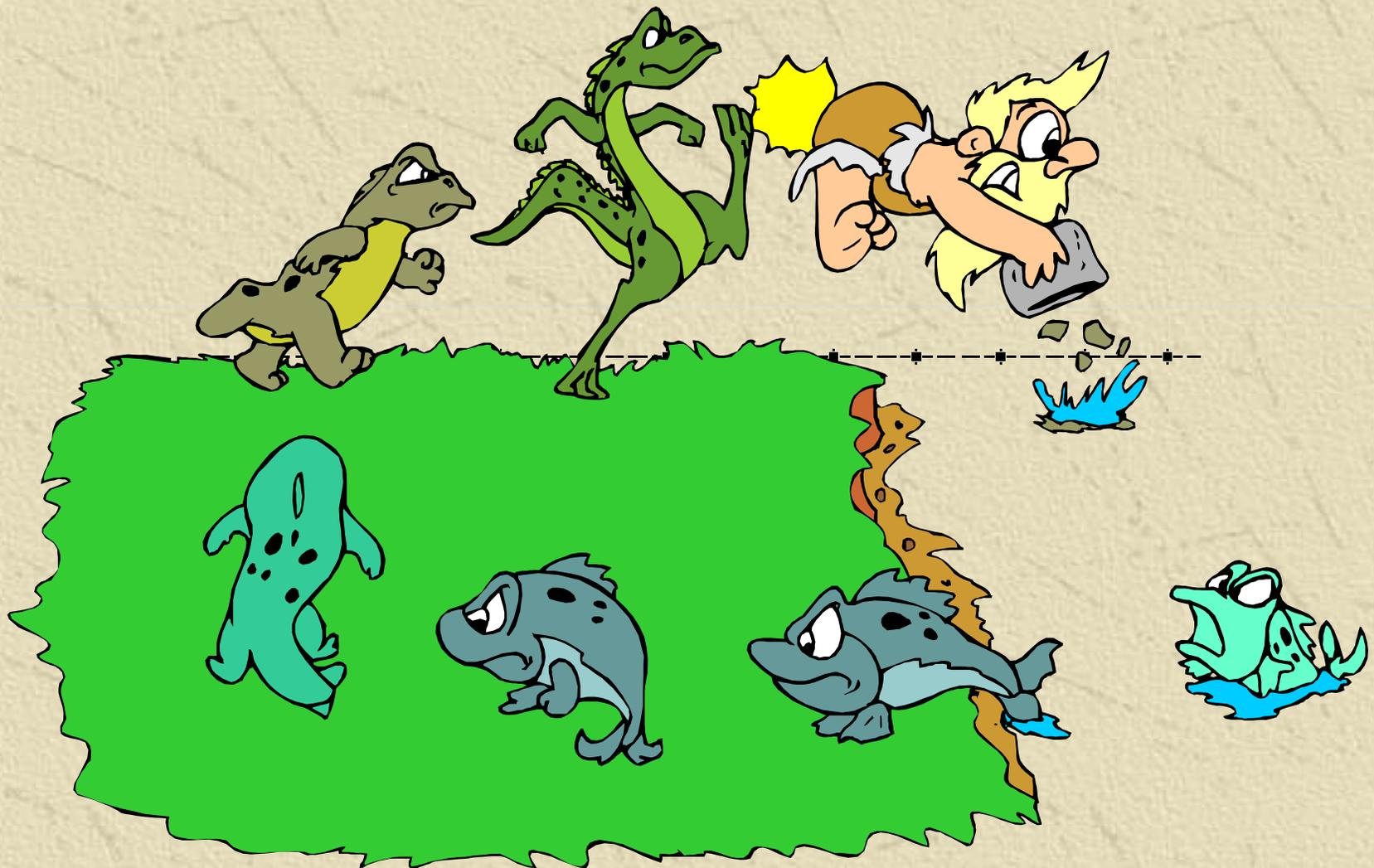


Evolution



What is evolution?



Evolution in general means:

- ◆ Change over time.





