

## Unit Two: Evolution & Prehistoric Oceans

### Chemical Evolution

- Chemical evolution of the \_\_\_\_\_ 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 a number of experiments since 1953.

### Biological Evolution

- Biological evolution is the change in a population's genetic makeup through successive \_\_\_\_\_.
  - \_\_\_\_\_ describes the small genetic changes that occur in a population
  - macroevolution describes long-term, large-scale evolutionary changes among groups of species

### Natural Selection

- The process of natural selection occurs when some individuals of a population have genetically based \_\_\_\_\_ that cause them to better survive and produce offspring.
  - This trait is called an adaptation, 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
  - the trait leads to differential \_\_\_\_\_
- There are three types of natural selection:
  - \_\_\_\_\_ natural selection causes allele (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 middle of the normal range, eliminating both ends
  - \_\_\_\_\_ natural selection causes allele frequencies to shift toward both ends, eliminating the middle
- Vestigial structures are often reoccurrences of traits (through mutation) that were selected against

### Transitional Forms

- *Acanthostega*
- *Ambulocetus*

### Extinction

- When environmental conditions change, a species may either evolve or become \_\_\_\_\_
- 99% 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 \_\_\_\_\_ changes (continental drift, orbit shifts of the earth)
  - rapid climate change (large volcanic eruptions, asteroid impact)
  - human influence
- Inevitably, some species disappear at some low rate called \_\_\_\_\_ 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 Cretaceous, 65 million years ago, marking the end of the dinosaurs.

## The Fossil Record

- Paleontologists 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
- \_\_\_\_\_ 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
    - (La Brea Tar Pit in CA is 15,000 years old)
  - Freezing – often in Siberia
  - Petrification – mineral 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
- Index fossils are found exclusively in rock layers of a particular geologic age
  - \_\_\_\_\_ are 245 – 570 million years old

## Geologic Time

### Precambrian 4.6 BYA – 570 MYA

- 4.6 BYA - The Earth was formed. Early atmosphere was water vapor, carbon dioxide, nitrogen
- 4.2 BYA – \_\_\_\_\_ formed as the planet cooled and water vapor condensed
- 3.6 BYA - The first evidence of life, \_\_\_\_\_
- 2.5 BYA - Oxygen began to accumulate in the atmosphere

### Paleozoic 570 MYA – 248 MYA

- 490 MYA - brachiopods, cephalopods and trilobites dominate
- 443 MYA – 354 MYA - The Devonian Period is known as the “Age of \_\_\_\_\_”
- By the end of the Paleozoic, the supercontinent \_\_\_\_\_ was formed and some species began to move onto land
- 250 MYA - Large scale climatic changes led to the Permian extinction, wiping out 90% of marine species.

### Mesozoic 248 MYA – 65 MYA

- The Mesozoic Era is known as the “Age of Reptiles” as reptiles (\_\_\_\_\_) dominate the land.
- 200 MYA – Pangaea breaks up and continents begin to move to their current locations
- In the oceans, a wide variety of fish and cephalopod species feed on a growing variety of plankton. Reptiles return to the sea to exploit the resources. Examples include Plesiosaurs and Ichthyosaurs. \_\_\_\_\_ (modern ray-finned fishes) appear towards the end of the Mesozoic
- 65 MYA - The Mesozoic ended with the \_\_\_\_\_ extinction event. It was caused by a large asteroid hit off the Yucatan Peninsula in the Gulf of Mexico

### Cenozoic 65 MYA - Present

- The Cenozoic is known as the “Age of Mammals” with mammals replacing reptiles as the dominant land animals.
- In the oceans, diversity continued to increase. The first marine mammals appear \_\_\_\_\_, evolving from the land mammal *Ambulocetus*.
- Humans evolved 2.5 MYA, with modern *Homo sapiens* appearing 250,000 years ago. Modern humans began significantly impacting the oceans only in the last 200 years, primarily through \_\_\_\_\_ and pollution.