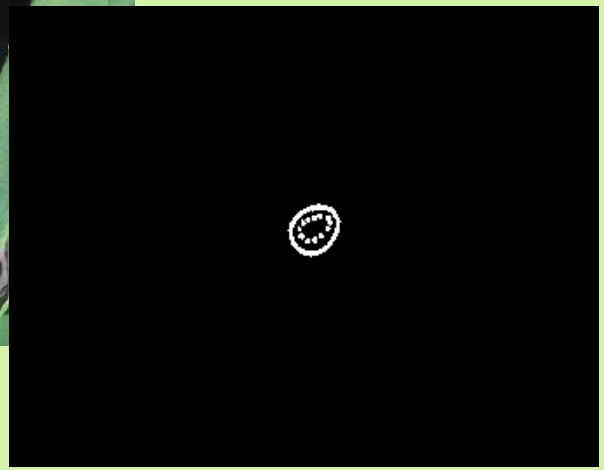
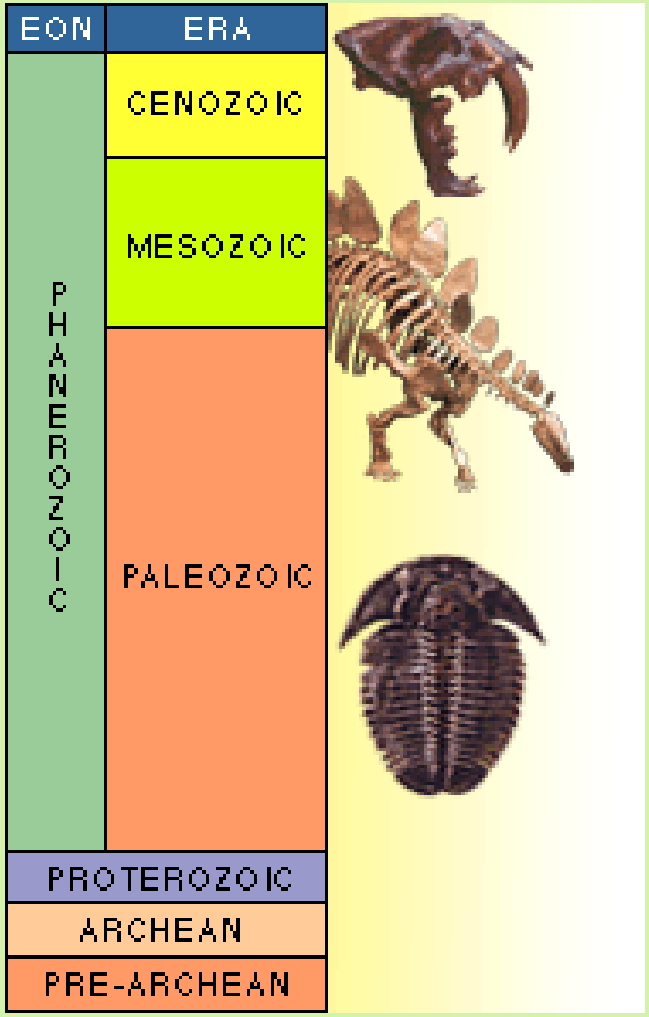
Evolution: Evidence and Theory