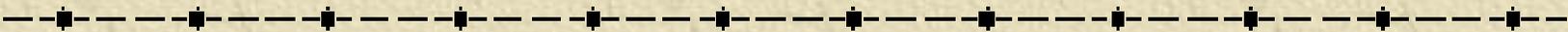
Biological Evolution is:

- ◆ **Change of allele frequency in a population over time**



Biological Evolution is:

- ◆ **Process by which modern organisms have descended from ancient organisms (slow change over long time)**
 - Even relatively quick evolution takes hundreds of thousands of years.



Where did the idea of evolution come from?

✦ People started finding fossils

Jean Baptiste de Lamarck (1744-1829)



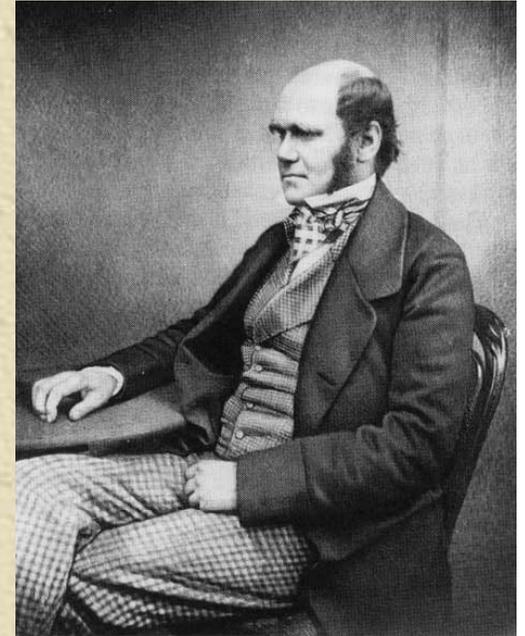
- ✦ Recognized that organisms were adapted for their environments and that they change
- ✦ He relied on three ideas:
 1. **A desire to change** (the ladder of complexity- innate drive for perfection)
 2. **Use and disuse** (Giraffe's necks and vestigial organs)
 3. **Inheritance of acquired characteristics**

