Chapter 7: Evolution

Reading:

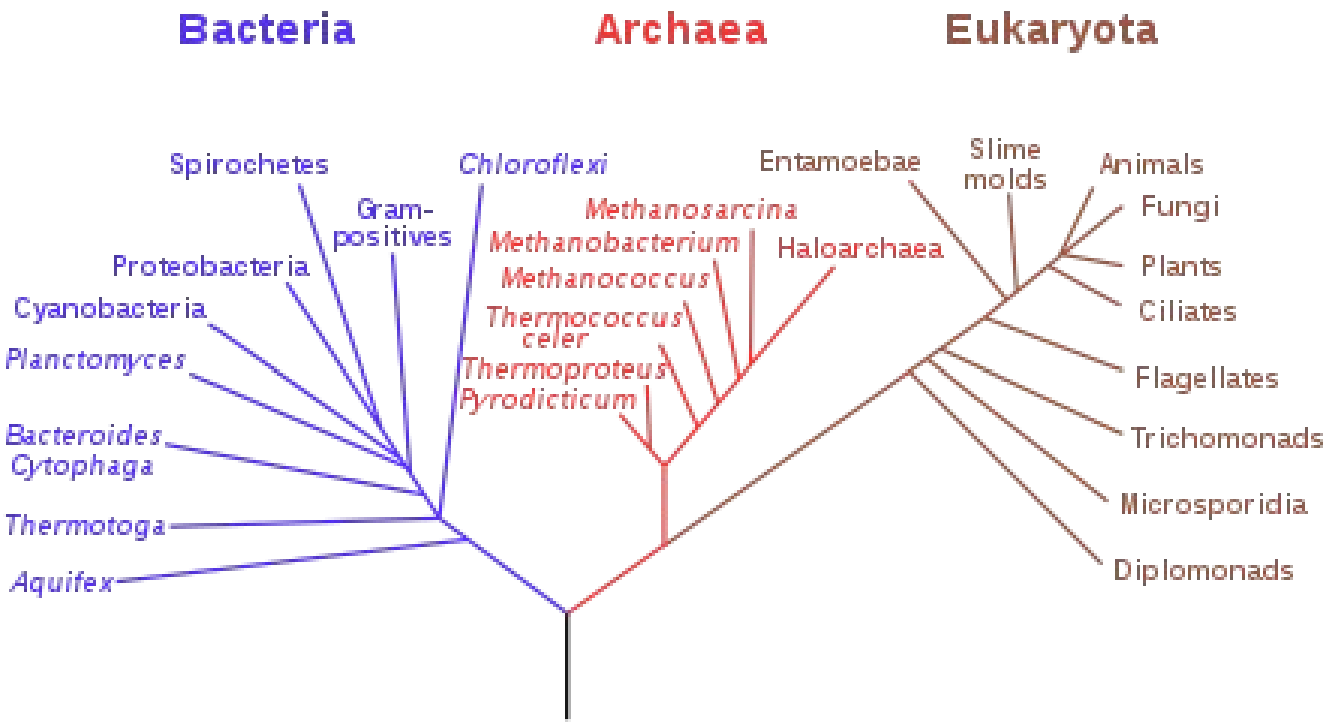
- Read lab manual chapter 7
  - Pages 193-196

What is Evolution?

- Change in heritable traits over time
- Described by Charles Darwin as descent with modification

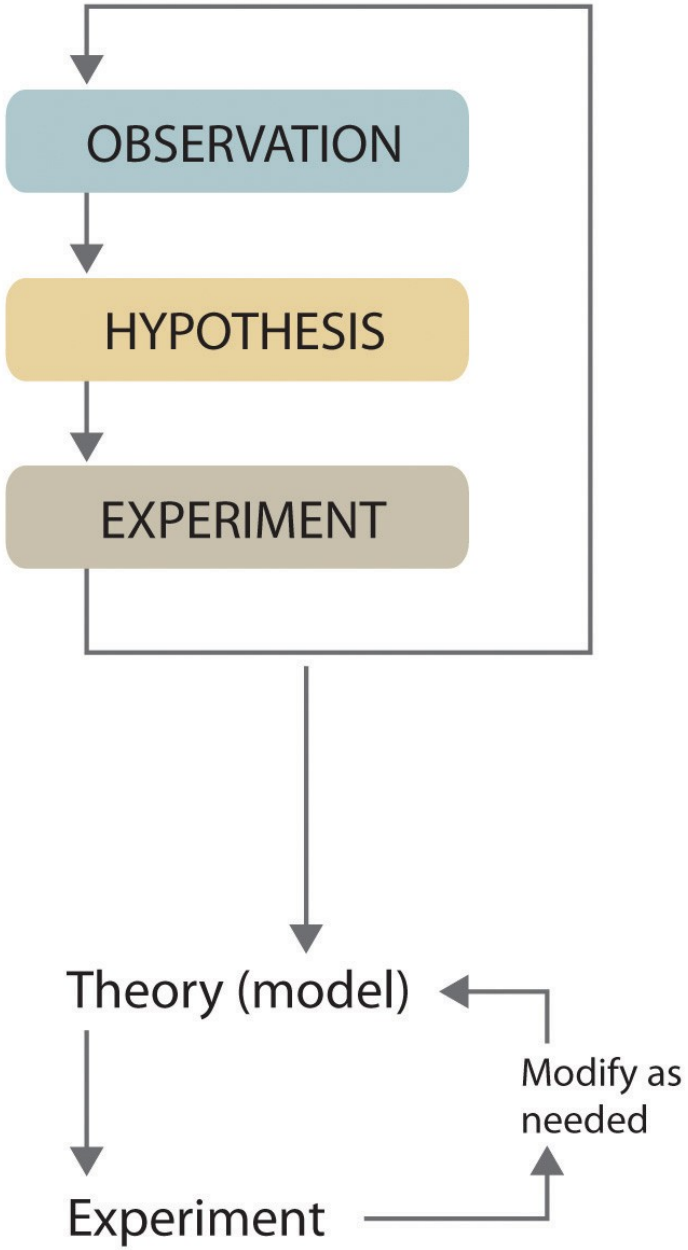
What is Evolution?