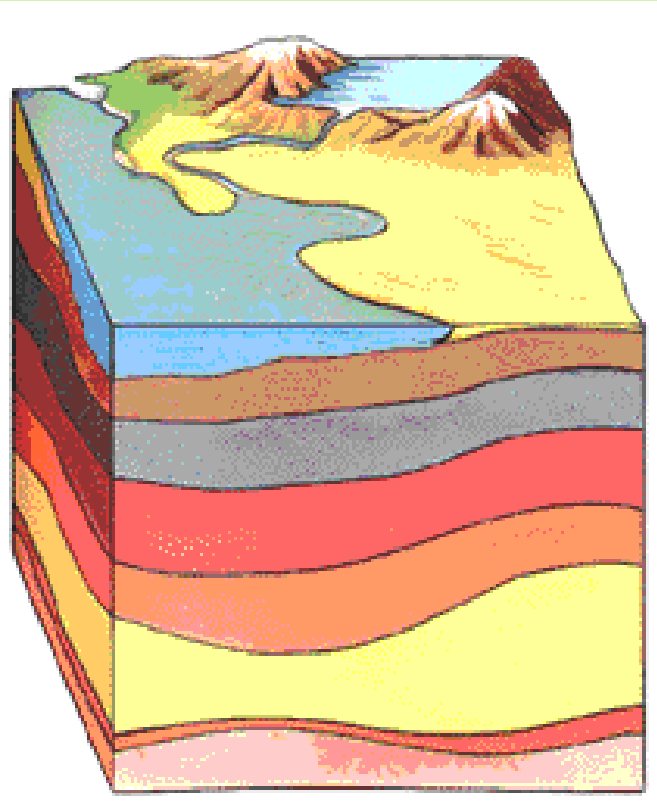


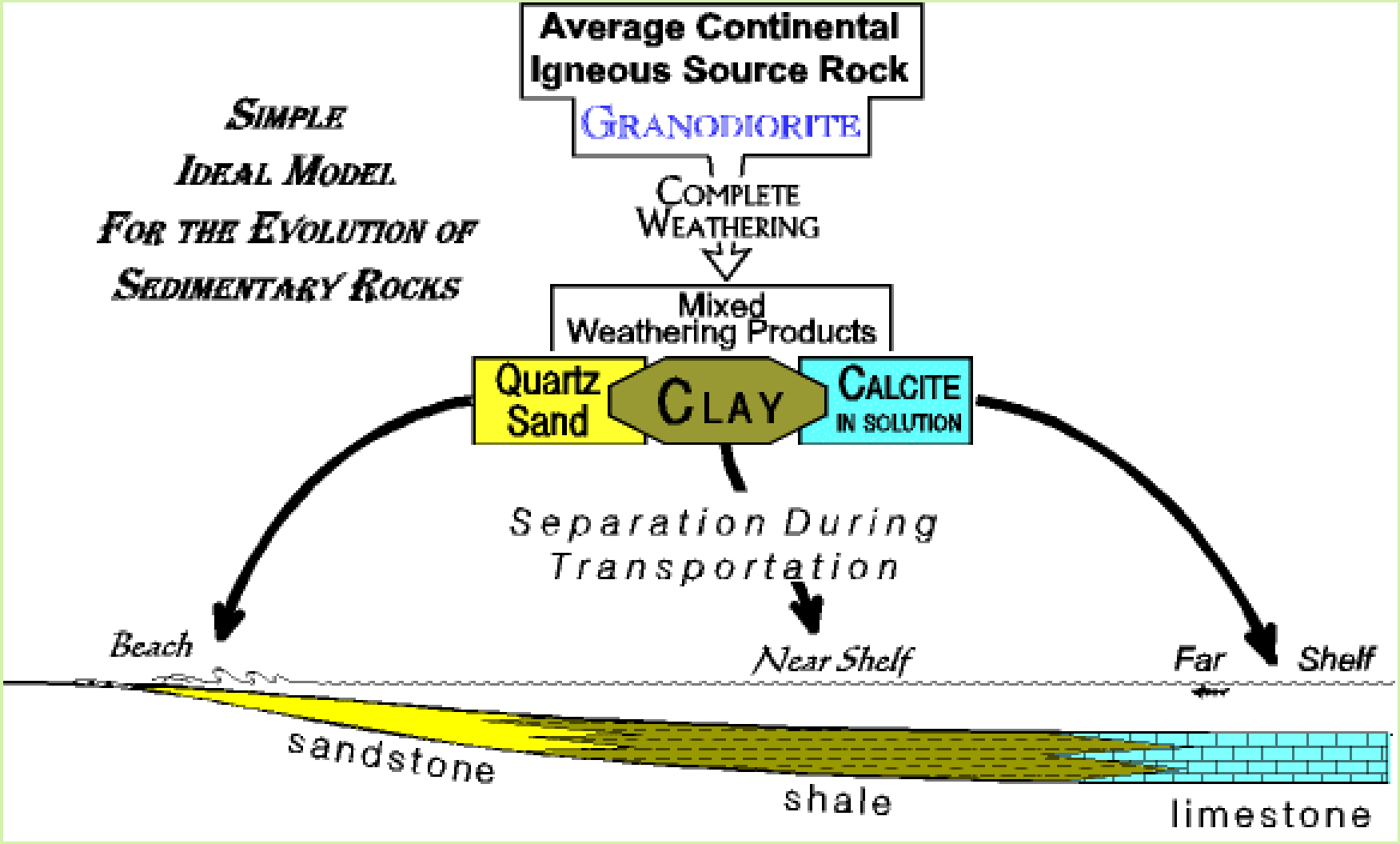
Evolution


EON
ERA
PHANEROZOIC
CENOZOIC
MESOZOIC
PALEOZOIC
PROTEROZOIC
ARCHEAN
PRE-ARCHEAN

Where are fossils found?

- Sedimentary Rock made of sand, dust, mud= Sandstone, Limestone and Shale.




Simple
Ideal Model
For the Evolution of
Sedimentary Rocks
Average Continental
Igneous Source Rock
Granodiorite
Complete
Weathering
Mixed
Weathering Products
Quartz
Sand
Clay
Calcite
in solution
Separation During
Transportation
Beach
Near Shelf
Far Shelf
sandstone
shale
limestone

Review of the types of fossils:

- **Molds:** Inward, like a cake pan.
- **Casts:** Outward, like the cake.
- **Amber:** Fossilized sap with trapped life forms.
- **Frozen:** Trapped in ice.
- **Trace:** Footprints, leaves, etc.

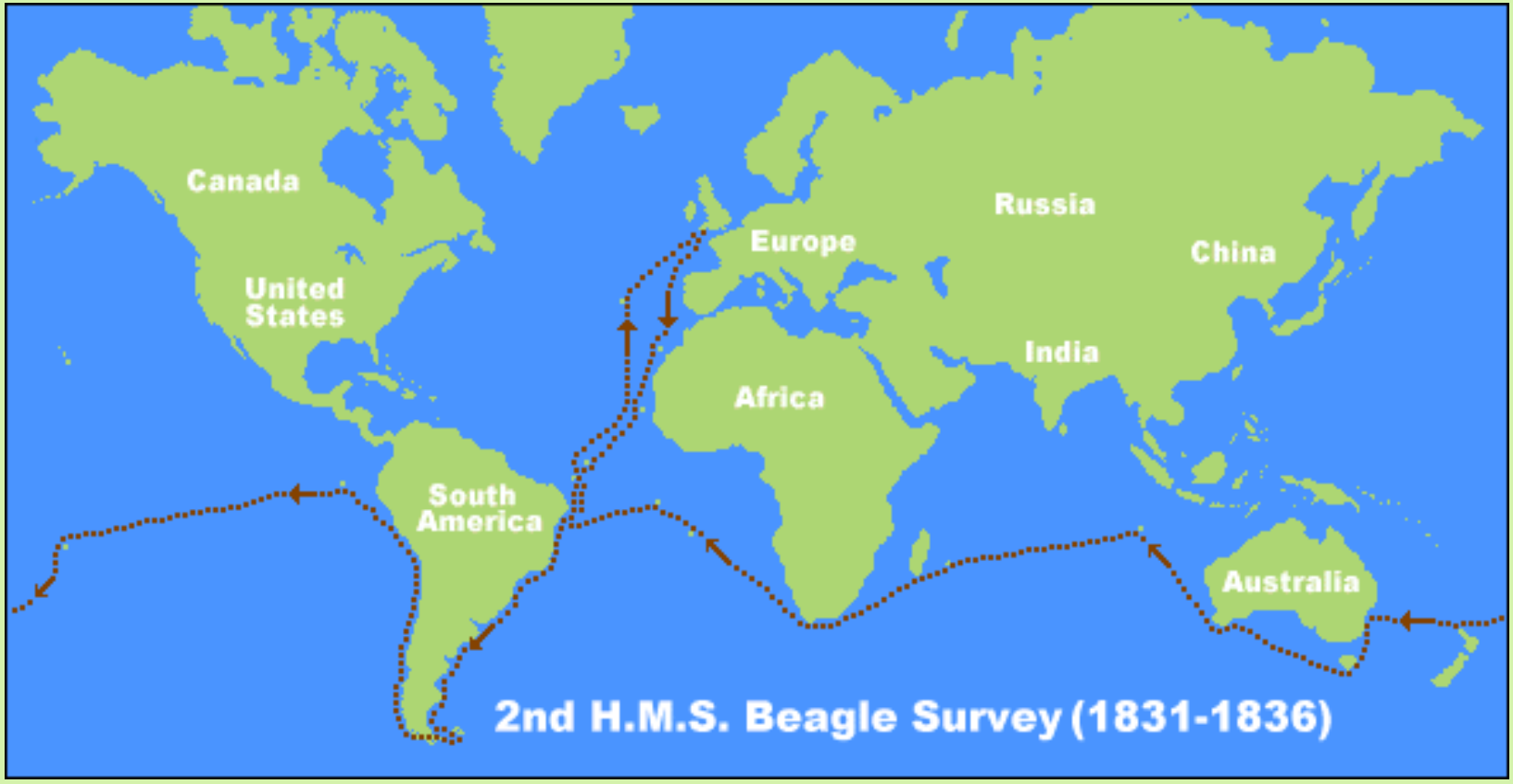
Mold & Cast Formation

How do we know how old fossils are?

- **Law of superposition**: The rock on the bottom layer are the oldest, the rocks on the top layer are the youngest.
  - Gave a **relative age** of the fossil
  - **Absolute age** is estimated through radiometric dating.

Theories of Evolution

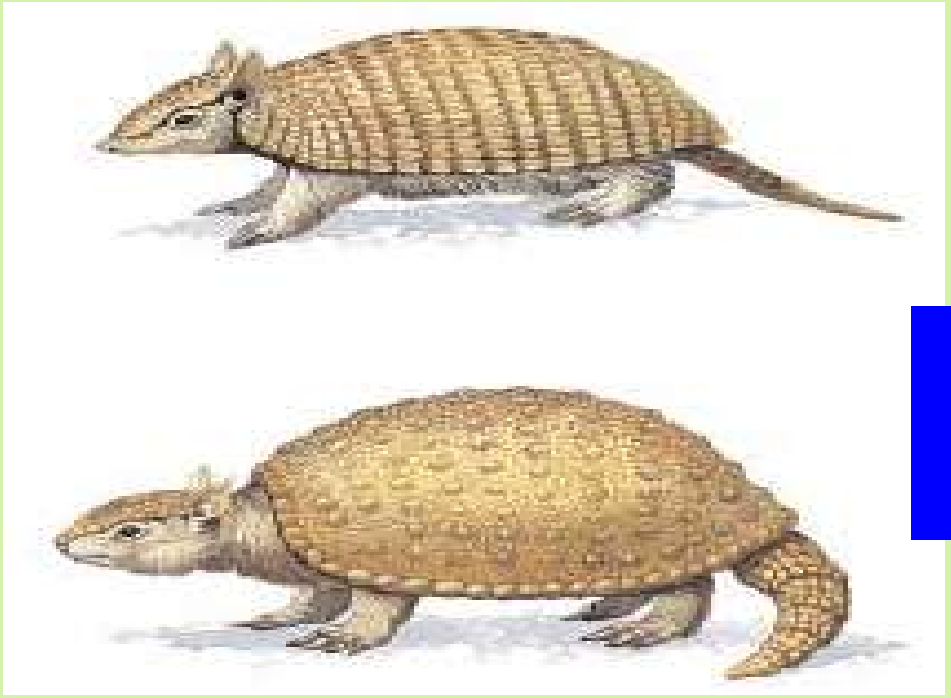
- Lamarck- Late 1700's
  - Theorized that organisms changed to modern beings through acquired traits, not determined by genes.
- Darwin- 1850's Voyage on the HMS Beagle
  - (Fig. 15-4). Noticed biogeographically changes.
  - Over thousands and millions of years a species could evolve through changes in traits that affected the population. Called **Adaptive Advantage**.
  - All organisms originated from one form of life.