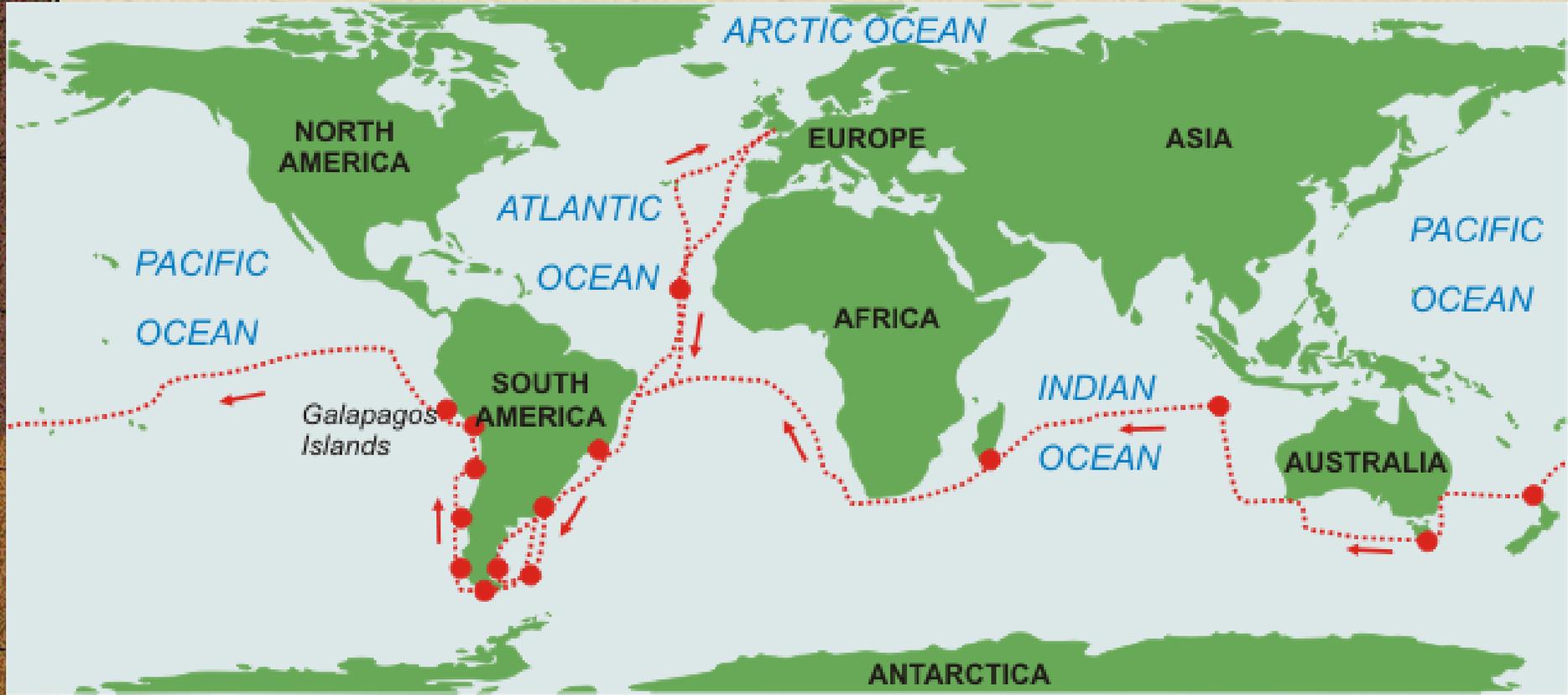
The Life of Charles Darwin

- ✦ Born in 1809 in Shrewsbury, England
- ✦ Wealthy family, Dad was a doctor
- ✦ Went to medical school at Edinburgh but decided against medicine after witnessing surgery
- ✦ Went to Cambridge to become a minister – highly influenced by his professors who taught geology and botany

The Life of Charles Darwin

- ✦ Graduated and **signed on to be the naturalist on the *HMS Beagle***
- ✦ 2 year commitment – no pay
- ✦ **Left England in 1831**
- ✦ Stops: Canary Islands, Cape Verde, Brazil, Tierra del Fuego, Chile, Galapagos Islands, Tahiti, New Zealand, Tazmania, South Africa
- ✦ **Returned to England in 1836**







✦ Everywhere they stopped, he took lots of notes and collected specimens

✦ **Key Observations**

✦ **Diversity of species in Brazil**

✦ **Fossil coral reefs at 10,000 ft in the Andes**

✦ **Found fossil bones of giant extinct mammals**

✦ **Earthquake in Chile where the land rose 4 ft**

✦ **Adaptation of animals in the Galapagos**

The Galapagos Islands



The Galapagos Islands

- ✦ He saw adaptations!
- ✦ **Mockingbirds** –differed from island to island, similar to birds found on the mainland (Ecuador)
- ✦ **Flightless Cormorant** – lost the ability to fly



✦ **Blue-footed booby** – courtship rituals,
capable of ocean diving

✦ **Great Frigate bird** – Unique adaptation for
mating rituals



✦ **Iguanas** – adapted for swimming

✦ **Hawks** – adapted for catching iguanas



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✦ **Finches** – different foods and habitats,
different beaks

✦ **Tortoises** – different shell patterns from
each island



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Large Cactus-Finch in the Galapagos Islands



End of the voyage

- ✦ When Darwin returned home, he had become famous for his collections and travel journals
- ✦ He wrote down his ideas about species changing over time and continued researching
- ✦ He read an essay written by Thomas Malthus

Darwin's Dilemma

- ✦ **Thomas Malthus – wrote paper on population growth in Great Britain**
 - ✦ **Population grows exponentially**
 - ✦ **Limiting factors for growth create a struggle for existence**
 - **Food**
 - **Area**
 - **Resources**

Charles Darwin

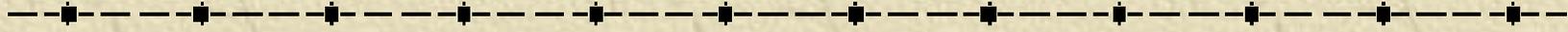
✦ All of Darwin's observations led him to create a theory to explain how evolution works

◆ Natural selection

- Organisms with favorable variations survive and produce more offspring than less well-adapted organisms
- Overtime this changes the traits found in a population

