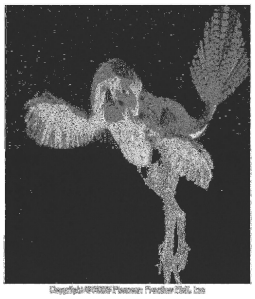
Principles of Evolution: Part 1

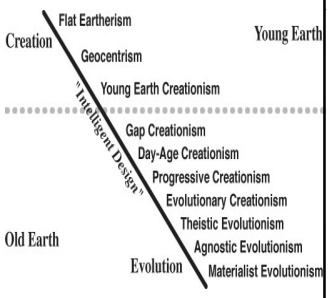
Chapter 14:
Sections 14.1 & 14.2



***Caudipteryx*:**
A feathered dinosaur

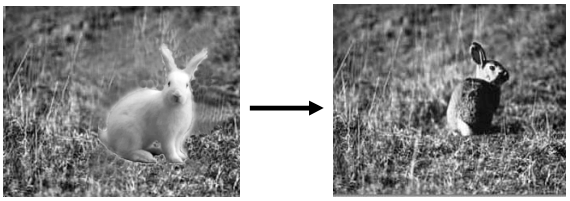
Evolution vs Creationism

- In…(1950), my predecessor [Pope] Pius XII has already affirmed that there is no conflict between evolution and the doctrine of the faith regarding man and his vocation, confirming that not only, to him and the people of his faith, are God and Evolution not mutually exclusive, but capable of coexistence
  – John Paul II



Evolution: Defined

- Evolution is the change in the genetic composition, and thus the characteristics, of a <u>population</u> over <u>generations</u>.



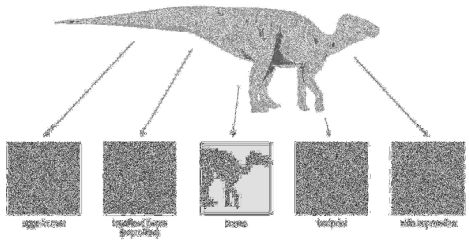
How did evolutionary thought "evolve"?

- Early scientists (i.e. Plato, Aristotle)
  - ❖Life forms are fixed; unchanging from their moment of creation by God.
- 18th century naturalists observe and catalog the diversity of life
  - ❖Notice high levels of diversity
  - ❖Notice resemblance of species to each other
    - ➢**Asked: Do similar species have a common ancestor?**

How did evolutionary thought evolve?

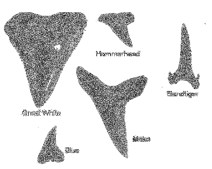
- Discoveries of fossils
  - A fossil is any part or trace of an organism preserved in rock or sediment

Fig. 14-3



Other fossil types

Living fossils



Body parts

Amber

How did evolutionary thought evolve?

- Organization of fossil layers (Smith)
  - Particular fossils always found in the same rock layers.
  - The organization of fossils and layers was consistent.
  - Organisms in upper layers (younger rocks) more closely resembled modern organisms.

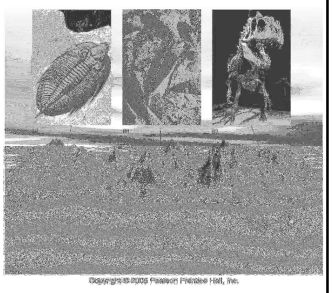


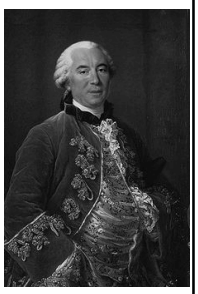
Fig. 14-4

How did evolutionary thought evolve?

- Non-evolutionary explanations for fossils
  - ❖Cuvier: catastrophism
    - ➢Many species initially created, but successive catastrophes destroyed most species
    - ➢Prediction: Fossils of modern species should be found in all layers.
      - » Not supported by data!
  - ❖Louis Agassiz's modification of catastrophism
    - ➢New creations occurred after each catastrophe.
      - – Periods of catastrophic extinctions seen in fossil layers.

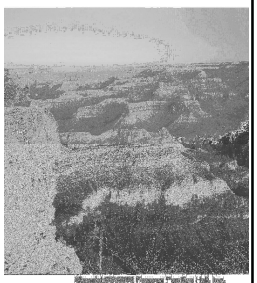
How did evolutionary thought evolve?