Canada
United States
Europe
Russia
China
India
Africa
South America
Australia
2nd H.M.S. Beagle Survey (1831-1836)

Influences on Charles Darwin

- **Charles Lyell:** ***Principles of Geology*** earths process do not change.
- **Alfred Wallace:** naturalist
- **Thomas Malthus:** exponential growth of populations limited by conditions.

Some of Darwin's Observations



Galapagos Animals

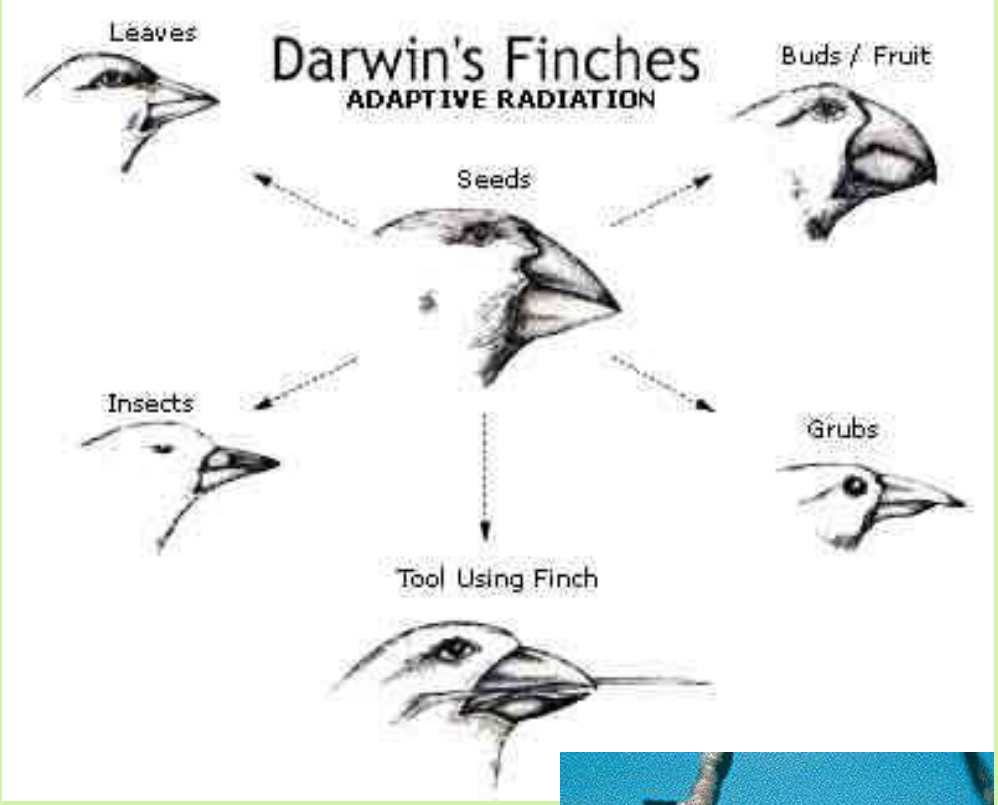
Albatross: 6-11ft wingspan.

Want to see the Frigate bird? I'll only show you The male.

HHMI Galapagos

Examples of Natural Selection

- Darwin's Finches
- Darwin's finches are an excellent example of the way in which species' gene pools have adapted in order for long term survival via their offspring. The Darwin's Finches diagram illustrates the way the finch has adapted to take advantage of feeding in different ecological niche's.
- Their beaks have evolved over time to be best suited to their function. For example, the finches who eat grubs have a thin extended beak to poke into holes in the ground and extract the grubs. Finches who eat buds and fruit would be less successful at doing this, while their claw like beaks can grind down their food and thus give them a selective advantage in circumstances where buds are the only real food source for finches.