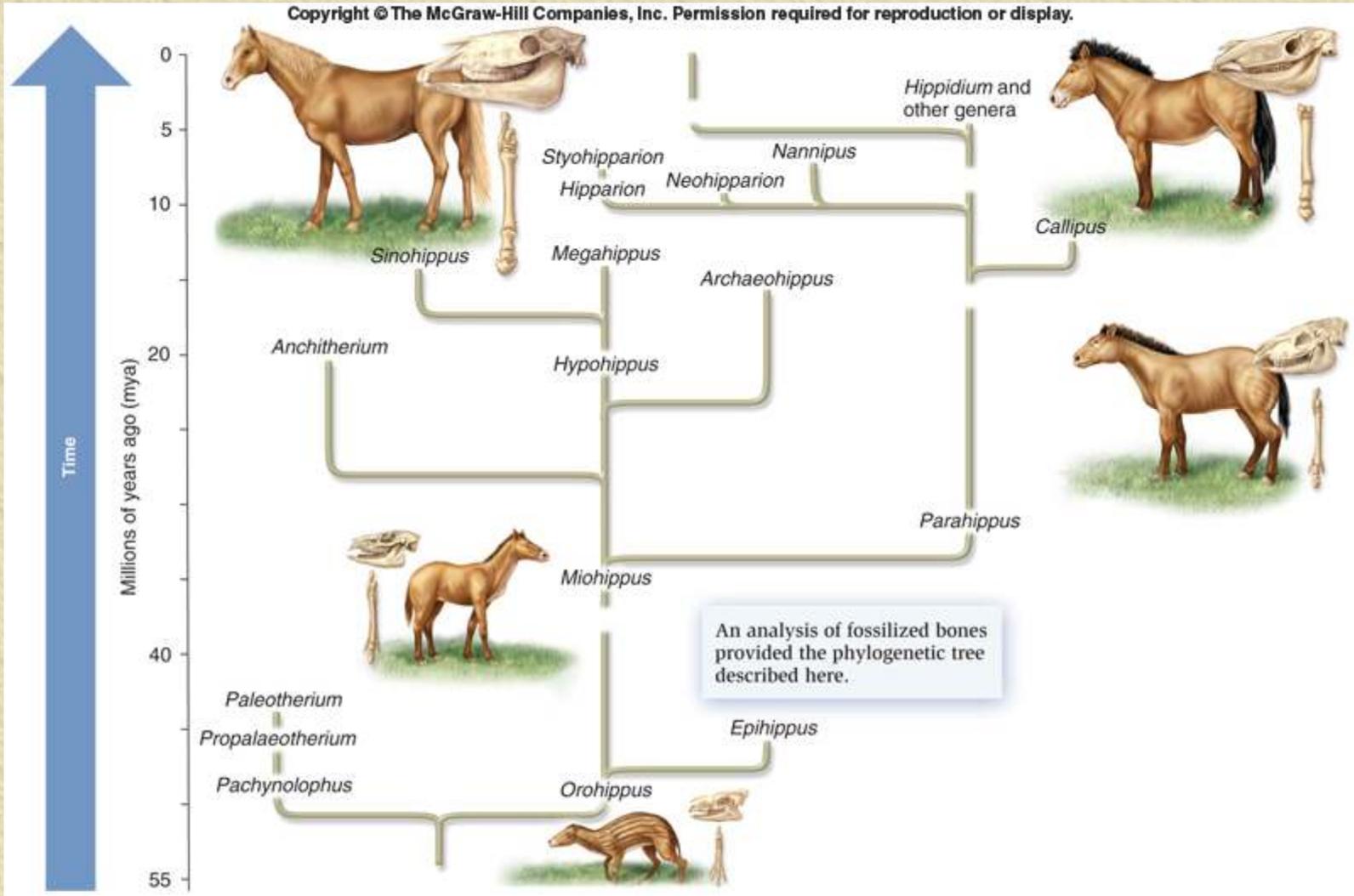
What evidence do we have?