- All life on Earth shares a common ancestor
- Descendants of this ancestor together comprise Earth's biodiversity
- All life on Earth is distantly related

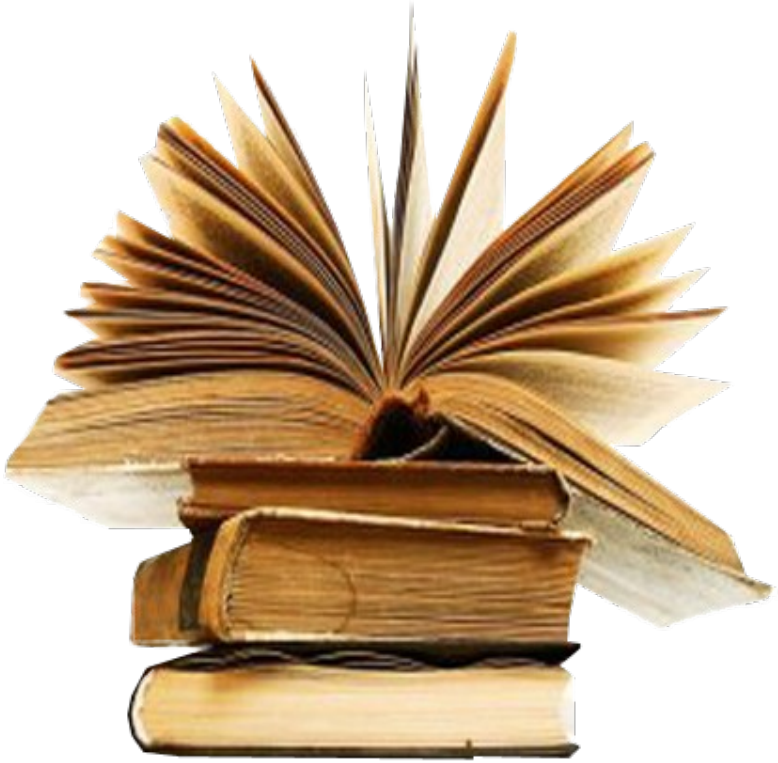


What is Evolution?

- Extremely well supported scientific theory
- Theory: mature, coherent body of interconnected explanations based on reasoning and evidence
  - Parts of theory may be discarded in light of new data
  - Theory doesn't stand or fall based a single critical test (as a hypothesis does)



A Brief History of Evolutionary Thought



Catastrophism

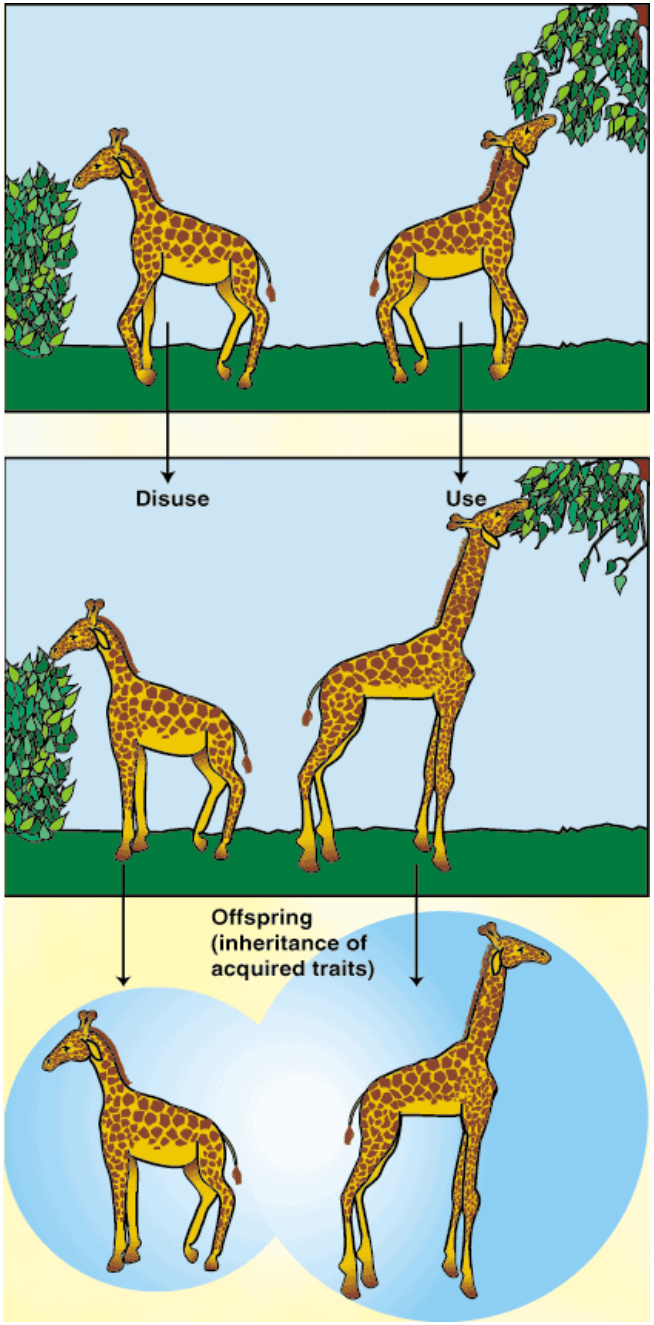
- Earth's current landscape is due solely to catastrophic and supernatural events of the past, at the time of the creation of the earth
- Features, like mountains, were formed by sudden and abrupt changes