- LeClerc: combined non-evolutionary and evolutionary mechanisms
  - ❖Original creation → a few species
  - ❖Modern species were "conceived by Nature and produced in Time" by natural processes.
    - ➢Similar to theistic evolution thought.



How did evolutionary thought evolve?

- Age of the earth and time for evolution
  - **Hutton and Lyell: Uniformitarianism**
    - Layering of rocks occurred consistently over time
    - Caused by natural processes (wind, water, earthquakes & volcanoes)
    - Their calculations suggested earth was at least millions of years old



How did evolutionary thought evolve?

- Lamarck's hypothesis: Evolution of acquired characteristics
  - **Concept**
    - Animals change through lifetime
    - Changes acquired are passed to offspring
  - **Example**
    - Ancestral giraffes stretched their necks to reach for high vegetation.
    - The trait of a longer neck was passed to offspring.
  - **NOTE: <u>Falsified</u> based on principles of inheritance via genes. (MENDEL)**

How did evolutionary thought evolve?

- Darwin and Wallace developed current theory of evolution by natural selection
  - Based their theory on observations made in their travels
  - Darwin's voyage of the Beagle & Wallace's travels in Indonesia!
  - Key observation: Many species differ only in subtle, yet ecologically important ways
    - Example: "Darwin's finches"

Darwin's finches (Galapagos)

- Beak size and shape were related to food type
- Other aspects were similar, suggesting the birds were related

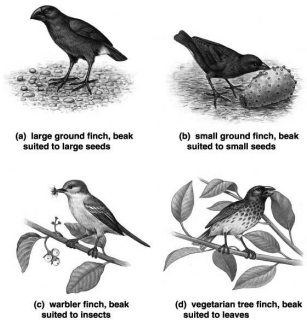


Fig. 14-5

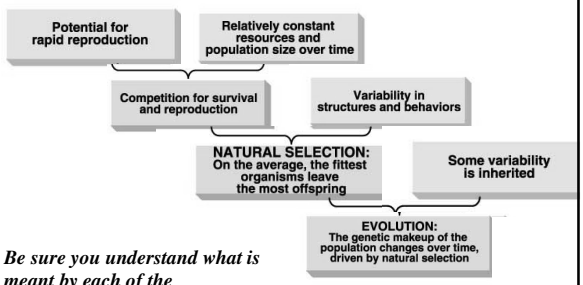
Theory of Evolution by Natural Selection

- "Evolution" and "Natural selection" are not the same thing!
  - ❖Evolution is...change in the genetic make-up of a population over generations.
  - ❖Darwin and Wallace's theory of evolution by natural selection is an explanation for one mechanism of evolution.
  - ❖Natural selection is not the only mechanism of evolution.
    - ➢We will discuss other mechanisms in a later lecture.

Theory of Evolution by Natural Selection

- Natural selection: defined:
  - ❖The differential survival and reproduction of members of a population that occurs on the basis of differences among individuals in their adaptation to the environment.
    - ➢"Environment" includes all aspects of their niche, both living and non-living.
- The theory is based on four observations along with the conclusions derived from these observations.
  - ❖We will go through these step by step…

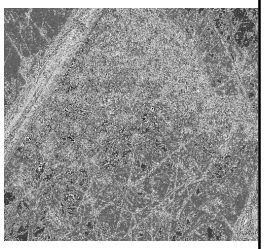
Theory of Evolution by Natural Selection



Be sure you understand what is meant by each of the observations and conclusions. Don't just memorize them!

Theory of Evolution by Natural Selection

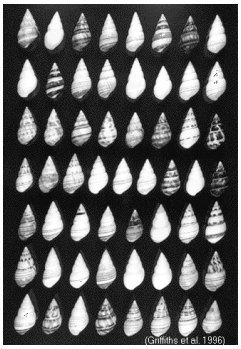
- Many animals have large numbers of offspring
- Only some of these survive to adulthood
- Only some of the adults will reproduce



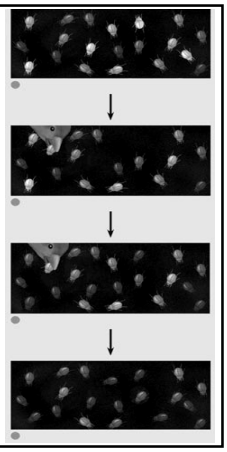
Many *Dolomedes* spider juveniles.