- ✦ Fossil record
 - ✦ Chemicals of life
 - ✦ DNA
 - ✦ Homologous structures
 - ✦ Vestigial Structures
-
- ✦ Why do living things have so much in common?
 - ◆ Because they are all related
 - Shared genes





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Evidence in Living Organisms

✦ Cytochrome c is a highly conserved respiratory protein containing 104 amino acids in humans

Cytochrome c Evolution

	Organism	Number of amino acid differences from humans
	Chimpanzee	0
	Rhesus monkey	1
	Rabbit	9
	Cow	10
	Pigeon	12
	Bullfrog	20
	Fruit fly	24
	Wheat germ	37
	Yeast	42

Evidence in Living Organisms

✦ **Comparative biochemistry and molecular biology:**

- ✦ **All cells have DNA, RNA and ribosomes. They use the same 20 amino acids and use ATP as an energy carrier.**

✦ **What does this mean?**

Evidence in Living Organisms

Embryo resemblances

Fish



Salamander



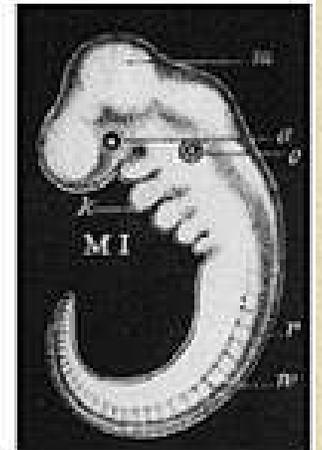
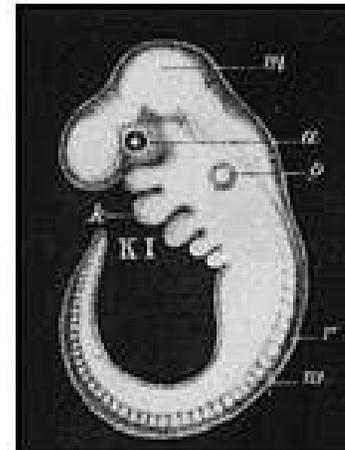
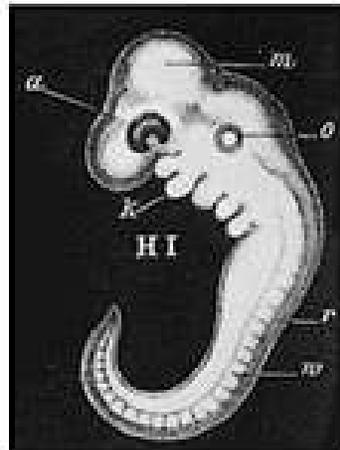
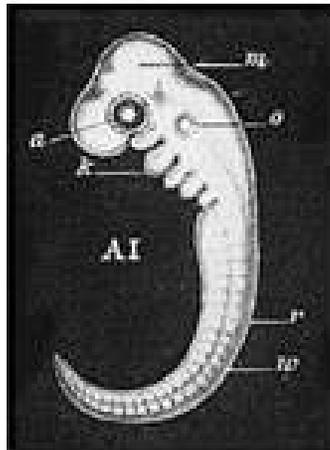
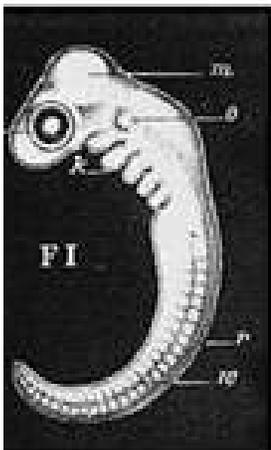
Chicken



Rabbit



Human



Evidence in Living Organisms

✦ Comparative embryology:

- ✦ **Similarities in anatomy indicate different species share common genes**
- ✦ Embryos become more dissimilar as they grow - Cell specialization and differentiation
- ✦ Common ancestor?
- ✦ Ernst Haeckel – famous zoologist who oversimplified drawings of embryos to support his ideas
 - hurt the credibility of evolutionary theory for a long time