Jacanas
And
Polyandry

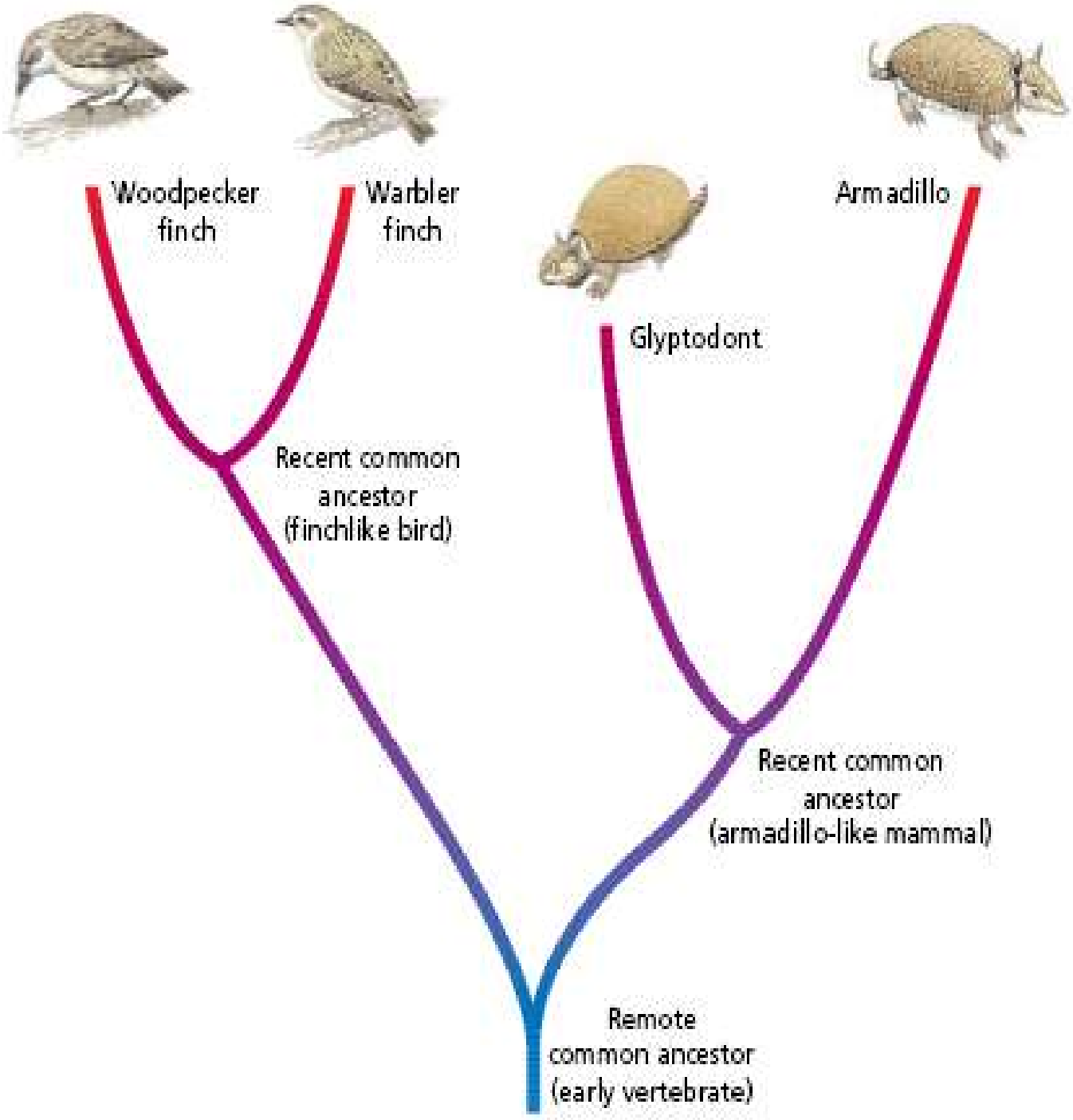


FIGURE 15-6

Darwin reasoned that if the Galáp
finches were similar to each othe
because of recent common ances
then organisms that are more dis
lar, such as finches and armadillo
share a more remote ancestor.

Peacocks

Eco Connectio

Galápagos Islands

The exotic and fragile ecosysten
the Galápagos that fascinated
Charles Darwin in the mid-1830

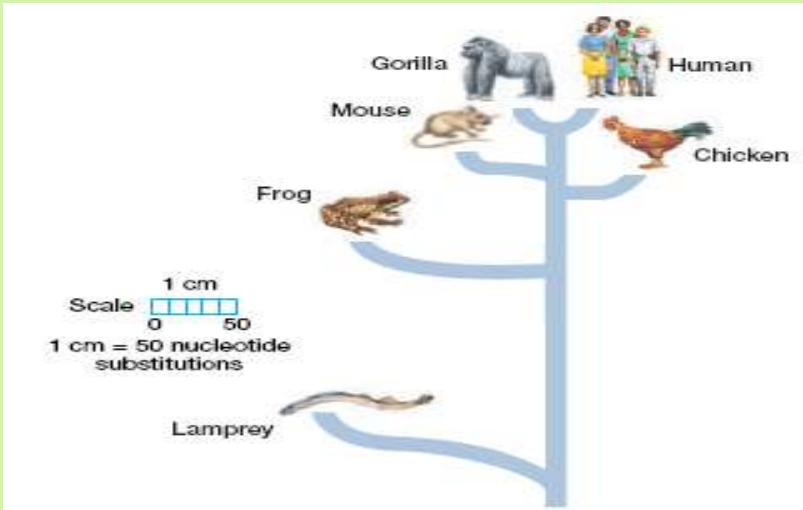
Darwin's Theory Updated

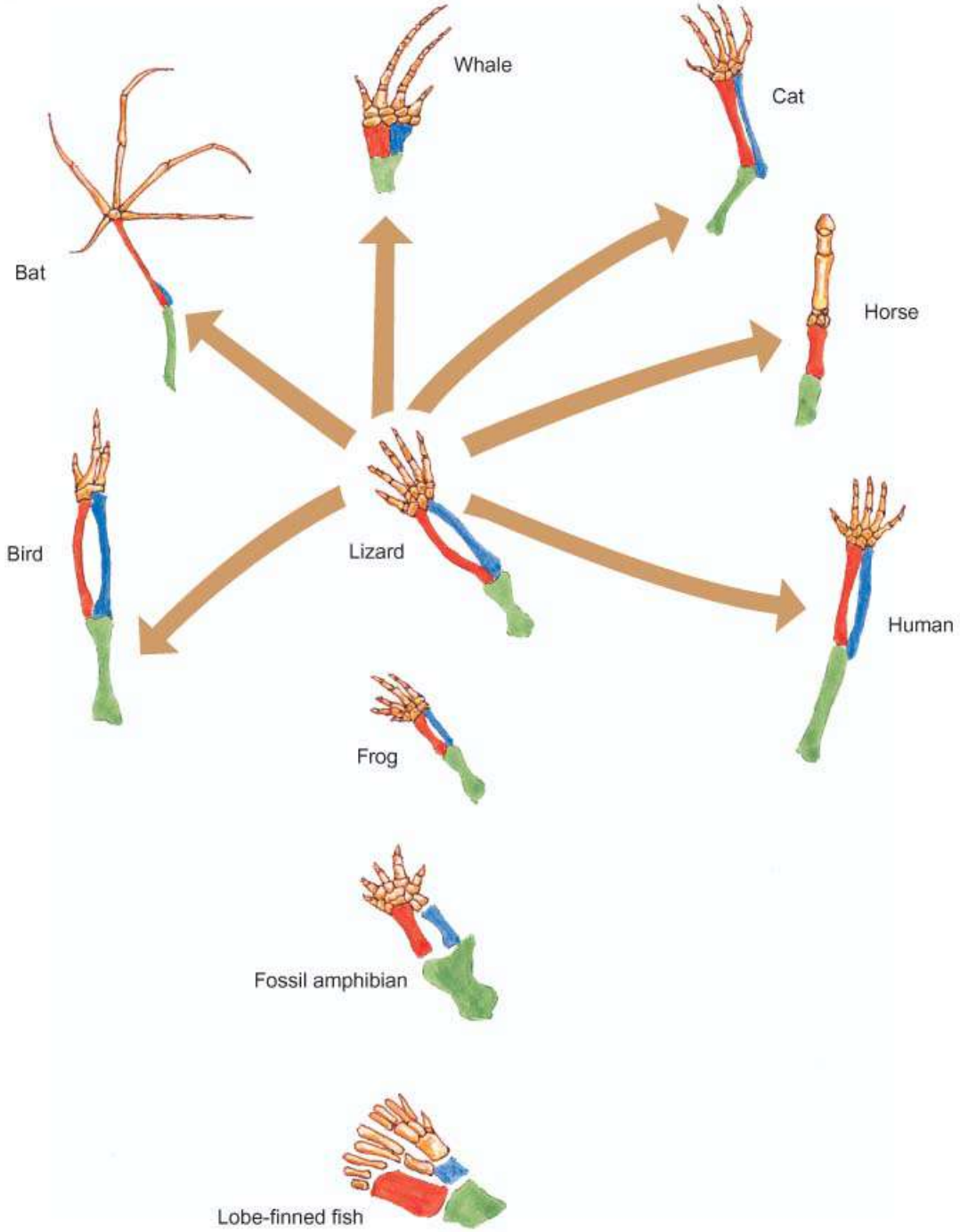
- **Certain genes or alleles may give an organism an adaptive advantage. That organism then may be more reproductively fit and reproduce more, thus increasing the allelic frequency of that particular trait resulting in a change in the population.**