Uniformitarianism

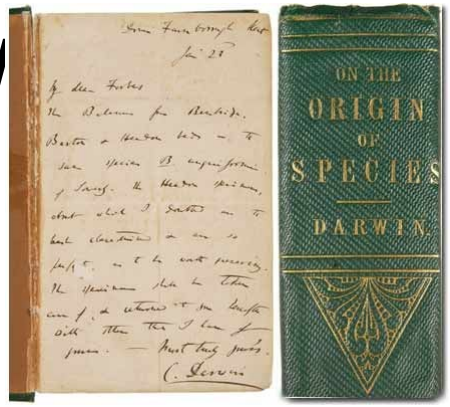
- Earth is very old, undergoing uniform cycles of change today as it did in the past
- Landscapes formed over long periods of time through gradual processes, typically imperceptible to us, but ultimately leading to large changes over time
- These processes happen the same way that they have happened in the past
- Mountain uplift, erosion, valley formation, etc.
- Gradual change in the environment

Lamarckian Evolut

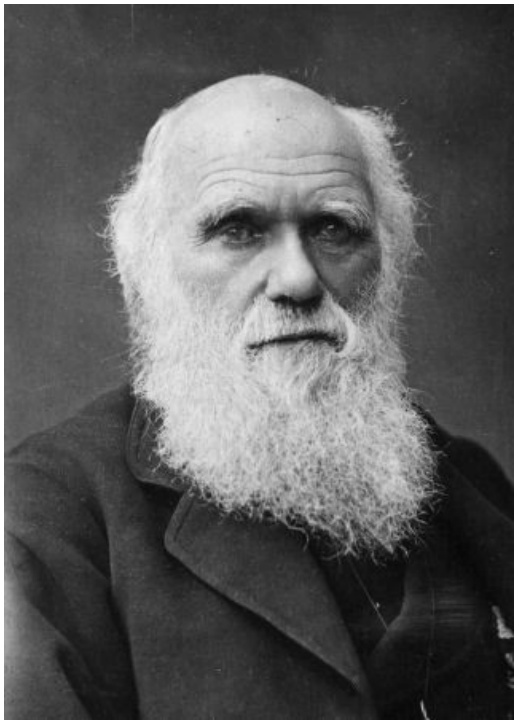
- Change through use and disuse
- Change occurs during an individual's life time
  - Giraffe neck
- Changes passed onto offspring
  - If a giraffe stretches its neck to reach leaves, will its neck permanently lengthen, and would this length be passed onto future offspring? No
  - If I whiten my teeth, would my future offspring be born with whiter teeth? No
  - If you dye your hair blue, will your offspring have blue hair? No
- **Based on erroneous explanation of inheritance**



Charles Darw

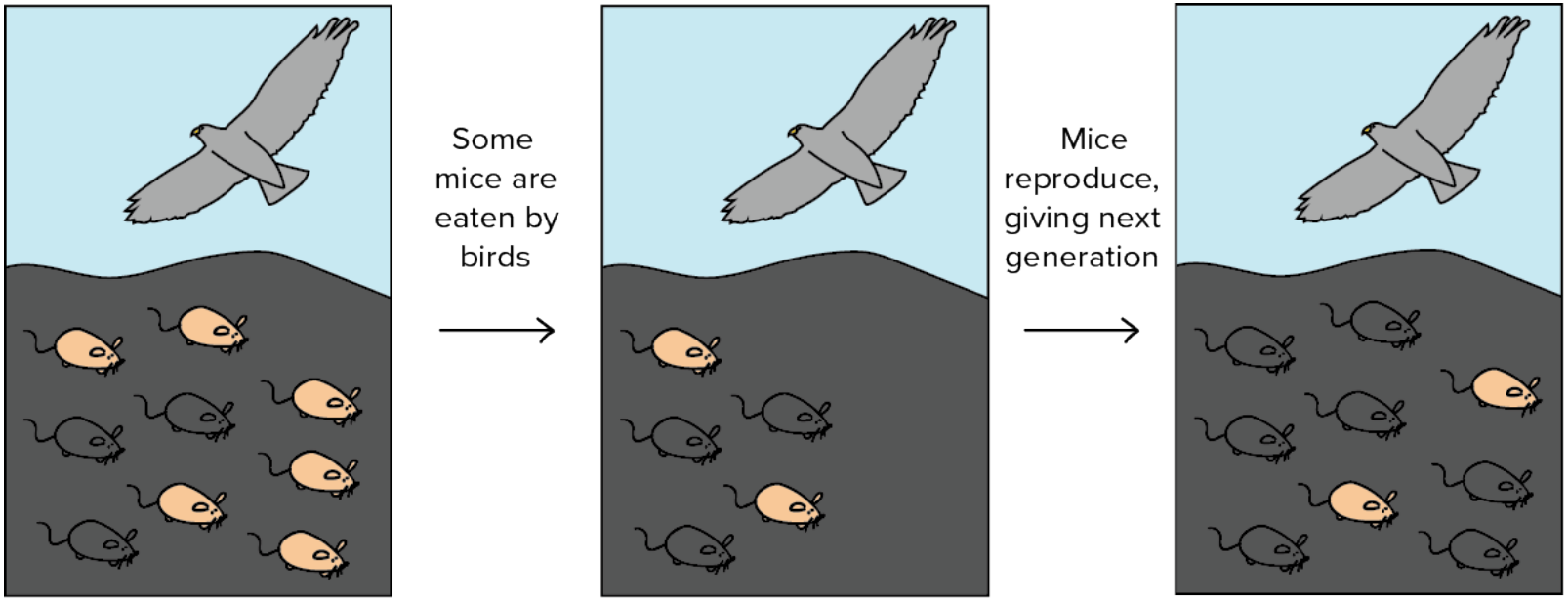


- English upper-middle class
- Mediocre student
- HMS Beagle
  - 5 year journey to central and south America
  - Plant, animal, fossil, mineral collection
- Interested why there is so much biodiversity
  - For example, the wide variety of finch species on Galapagos Islands that assumed many different niches
- Was not the first to notice that organisms change over time
- Proposed mechanism for this change
  - Natural selection



Evolution by Natural Selection

The process whereby individuals better adapted to their environments tend to better survive and reproduce, changing the genetic makeup of populations over time



A population of mice has moved into a new area where the rocks are very dark. Due to natural genetic variation, some mice are black, while others are tan.