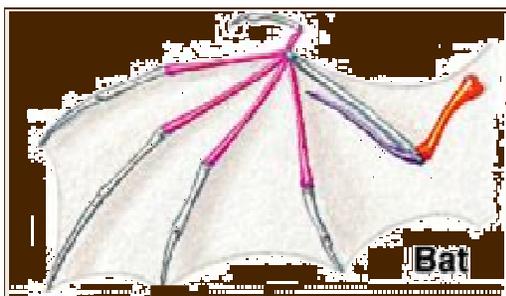
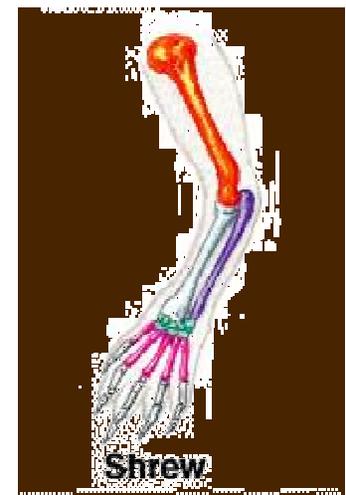
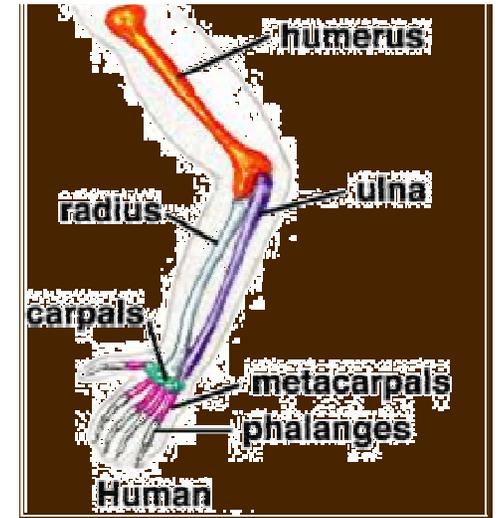
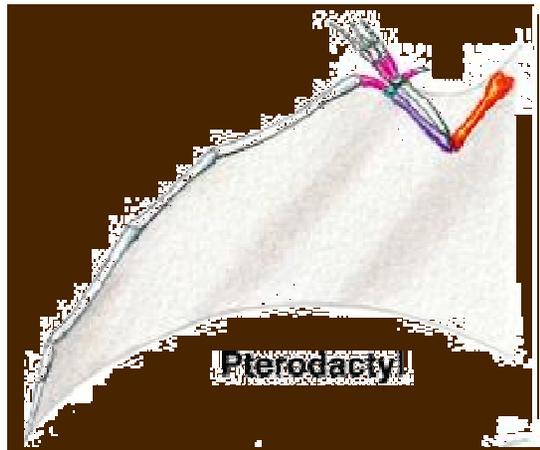
Evidence in Living Organisms

✦ Comparative anatomy:

- ✦ Homologous Structures – Structures that are similar in anatomy, but may serve very different functions.