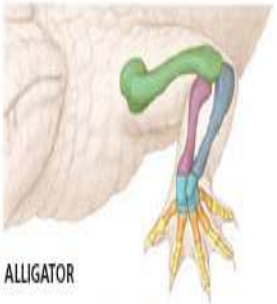
Reminder of the Evidence of Evolution

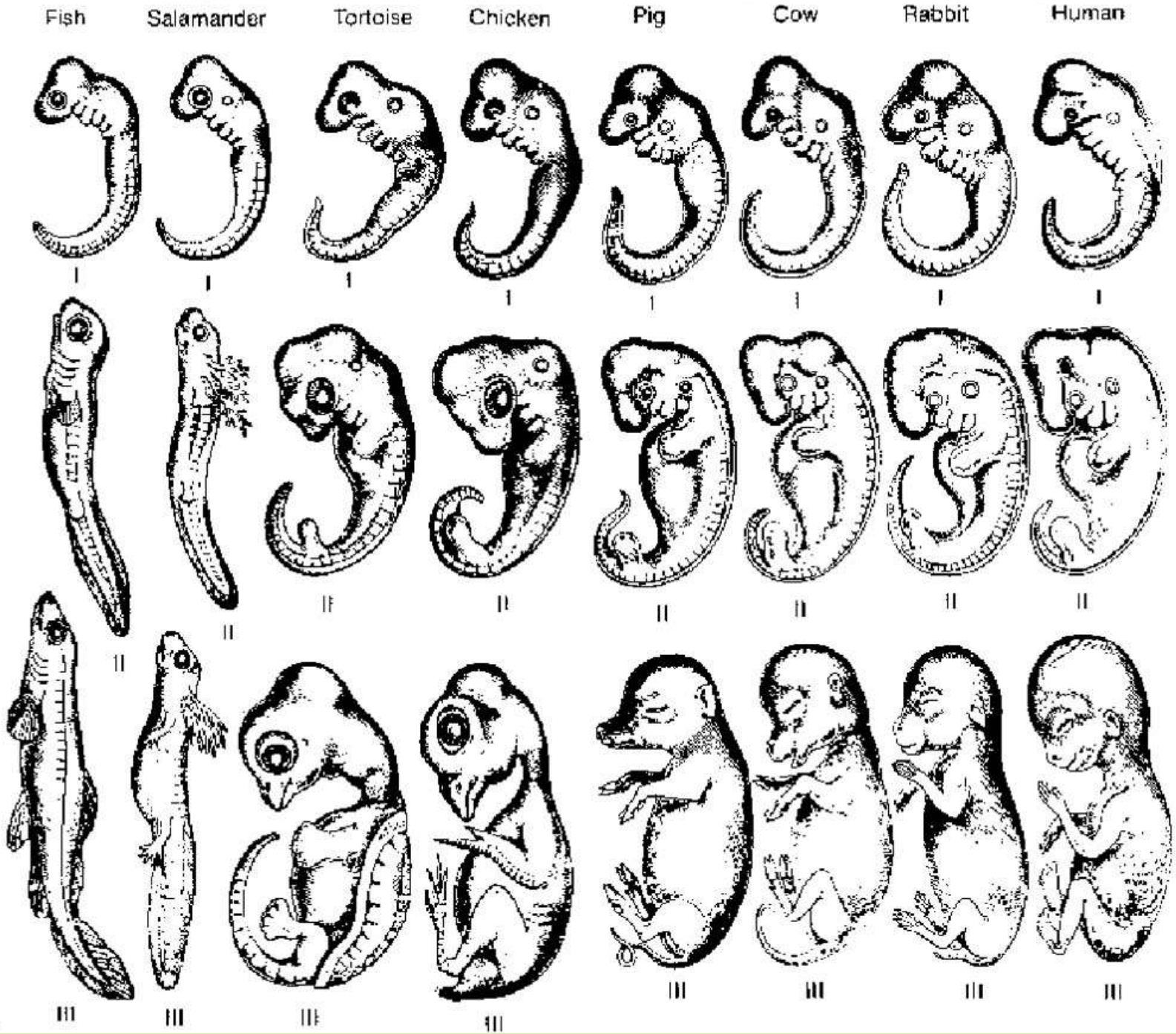
- Homologous Vs. Analogous Structure (Page 312-313)
- Vestigial Structures (314)
- Embryology Similarities and Macromolecules

Embryos









What are the Patterns of Evolution?

Coevolution

- **Convergent Evolution**
- **Divergent Evolution-** Can be caused by adaptive radiation

Lice

Whale evolution

How does Evolution Really Work?

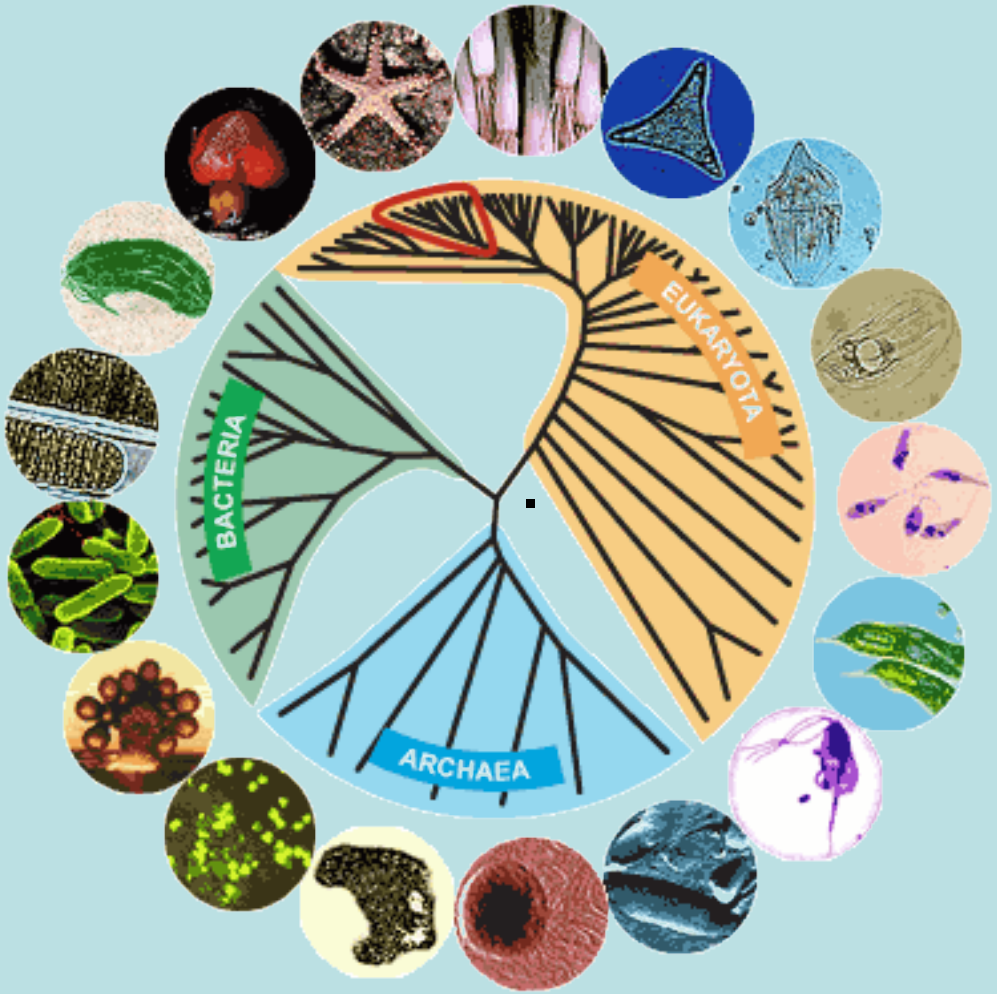
- Wooly Worm Lab: After Video

Evolution Computer Lab

Humming Bird Evolution

Natural Selection Comp Lab

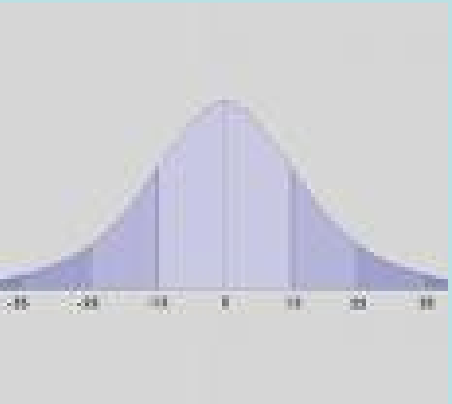
Evolution of Populations and Speciation



DNA

What is Population Genetics?