Tan mice are more visible to predatory birds than black mice. Thus, tan mice are eaten at higher frequency than black mice. Only the surviving mice reach reproductive age and leave offspring.

Because black mice had a higher chance of leaving offspring than tan mice, the next generation contains a higher fraction of black mice than the previous generation.

The Four Pillars of Natural Selection

1. **Variation**

   Individuals within a population have traits that vary

2. **Inheritance**

   Some traits are passed onto offspring

3. **High rate of population growth**

   More offspring are produced than might survive in a generation

4. **Differential survival and reproduction**

   Individuals who survive and go on to reproduce, or reproduce the most, are those with most adaptive traits

Artificial selection

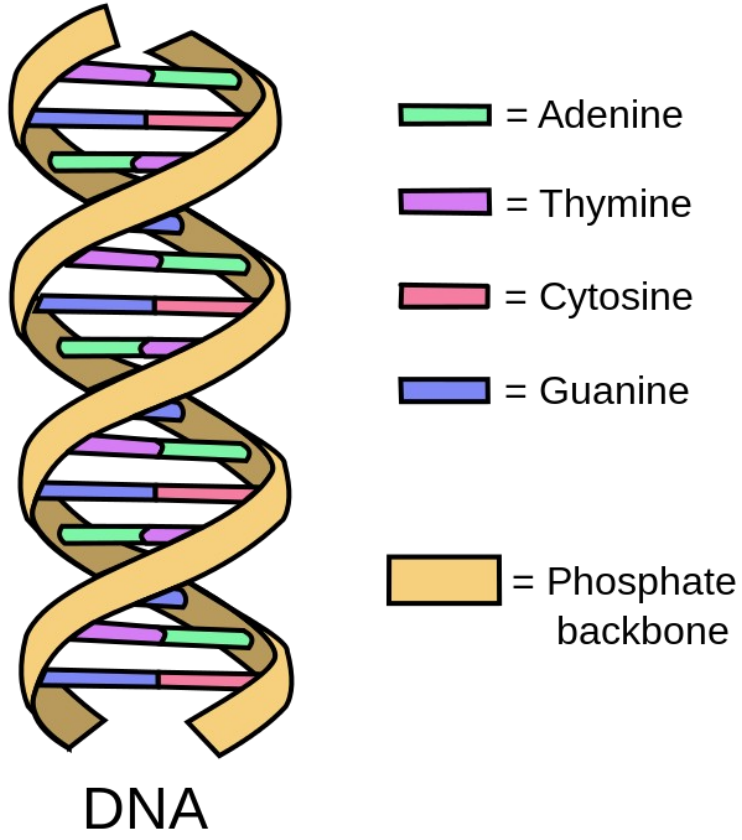
Process by which humans identify particular observable traits and select breeding pairs to produce offspring which reflect those desired phenotypes

Sexual selection

- Selection which acts on an organism's ability to obtain and/or successfully copulate with a mate
- Darwin felt natural selection alone could not account for certain adaptations
  - Ex: Long tail feathers hinder survival

Modern evolutionary synthesis

- 1930-1950
- Integrated Darwinian evolutionary theory with genetics
- Allowed for additional mechanisms

