CH4 - Evolution and Biodiversity

4.6 BYA – How Do We Know?

- Solar Evolution: The sun is approximately _____ billion years old based on its mass and the ratio of H and He
- James _____ – Principle of Uniformitarianism: current geologic process are the same today as the past
- Nicholas Steno – Law of _____: undeformed sedimentary rock layers are older than layers above them
    - Sedimentary rock in glacial lakes have clear, consistent sedimentation rates. Age may be determined by counting the layers (varves).
- Radiometric Dating: Elements emit particles and energy at a constant measurable rate based on half-life. Common elements used include U-238, K-40, C-14
- Fission Track Dating measures damage tracks from the spontaneous fission of U-238

The Fossil Record

- _____ study fossils to learn about the earth's history
- Fossils remains of plants or animals from a previous geological time that provide clues for climate, geologic events, and evolution. Fossil are only found in _____ rock. Trace Fossils are parts, footprints, burrows, etc

Formation of Fossils

- There are many types of fossils
    - Mummification – drying, often in desert
    - _____ – hardened tree sap
    - Tar Beds – thick petroleum at surface
    - Freezing – often in Siberia
    - Petrification – _____ solutions (ground water) replace original organic materials
    - Imprints, Molds, and Casts in sand or mud
    - Coprolites – fossilized dung or waste (poop!)
    - Gastroliths – fossilized digestive stones or eggs
- _____ fossils are found exclusively in rock layers of a particular geologic age. Ex: Trilobites are 245 – 570 million years old

Are We In a New Epoch?

- First proposed in 2000, the _____ is used to describe the current epoch due to the significant influence humans have had on the planet in the last 150 years.

Chemical Evolution

- Chemical evolution of the organic molecules, bipolymers, and systems of chemical reactions were first necessary to form the first protocells took about one billion years.
- Russian biochemist Alexander _____ first hypothesized that energy from lightning, volcanoes, and intense UV light created the first organic molecules from inorganic chemicals. This has been proven true in experiments since 1953.

Biological Evolution

- Biological evolution is the change in a population's genetic makeup through successive generations.
    - it is VERY important to understand that _____, not individuals, evolve by becoming genetically different
    - microevolution describes the small _____ changes that occur in a population
    - macroevolution describes long-term, large-scale evolutionary changes among groups of species

Microevolution

- Microevolution works through four processes:
    - _____ of the structure or number of DNA molecules
    - natural selection for individuals of a population that have genetically based traits that cause them to survive and produce more offspring than other individuals
    - gene _____, which is the movement of genes between populations
    - genetic drift; fluctuations of gene frequency in the gene pool (genetic composition of a population)

Natural Selection

- The process of natural selection occurs when some individuals of a population have genetically based traits that cause them to better survive and produce offspring.
    - This trait is called an _____, or adaptive trait.
    - A factor in a population's environment that causes natural selection to occur is known as a selective pressure.
    - The concept of natural selection was developed by Charles _____ in 1846 and was published in *On the Origin of Species by Means of Natural Selection* (1859). Natural selection is based on three conditions: natural variability of a trait within a population, the trait is heritable, and the trait leads to differential _____

- There are three types of natural selection:
    - directional natural selection causes _____ (gene forms) frequencies to shift toward one end of the normal range, eliminating the other end
    - stabilizing natural selection causes allele frequencies to shift toward the _____ of the normal range, eliminating both ends
    - diversifying natural selection causes allele frequencies to shift toward both ends, eliminating the middle

Speciation

- Speciation is the process by which two species arise from one.
    - The first step in speciation is geographic _____, which is the physical separation of two groups of the same population for fairly long periods into areas with different environmental conditions.
- The second step is reproductive isolation, which is when the two groups become so different, through mutation and natural selection, that they are no longer able to interbreed.

Species Diversity

- Speciation leads to greater species diversity. Species diversity, or species _____, of a community is the number of species it contains. Biodiversity can refer to genetic, species and habitat diversity.
- The relative abundance of individuals within each of those species is species _____.
- The differences in species diversity between ecosystems is explained by Robert MacArthur and Edward O. Wilson, who in 1960 developed the species equilibrium model or the theory of _____ _____
    - the species diversity of an island is determined by a balance between two factors: the immigration rate and the extinction rate.
    - Immigration and extinction rates are affected by the size of the island and its distance from a mainland source of immigrant species.

Generalist vs. Specialist

- Generalist species have broad _____. They can tolerate a wide range of environmental conditions. (ex. mice, white-tailed deer, channel catfish, cockroaches, humans)
- Specialist species have narrow niches, which makes them prone to becoming endangered when environmental conditions change. (ex. tiger salamanders, spotted owls, giant _____)

Species Classification

- Native species are species that normally live and thrive in a particular ecosystem.
- Species that migrate into an ecosystem or, more commonly, are introduced by humans (either by accident or deliberately), are known by several names: introduced, nonnative, _____, or alien species.
- Indicator species are species whose presence or absence demonstrates a distinctive aspect of an ecosystem.
- _____ species are species that play a pivotal role in the integrity of an ecosystem.

Modern Evolutionary Theory

- Modern evolutionary theory has progressed far beyond Darwinism to reflect new advances in science.
    - _____ _____ (Stephen Jay Gould & Niles Eldredge) - Evolution consists of long periods of time of little change with brief periods of rapid change (tens of thousands of years)
    - Hardy-Weinberg Equilibrium - Allele frequencies of a population stay constant over time unless specific disturbing influences occur (ie. mutations, selection, genetic drift)
    - Genetic Engineering &Artificial Selection - Human manipulation of genetic structure and/or breeding has led to new species or new traits in existing species

Extinction

- When environmental conditions change, a species may either evolve or become extinct
- _____% of all species that have ever existed on Earth are now extinct. Speciation and extinction are affected by several major factors
    - large scale movements of the continents
    - gradual climate changes (continental drift, orbit shifts of the earth)
    - rapid climate change (large volcanic eruptions, asteroid impact)
    - human influence
- Genetically diverse populations are more likely to survive these stressors.
- Inevitably, some species disappear at some low rate called background extinction. (1-10 species per year)
- An abrupt rise in extinction rates above the background level is classified as a mass extinction.
    - There have been five major mass extinction events in the earth's history. The largest was _____, 250 million years ago, with the disappearance of 90% of all marine species. The last mass extinction was the _____, 65 million years ago, marking the end of the dinosaurs.