- The study of evolution from a genetic point of view.
  - Populations: smallest unit in which evolution can occur
  - Often populations form a bell curve when their traits are compared. Fig. 16-1 Exp. Tall and small are extremes, most are average.



How does variation arise?

- Mutation: genetic flaws
- Recombination: during meiosis, due to independent assortment and crossing over
- Random fusion of Gametes: Chance
- Other causes: Diet, disease,etc – (variations that are not passed on.)

Pima Indian Variation


mares

What is a gene pool?

- The total genetic information available in a population.
- **Allele frequency**= Number of X allele/ total alleles in a population.

Modern Stickleback

Fossilized Fish Evolution

How Can You Predict Phenotype Frequency?

- Think back to Gregor Mendel
- Phenotype Frequency=

$$\frac{\text{Number of Individuals with X Characteristics}}{\text{Total number of Individuals in the Population}}$$

Problem: In a population of 88 Individauls, 32 are blond. What is the phenotype frequency?

Answer= 36%

What is Hardy-Weinberg Genetic Equilibrium?

- Allele frequency in a population remain the same unless acted upon by an outside influence.
- The Rules:
  - No net mutations
  - Individuals do not enter or leave the population
  - The population is large
  - The individuals mate randomly
  - Selection does not occur
- Watch the Video Clip and Explain How this violates Hardy Weinberg Genetic-Eq.

Hardy-Weinberg Explained

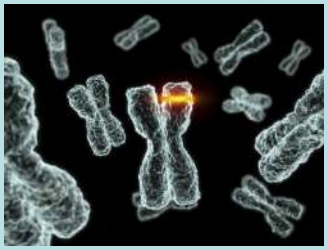
What can disrupt Genetic Equilibrium?

- Mutation
- Migration
  - Immigration
  - Emigration
- Genetic Drift (Fig. 16-6)
  - Allele frequency in a population change, frequently occurs in small and medium size populations. (e.g. Amish Populations)
- Nonrandom Mating
  - Due to geographic proximity, and assortative mating
- Natural Selection (figure 16-7)
  - Stabilizing Selection
  - Directional Selection
  - Disruptive Selection
  - Sexual Selection

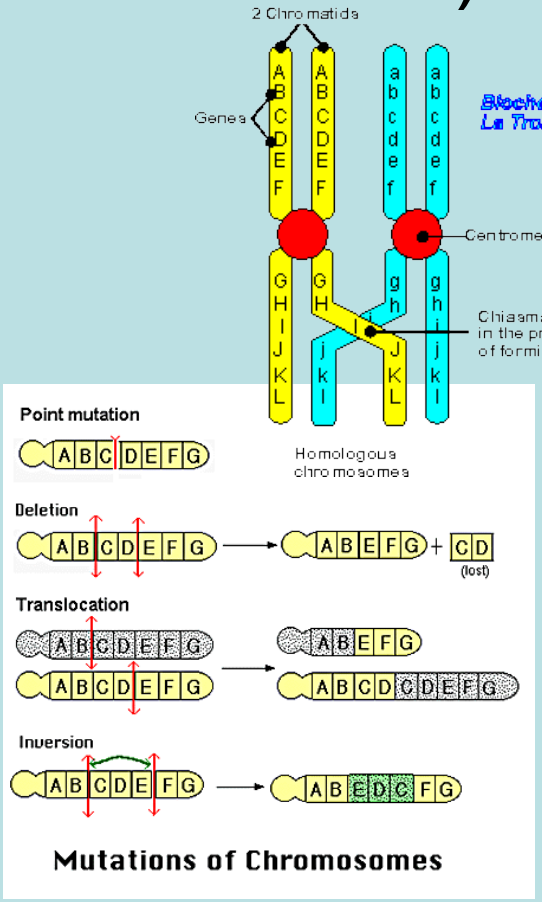
Hardy-Weinberg Ex. Examples

Evolution Of Corn

Where does genetic variation come from?



- Mutations on Gametes (reproductive cells)
  - Point mutations
  - Frameshift mutations
  - Chromosomal mutations
- Recombination
  - Meiosis
    - Crossover
    - Independent assortment
    - Segregation



What is a Species?

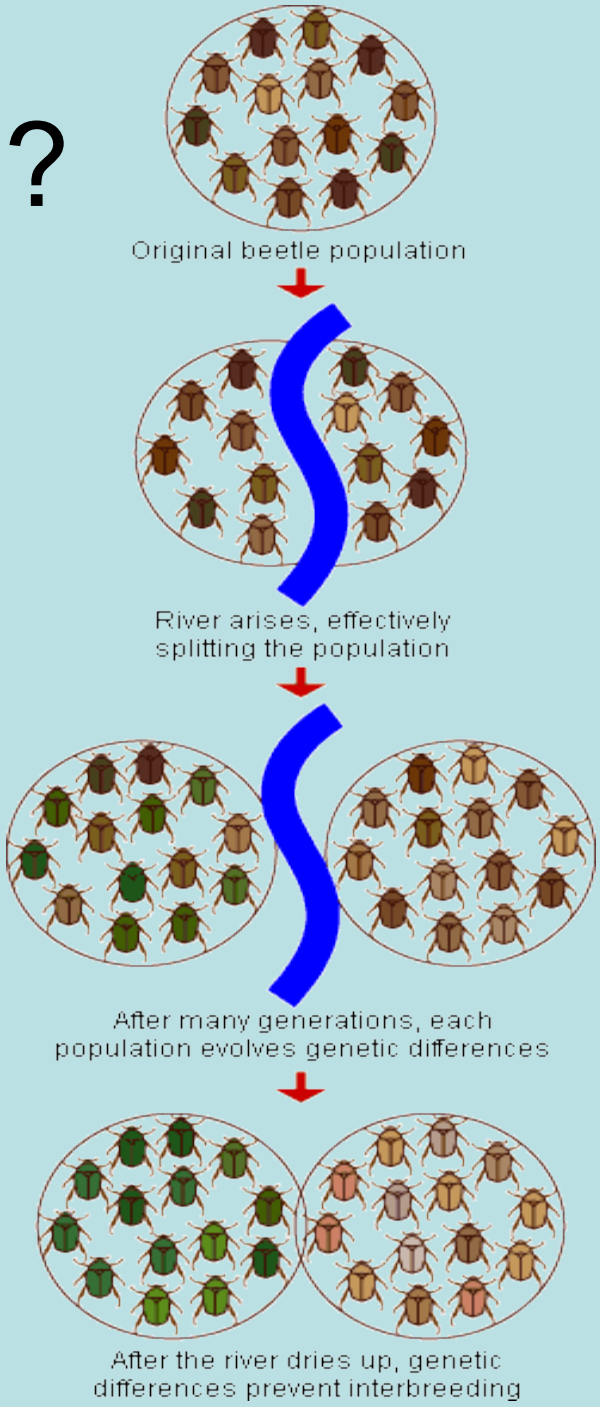
Fruit Fly

In Love

- **Species:** Population of organisms that can successfully interbreed and whose progeny can also reproduce.
- **Species**: Structure and appearance primarily define a species.
- Both are necessary definitions in order to group all living things such as bacteria, fungi, and humans.