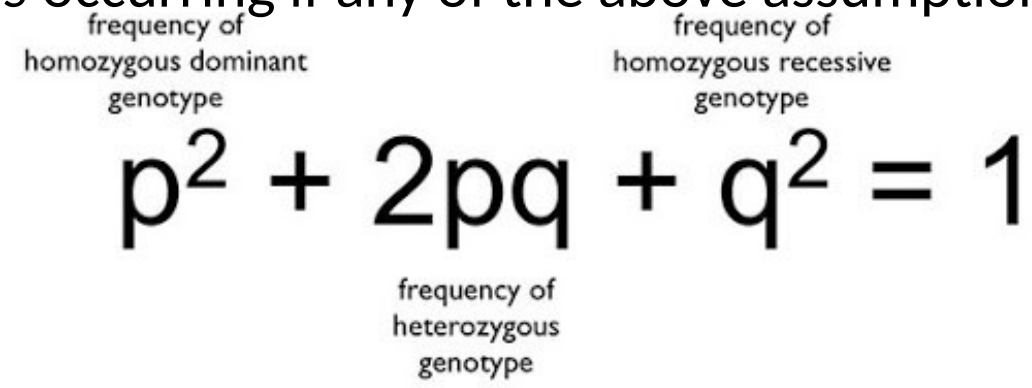


We now know that there are multiple mechanisms of evolution

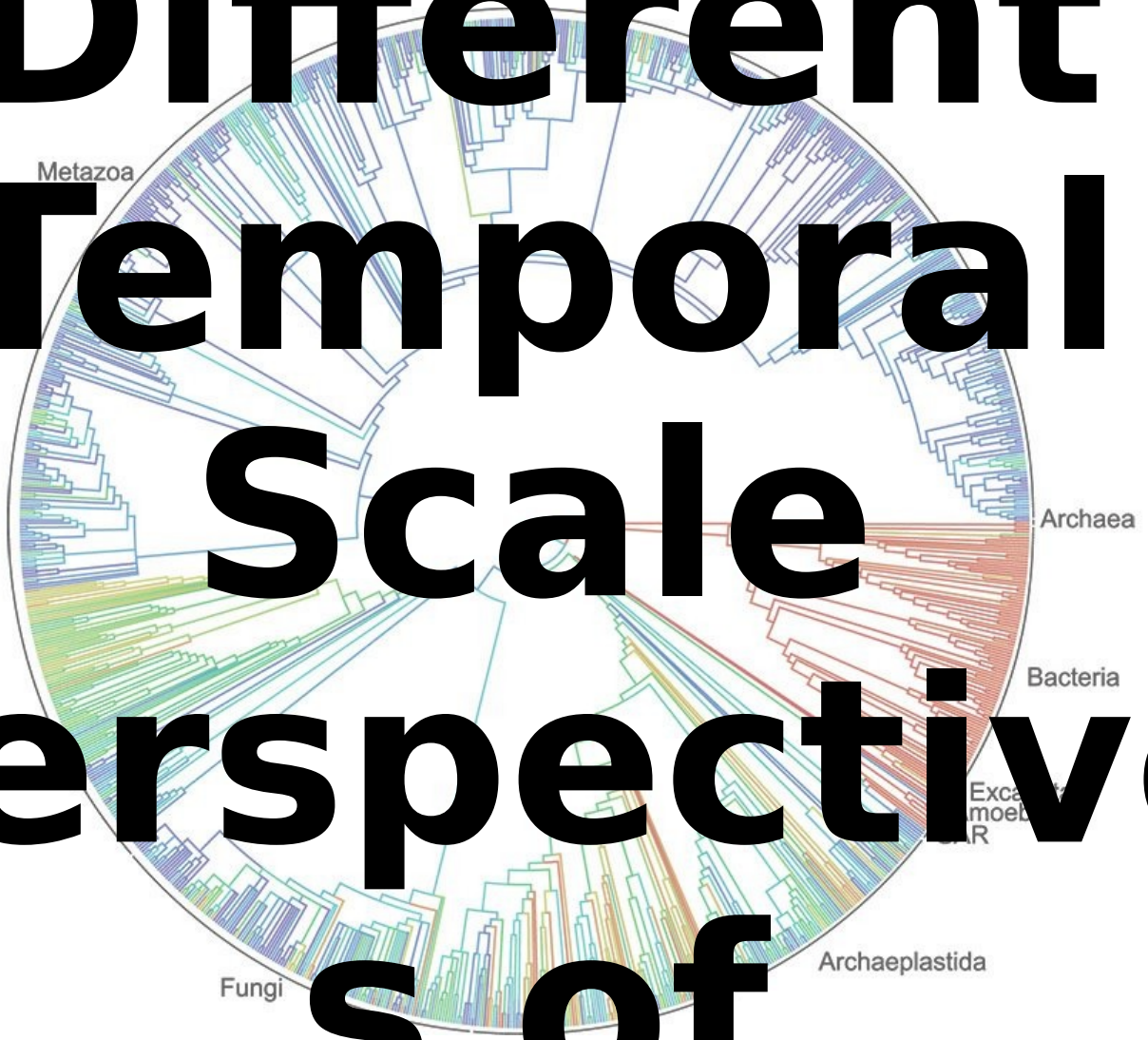
- Mutation
  - A change in DNA
  - New alleles are introduced into the population
- Genetic drift
  - Random variation in the relative frequency of alleles in a population
  - Alleles can become either fixed or lost by chance
  - Most impactful in small populations
- Gene flow
  - Migration
  - Transfer of genetic material from one population to another
- Non-random mating
  - Individuals prefer mates with particular characteristics
- Selection
  - Differential survival and reproduction of certain genotypes by means of natural or artificial factors

Hardy-Weinberg Equilibrium

- A mathematical model and hypothetical situation that describes control conditions for evolution
  - A basis for comparison
- A population is *not* evolving if these assumptions are met:
  1. There is no differential reproductive success among individuals
  2. The population is infinitely large, so random changes in allele frequencies are trivial
  3. There is no net immigration or emigration of individuals
  4. There are no new mutations
- Evolution *is* occurring if any of the above assumptions are violated



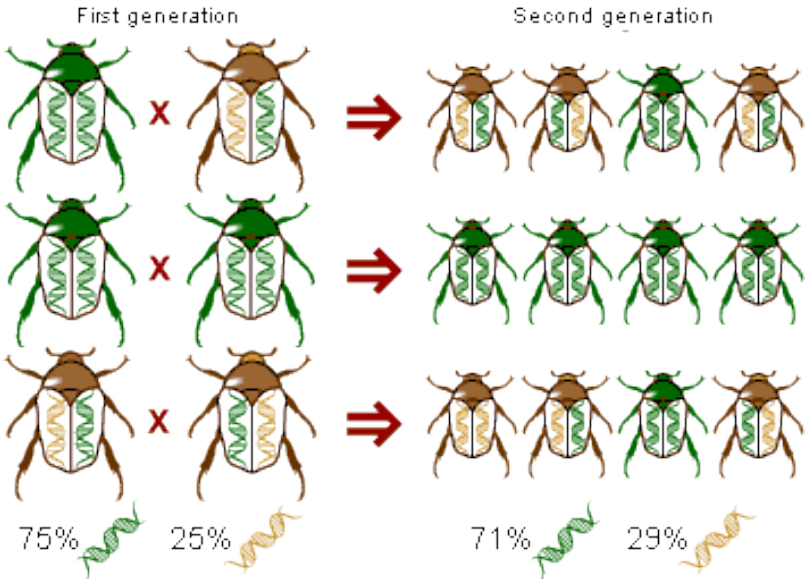
Different Temporal Scale Perspectives of



Microevolution

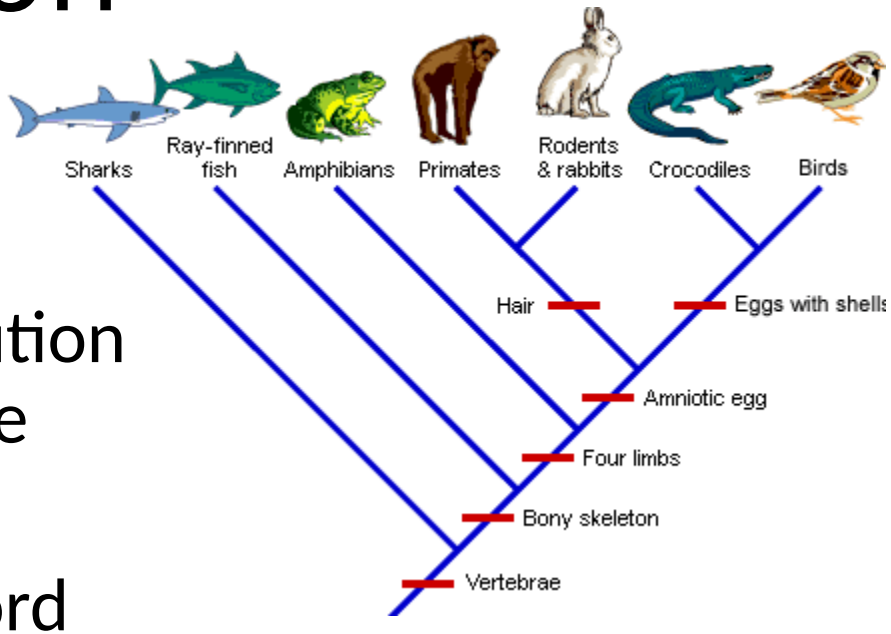
- Evolutionary change *within* populations
- A change in gene frequency within a population
- Can occur over short periods of time from generation to generation
- Caused by

