

BIOLOGY 1202

- Descent with Modification: a Darwinian View of Life
- What is evolution and adaptation?
 - Evolution: two main ideas
 - 1. Change over time of the genetic composition of a population
 - 2. Descent of modern organisms with modification from preexisting organisms
 - Evolutionary adaptation
 - Accumulation of inherited characteristics that enhance organisms' ability to survive in specific environments
- Pre-Darwinian Theory of Evolution
 - Catastrophism
 - The principle that events in the past occurred suddenly by mechanisms not operating today
 - Uniformitarianism
 - Geologic change results from mechanisms that operated in the past in the same manner as at the present time
 - Gradualism
 - The hypothesis that evolution proceeds chiefly by the accumulation of gradual changes
 - Lamarck
 - Use and disuse
 - Bodies of living organisms are modified through the use or disuse of parts
 - Inheritance of acquired characteristics
 - These modifications are inherited by offspring
 - These ideas turned out to be wrong
- Evolution by Natural Selection
 - Darwin and Wallace developed the theory independently
 - Darwin – voyage of the *Beagle*
 - Wallace – naturalist in Indonesia
- Natural Selection
 - The unequal survival and reproduction of organisms due to environmental forces, resulting in the preservation of favorable adaptations
 - Process "selects" from what is available in the gene pool
 - New characteristics are not created on demand
 - Unfavorable traits decrease in frequency, favorable traits increase
- Mechanisms Behind Natural Selection
 - Observations
 - Individuals in a population vary in their heritable characteristics
 - Organisms produce more offspring than the environment can support

- Inferences
 - Individuals that are well suited to their environment tend to leave more offspring than other individuals
 - Over time, favorable traits accumulate in the population
- Natural Selection: A Summary
 - Natural selection is a process in which individuals that have certain heritable traits survive and reproduce at a higher rate than other individuals because of those traits.
 - Over time, natural selection can increase the match between organisms and their environment.
 - If an environment changes, or if individuals move to a new environment, natural selection may result in adaptation to these new conditions, sometimes giving rise to new species.
 - Although natural selection occurs through interactions between individual organisms and their environment, *individuals do not evolve*.
 - It is the population that evolves over time.
 - Natural selection can amplify or diminish only those heritable traits that differ among the individuals in a population.
 - Thus, even if a trait is heritable, if all the individuals in a population are genetically identical for that trait, evolution by natural selection cannot occur.
 - Environmental factors vary from place to place and over time.
 - A trait that is favorable in one place or time may be useless – or even detrimental – in other places or times. Natural selection is always operating, but which traits are favored depends on the context in which a species lives and mates.
- Artificial Selection
 - Selective breeding of organisms to encourage the occurrence of desirable traits
 - Analogous to natural selection
- Evolution is supported by an overwhelming amount of scientific evidence
- Homologous and Analogous Structures
 - Homologous
 - Structures or other attributes in different species that resemble each other because of common ancestry
 - Not similar in function, **similar in structure**
 - Example: mammalian forelimbs
 - Analogous
 - Structures that are **similar in function** but not in structure and developmental and evolutionary origin
- Homologous Structures: Vertebrate Embryos
 - All vertebrates share similar developmental genes
 - Differences arise by some genes being switched on or off at varying times during development

- Homologous Structures: Biochemistry and Molecular Biology
 - DNA is universal genetic material
 - All life forms use approximately the same 20 amino acids to make proteins
 - All use ATP as the primary form of cellular energy
 - All use RNA and ribosomes to make proteins
- Trees vs. Scala Naturae
 - Scala Naturae
 - Ladder of nature (see pg 453)
 - Evolution not about climbing “ladder of nature” from lower to higher
 - Evolution is a “bush” with lineages branching from one another
- Convergent Evolution
 - Similarity between 2 organisms, structures, or molecules due to independent evolution along similar lines rather than descent from a common ancestor
- Fossil Record
 - Show change in organisms through time
 - Change in types of organisms
 - Past organisms differ from present-day organisms
 - Many species have become extinct
 - Not only provides evidence of small-scale changes but of origin of major groups
 - E.g., the cetaceans
- The Evolution of Populations
 - The smallest unit of evolution
 - One common misconception about evolution is that individual organisms evolve during their lifetime
 - Evolutionary processes (e.g., natural selection) act on individuals, but populations evolve
- Genetic variation makes evolution possible
- Mutation
 - Mutations: changes in nucleotide sequence of DNA
 - Source of new alleles and genes
 - Point mutation: change in one nucleotide base in a gene
 - Chromosomal mutations: delete, disrupt, or rearrange many loci on a chromosome
 - Gene duplications: duplication of whole segments of a chromosome
 - Mutation rate averages 1 in every 100,000 genes per generation
- Sexual Recombination
 - In sexually reproducing organisms, sexual recombination produces most of the variability in each generation
 - Crossing over during prophase I
 - Independent assortment during metaphase I
- Variation within a population
 - Discrete characters: classified on an either-or basis