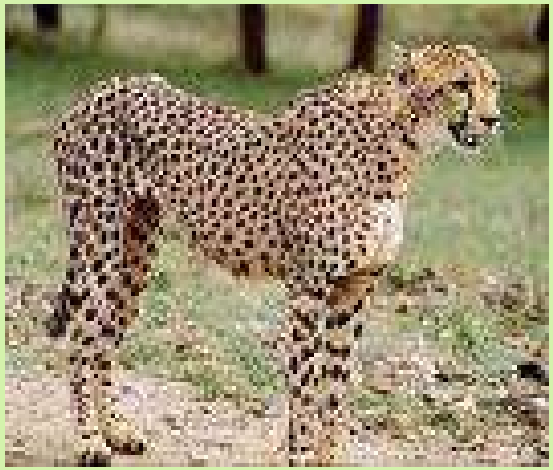
How do species arise?

- Geographic Isolation
- Reproductive Isolation
  - Behavioral isolation
  - Temporal isolation
- Natural Selection



Habitat isolation

- Cheetahs share the same general area with leopards and lions. What makes them separate from these other felids is that cheetahs are primarily diurnal, that is they are active during the day. Lions on the other hand are more active at night



Temporal isolation: Species that breed at different times of the day, different seasons, or different years cannot mix their gametes

(c)

(d)

Behavioral isolation: Courtship rituals and other behaviors unique to a species are effective barriers

Reproductive Isolation **Sympatric:** not geographic.

- Reproductive isolation is the existence of biological factors (barriers) that impede two species from producing viable, fertile hybrids

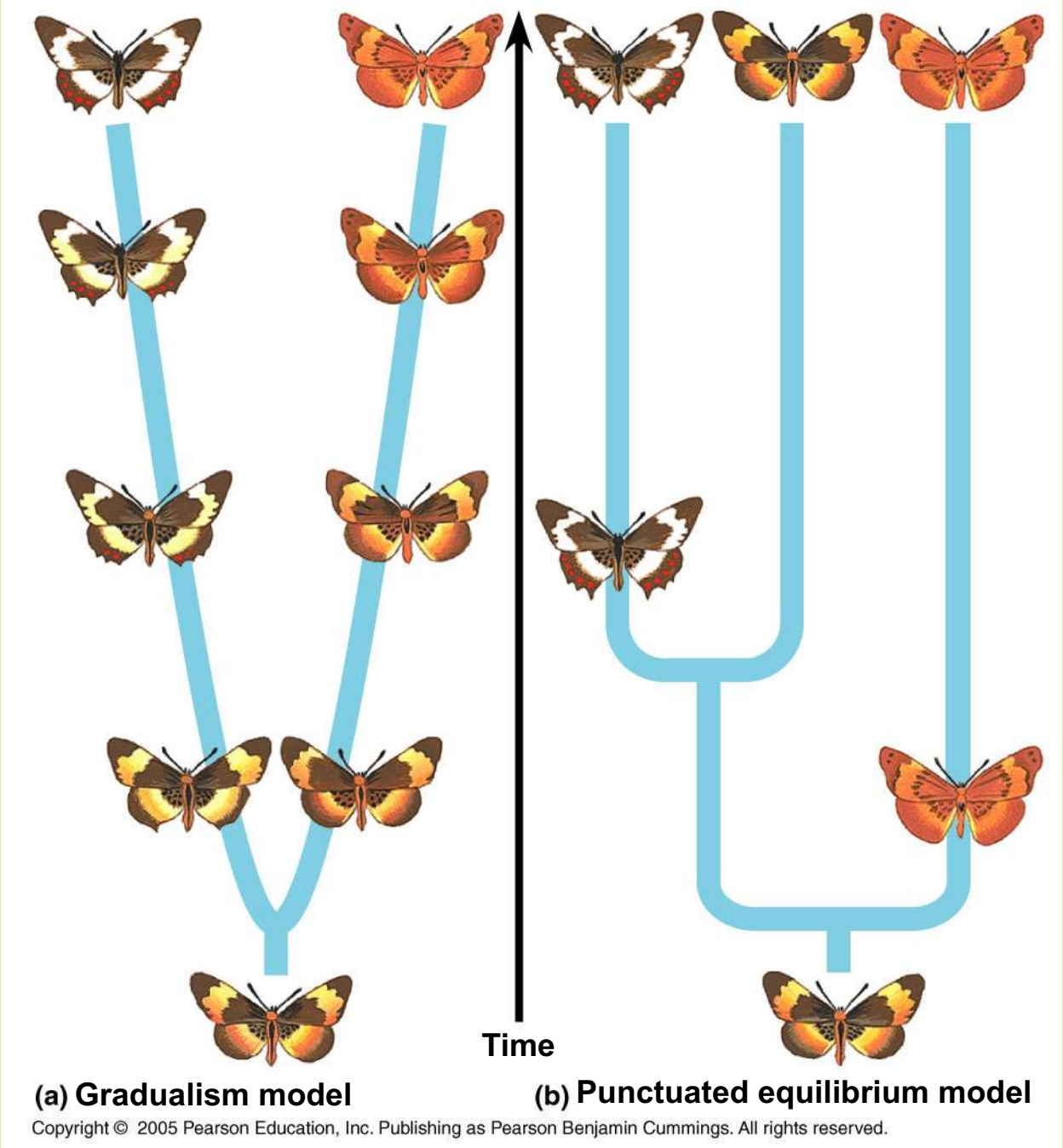
Gametic isolation

(h)

How fast are species made?

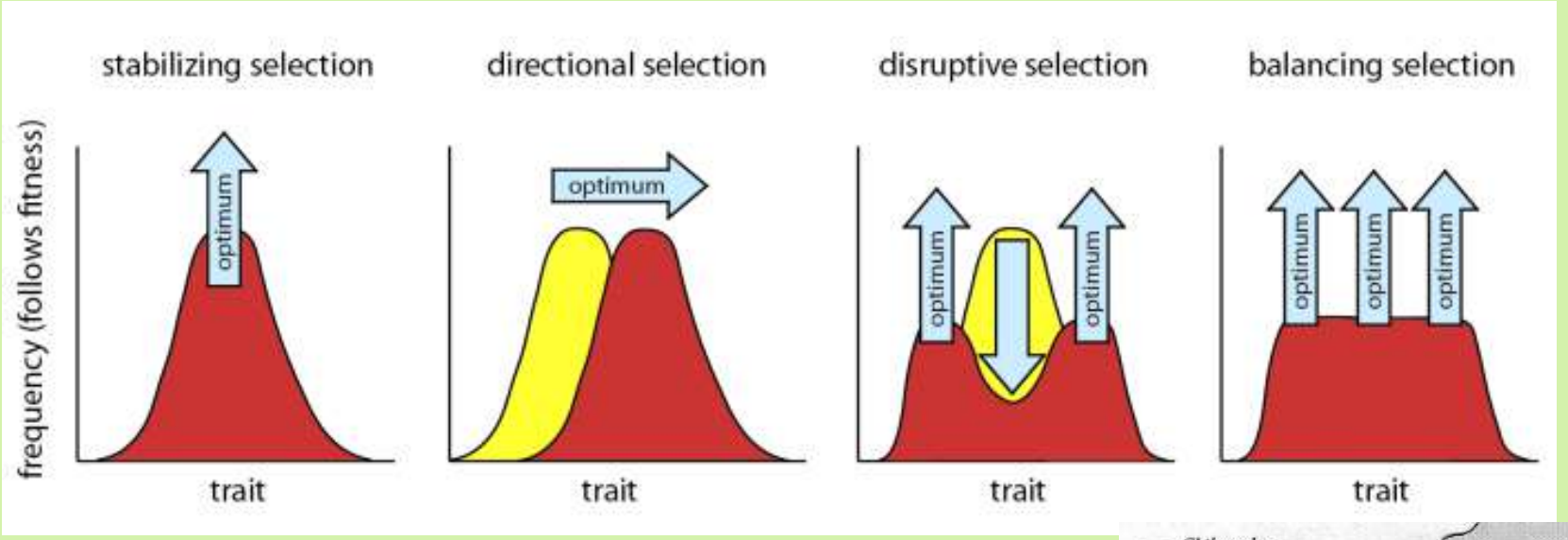
- Two Models (Fig: 16-12):
  - **Gradual Speciation**: When Evolution takes place slowly. May take hundreds of thousands or millions of years to take place.
  - **Punctuated Equilibrium**: Species are stable over time, until an event causes rapid speciation which may occur in a few thousand years.