Isolation
Genetic drift
Non-random mating
Mutation
Selection

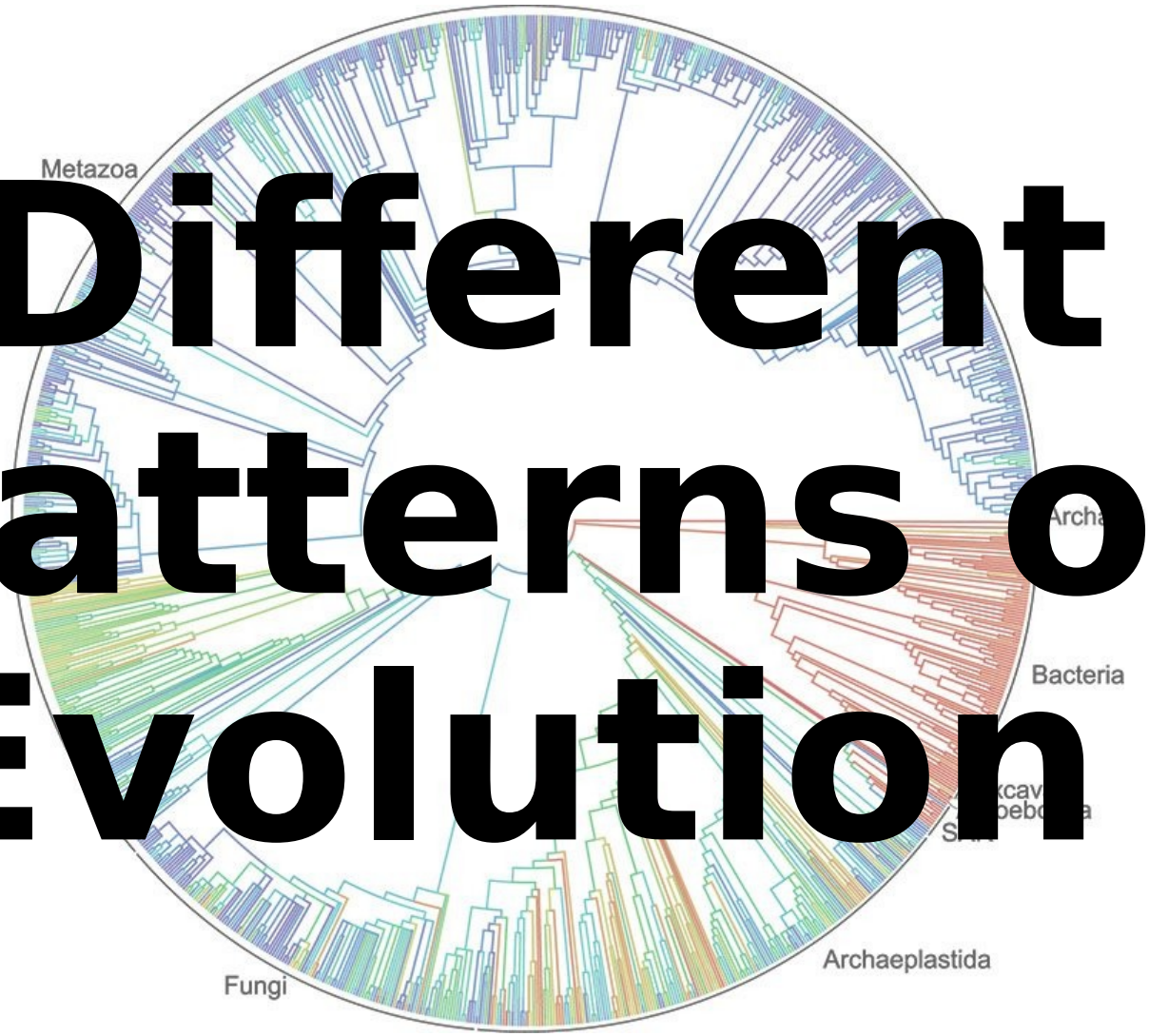


Macroevolution

- Interspecific variation
- Major trends and transformations in evolution over long periods of time (geologic time)
- Studies of the fossil record and living organisms



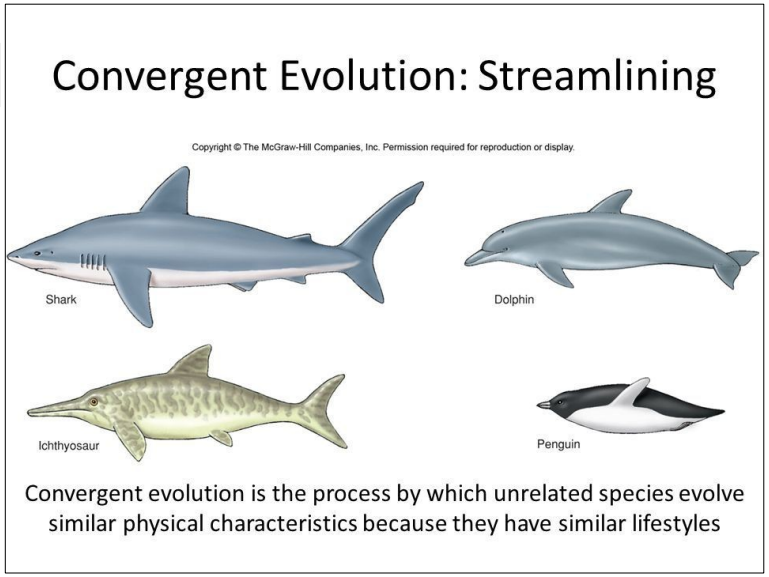
Mutation
Gene flow
Genetic drift
Natural Selection
+ 3.8 billion years
= Macroevolution