Theory of Evolution by Natural Selection

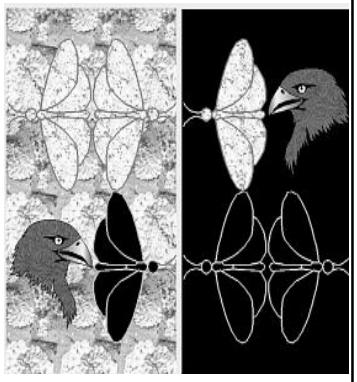
- Variations in size, color, spotting/striped patterns, disease resistance, etc. affect survivorship and reproduction.
  - ❖What survives is determined by the environment.
  - ❖*Natural selection*



- Fig. 1-21: Natural selection at work.

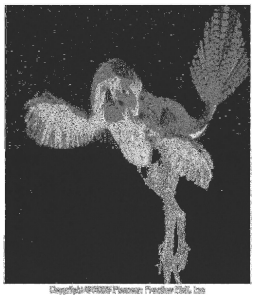


- Natural selection at work
  - ❖Which survive depends on the environment



Principles of Evolution: Part 2

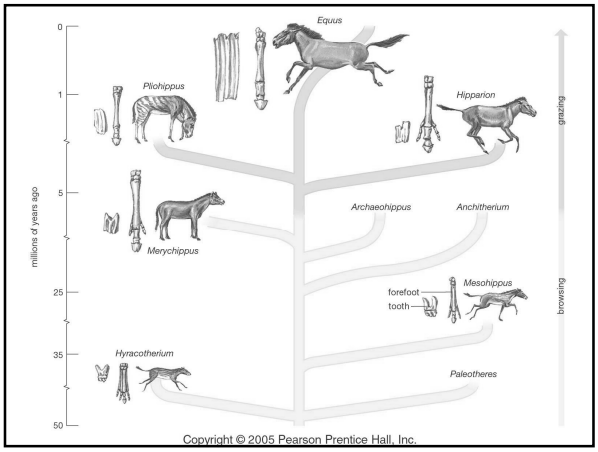
Chapter 14:
Sections 14.3 & 14.4



***Caudipteryx*:**
A feathered dinosaur

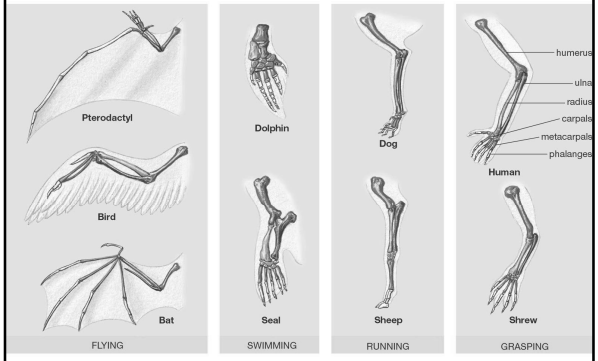
Evidence that evolution has occurred

1. Progressive series of fossils
   - ❖ Ancient form → Intermediate stages (several) → modern form
     - ➢ Example: Evolution of the horse [Fig. 14.6]
     - ➢ What types of changes occurred in teeth, hooves and body size and how are these changes adaptive?
   - ❖ NOTE: Many of these types of series exist for a variety of organisms.



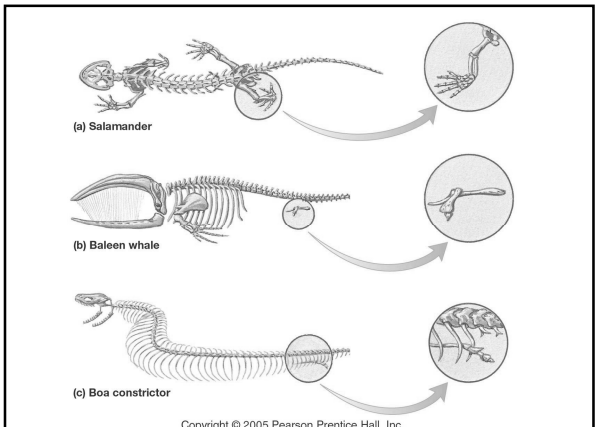
Evidence that evolution has occurred

2. Homologous structures: structures that may differ in function but have <u>common anatomy</u>, suggesting that they were derived from a <u>common ancestor</u>.
   - ❖ Example: forelimbs of birds and mammals
     - ➢ Can clearly identify similar arrangement of bones
     - ➢ Modifications of these bones are related to their functions



Evidence that evolution has occurred

3. Vestigial structures: structures that serve no apparent purpose, but are homologous with functional structures in related organisms
   - ❖ Often reduced in size
     - ➢ Examples:
     - ➢ Pelvic/hindlimb bones of some snakes and whales indicate relationship with animals that use their hindlimbs.
     - ➢ Molars in blood-sucking vampire bats indicate relationship with bats that chew food.