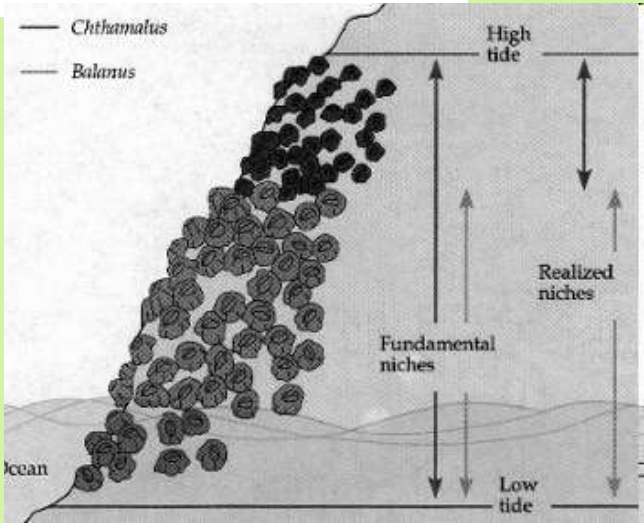
LE 24-13



Adaptive Radiation: the rapid evolution of many diverse species from ancestral species.

Populations display different types of selection.





What are the types of selection mechanisms in populations?

- **Stabilizing selection:** Eliminates extremes and favors intermediate forms.
  - Birth weight in humans: 6-8 lbs.
- **Disruptive/ diversifying Selection:** Increases extreme types.
  - **Balanced polymorphism:** a population in which intermediates are eliminated. Can result in two new species./ 2 or more phenotypically distinct traits. ***SNAILS***

What are the types of selection mechanisms in populations?

- **Directional selection:** one phenotype replaces another in a population
  - Peppered moth
  - Allelic frequencies in antibiotics

Kettelwell's Experiment

- **Sexual Selection:** used to attract and compete for mates
  - Sexual dimorphism: Peacock vs. Peahen
  - Horns in Rams

Peacock

- **Artificial selection:** breeding for certain traits: Fruits and Veggies, dogs and horses, milk cows

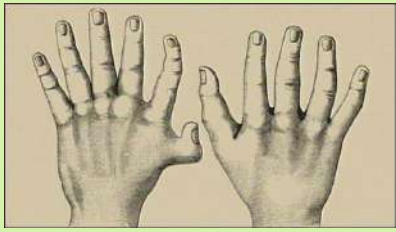
Sweaty T-shirt

What are other mechanisms of evolution?

- **Gene flow:** the movement of alleles from one population to another.
- **Genetic Drift:** Small populations by chance may increase certain alleles and decrease others.
- What is the problem with genetic drift?
  - Loss of genetic variation
  - Lethal alleles are more likely to show up.

Two specific types of Genetic Drift:

- **Bottleneck Effect:** Population size is greatly reduced and genetic drift occurs.
- **Founder Effect:** Small amount of individuals populate an isolated area.



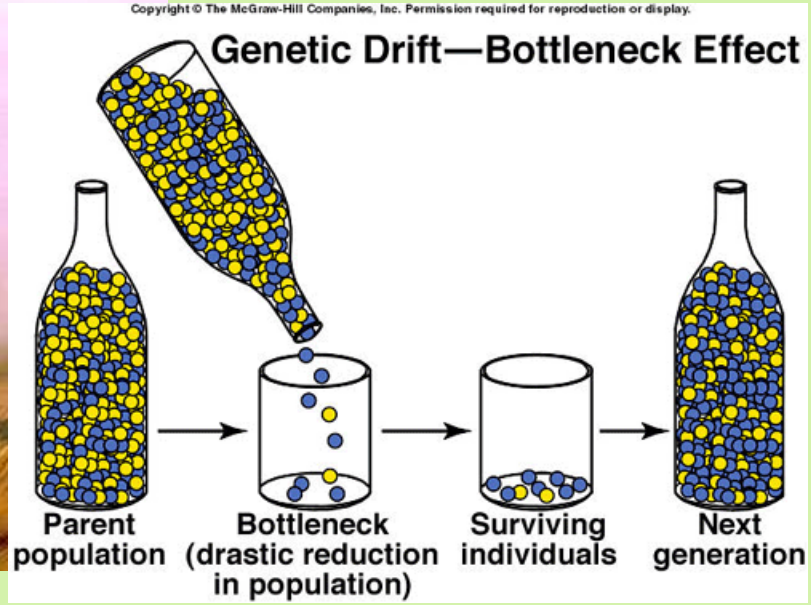


Figure 38-12 AN AMISH CHILD WITH ELLIS–VAN CREVELD SYNDROME.
The child has shortened limbs and six fingers on each hand. All the Amish with this syndrome are descendants of a single couple that helped found the Amish community in Lancaster County, Pennsylvania, in 1744. Because of inbreeding in the isolated community, the recessive trait is now common.

Elephant Seal

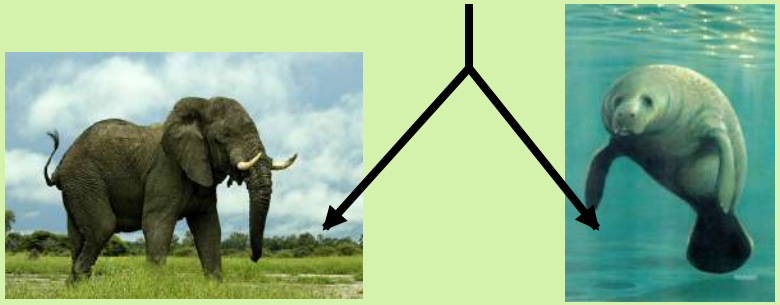
Micro Vs. Macroevolution

- **Microevolution** when small gene changes occur. These create small changes in a population or species over time.
  - The species is the same, but the allele frequencies may have changed.
- **Macroevolution** is evolution on a grand scale. This evolution is extreme and changes species.
  - The splitting of one species into two.

What are the Patterns of Evolution?

* **Convergent Evolution:** evolution of similar features in independent evolutionary lineages.

- **Parallel Evolution:** Two related species with similar adaptations. Marsupials of Australia & Placental of N. America.
- **Coevolution:** 
- **Adaptive radiation:** organisms form new species whose adaptations allow them to fill vacant ecological roles created by evolutionary change. Darwin's Finches.
- **Divergent Evolution-** Can be caused by adaptive radiation



What happens when a species dies out?

- Extinction
  - **Background Extinction:** continually at a low rate.
  - **Mass Extinction:** Dinosaurs. 5 major mass extinction where many species go extinct at one time.