- Ex: cat, whale, and human forearm

Homologous Structures



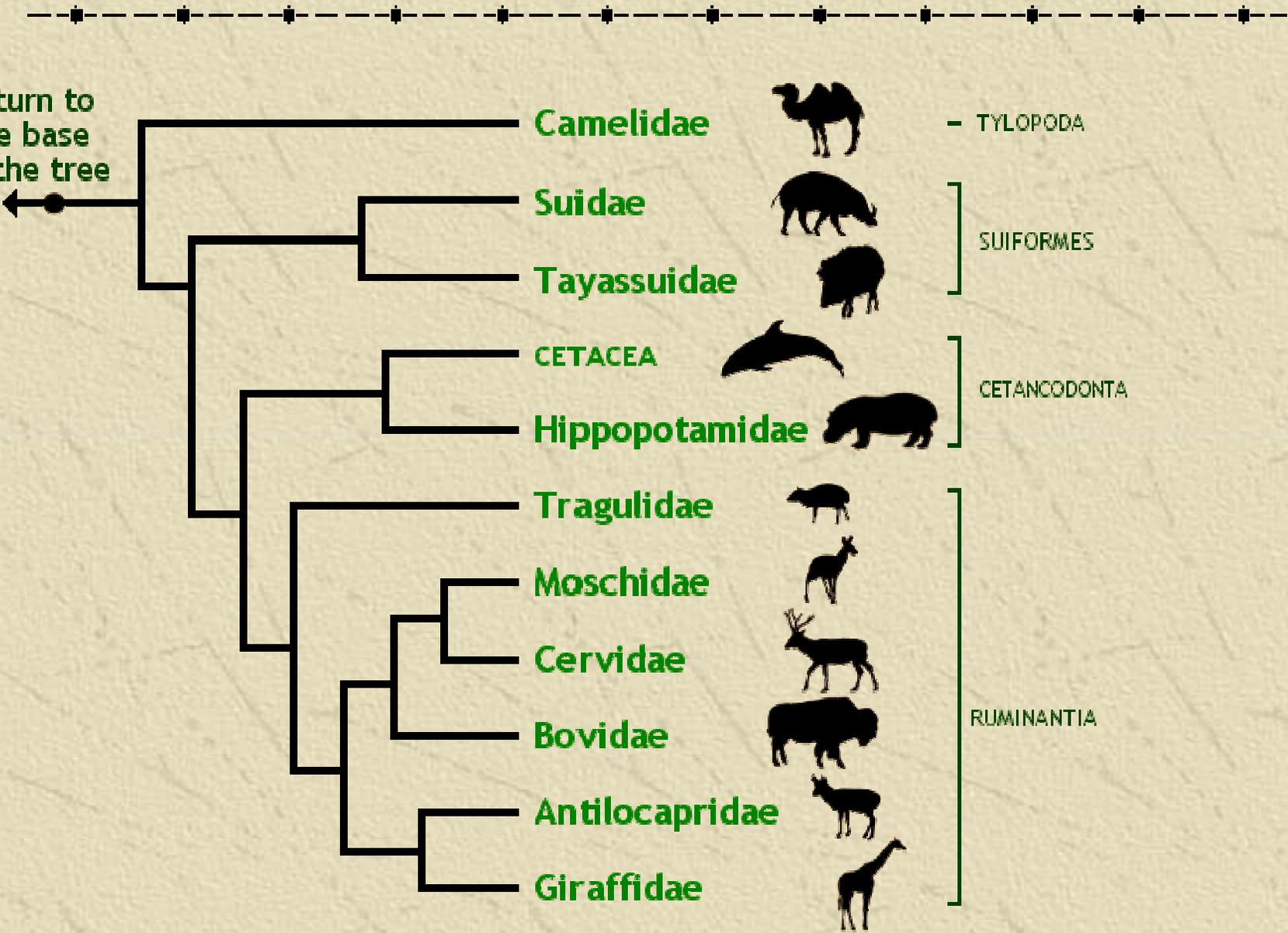
Flying

Swimming

Running

Grasping

Return to
the base
of the tree



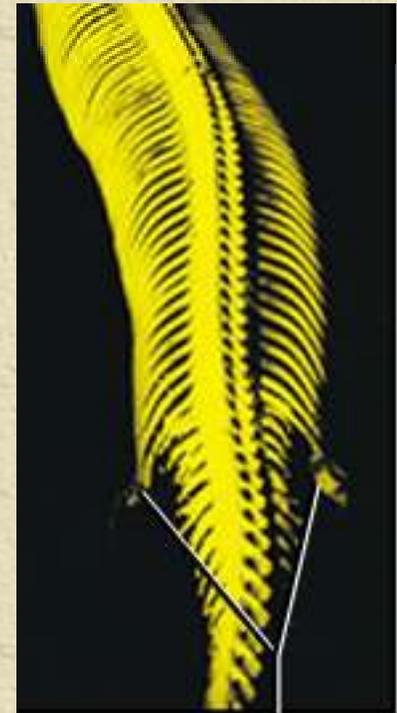
Evidence in Living Organisms.

✦ Comparative Anatomy (cont.):

- ✦ **Vestigial organs** – serve little or no purpose; may become smaller or even disappear

- **Ex: Tailbone or appendix in humans**
- **Ex: Tiny leg bones in snakes**

(Boas and Pythons)