Evidence that evolution has occurred

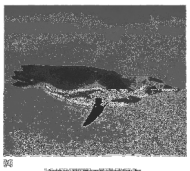
4. Convergent evolution: Similar characteristics in organisms arise due to similarity in environment or lifestyle, rather than relatedness
   - ❖ **Similar characteristics that arise via convergent evolution are analogous**
   - ❖ **KEY: Structures of two organisms are considered analogous if they share no common ancestor with the particular structure!**

Examples of analogous structures that arose via convergent evolution

- Insects and birds have no common ancestor with wings!
  - ❖ Thus, their wings are *analogous* structures!

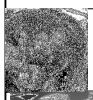
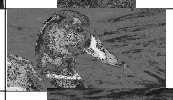
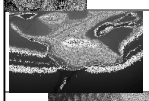
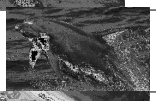
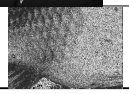
Homologous vs. analogous characteristics

- Describe a characteristic shared by seals and birds that is homologous between these animals.
  - ❖ Hint: Birds and mammals probably share a ancient reptilian ancestor.



- Describe a characteristic shared by seals and penguins that is analogous between these animals.
  - ❖ Hint: seals evolved from dog-like animals; penguins from flying birds.

Analogous vs homologous?

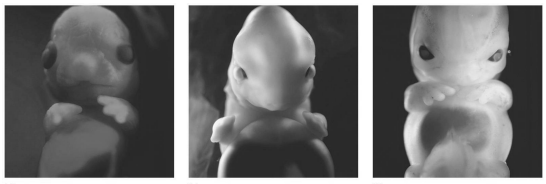
Organism 1	Organism 2	characteristic
		wings
		bill
		flippers
		scales

Evidence that evolution has occurred

5. Embryological similarities

- These are early embryos of

a) a lemur b) a pig, and c) a human.



(a) (b) (c)

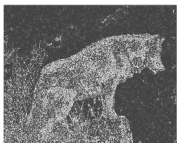
Evidence that evolution has occurred

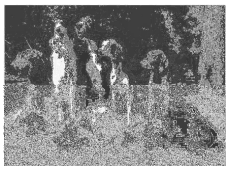
6. Biochemical and genetic similarities among all organisms suggest common ancestry of all life.

- All cells use DNA as the molecule of heredity.
- All cells use the same 20 amino acids to build proteins.
- Many other examples!

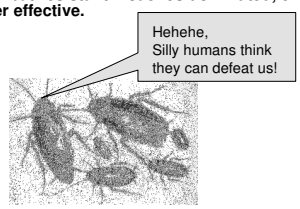
Evidence that evolution occurs by natural selection

1. Artificial selection works.
   - ❖ Humans breed plants and animals for desired traits.
     - ➢ Organisms with desired traits are allowed to breed;
     - ➢ their traits persist while less desired traits don't.
     - ➢ Humans are the selective force.

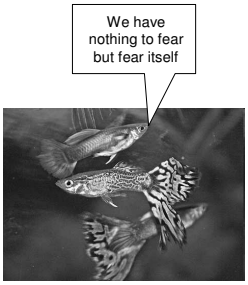


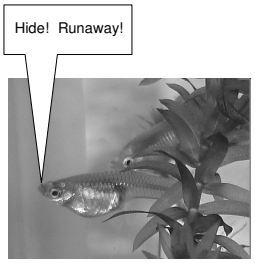


2. Many current examples of natural selection.
   - ❖ Example: Evolution of cockroaches to ignore "Combat", a poison bait
     - ➢ Most roaches were attracted to Combat and killed
     - ➢ A **very small** percentage of roaches did not like the bait (disliked glucose) due to a rare mutation.
     - ➢ These roaches survived and reproduced, and thus increased in the population!
     - ➢ **Over time, these "Combat-resistant" roaches dominated, & Combat was no longer effective.**



Guppies





Guppies are more colorful in predator free environments.