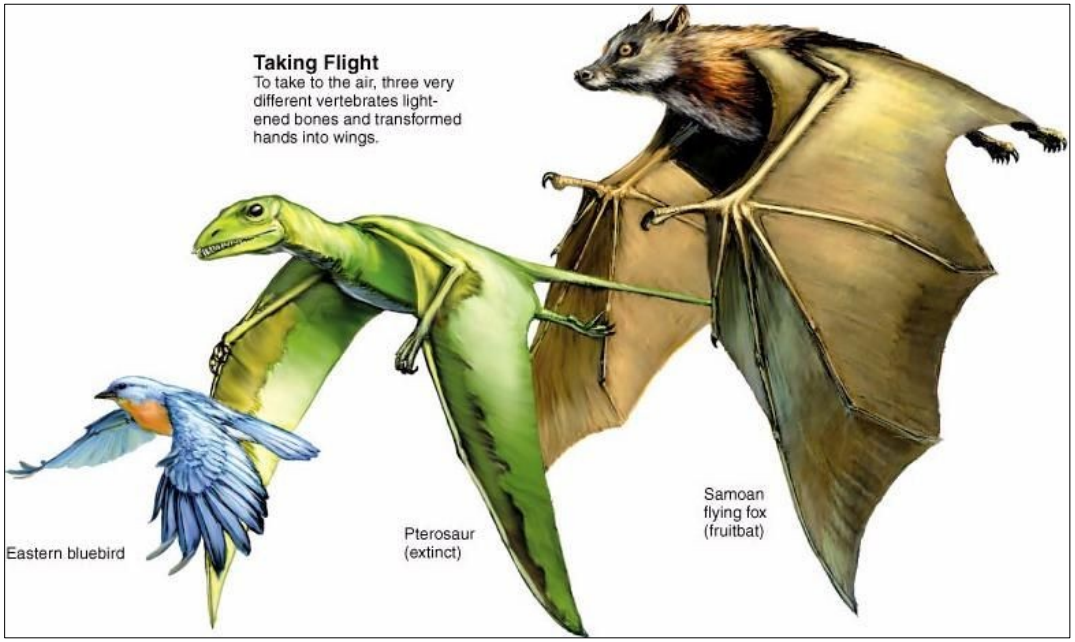


Different Patterns of Evolution

Convergent evolu

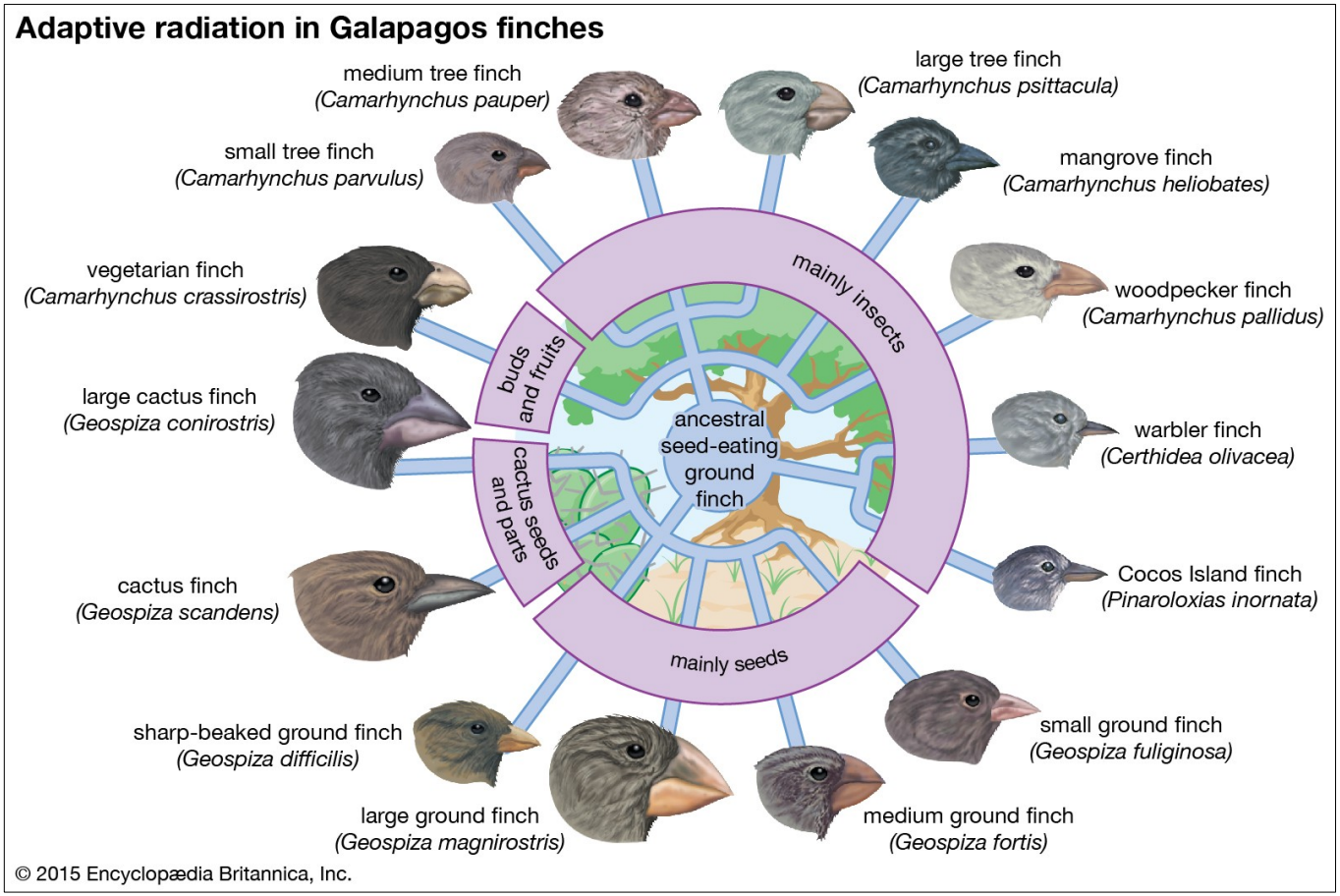
- Similar adaptations evolve independently in different lineages because of exposure to similar selection pressures
- Similarities not due to close relatedness, but rather, similar environments