Vestigial femurs

Whales

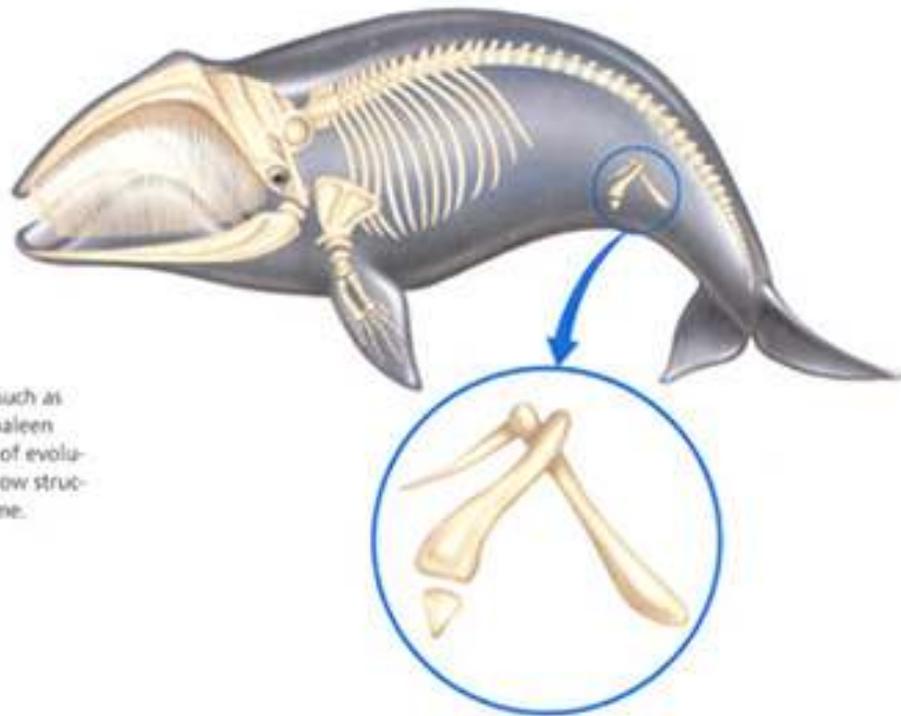
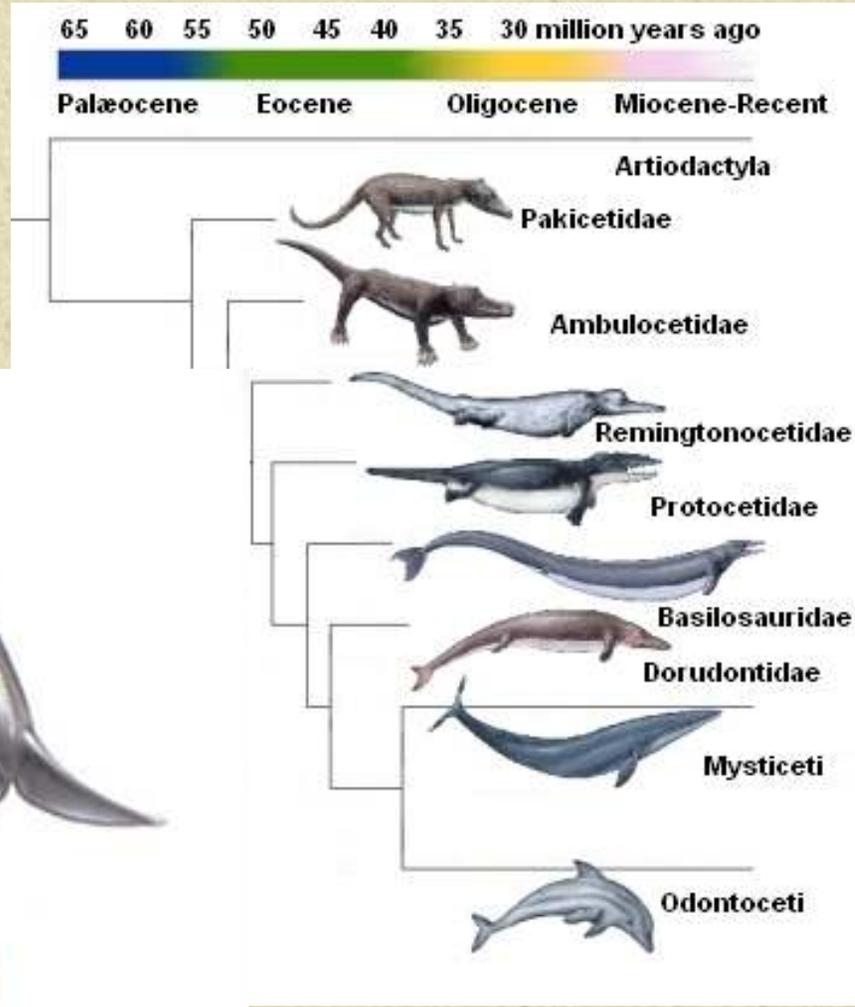


Figure 15.8
Vestigial structures, such as pelvic bones in the baleen whale, are evidence of evolution because they show structural change over time.



✦ How are new species made?

✦ Breeding vs. natural selection