Adaptive radiation

Diversification of a group of organisms into forms filling different ecological niches



Coevolution

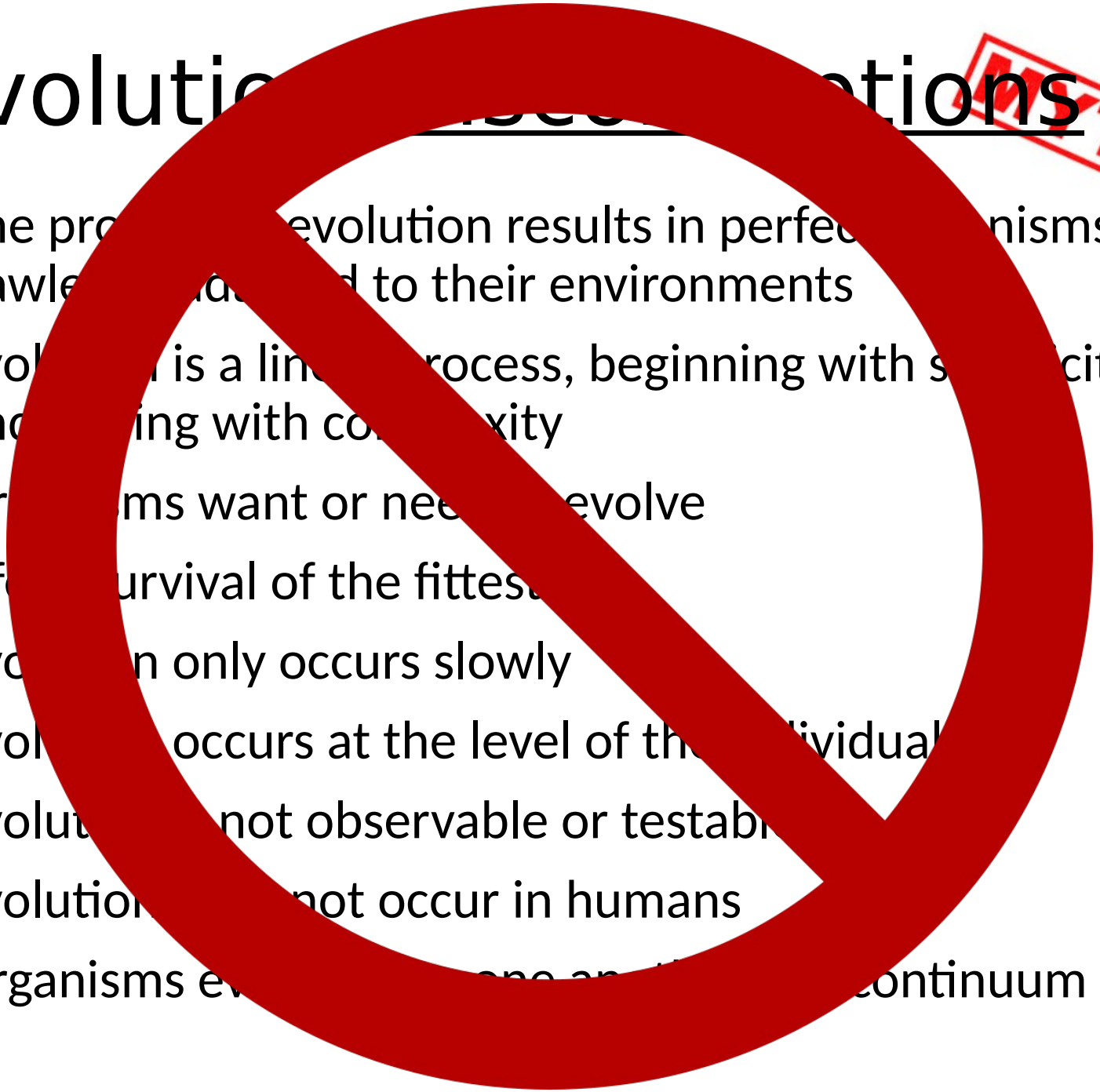
Discussion topic!

- Two or more species affect each other's evolution
- Likely to occur when different species have close ecological interactions with one another
  - Predator/prey
  - Parasite/host
  - Competition
  - Mutualism

Evolution Misconceptions

- The process of evolution results in perfect organisms, flawlessly adapted to their environments
- Evolution is a linear process, beginning with simplicity and ending with complexity
- Organisms want or need to evolve
- Life is survival of the fittest
- Evolution only occurs slowly
- Evolution occurs at the level of the individual
- Evolution is not observable or testable
- Evolution does not occur in humans
- Organisms evolve from one another in a continuum

Evolution Misconceptions



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- Evolution only occurs slowly
- Evolution occurs at the level of the individual
- Evolution is not observable or testable
- Evolution does not occur in humans
- Organisms exist on one and the continuum

Moth evolution simulation

- Peppered moth
  - Two color morphs
  - Differential survival based on environment
  - Changes in allele frequency
- Focuses on microevolution and natural selection
- Simulation in lab manual widget 7.F.2
- Lab report assignment on Canvas

Unpolluted Environment

Polluted Environment