BIOLOGY STUDY GUIDE – CHAPTER 15
ORIGINS OF BIOLOGICAL DIVERSITY

- Why is life diverse?
    - Because of the origin of multiple new species.

- **Species** = a distinct form of life
    - **Biological Species Concept** = a more detailed, accurate description of species
        - Describes a species as a population whose members can breed with one another in nature and produce *fertile* offspring (note: "fertile" means that an organism has the ability to mate and produce its own offspring).
        - Further, members of one species canNOT successfully breed with members of other species
        - Problem with the Biological Species Concept: does not include asexual reproducers.

- **Microevolution:** change in frequency of alleles *within ONE population*
- **Macroevolution:** major evolutionary changes (origin of new species, for example)

- **Speciation:** origin of a new species

- What keeps closely related (but still different) species from mating/breeding?

    - Some kind of barrier must exist that keeps two different species from breeding; we call these barriers forms of ***reproductive isolation***.
    - What are some barriers that cause reproductive isolation?
        - TIMING – two different species may have completely different mating seasons.
        - BEHAVIOR – two different species may have very different mating rituals (and what one species finds attractive, a different species finds repulsive)
        - HABITAT – two different species are adapted to and prefer different habitats in the same general location and so never meet (living at the lake's bottom versus open water, for example)
        - PHYSICAL INCOMPATIBILITY – literally, the reproductive structures of two different species do not "fit" together.
        - Note: even if fertilization does occur between two different species, the hybrid zygote may fail to develop or may mature into an infertile adult.

Geographic Isolation: separation of populations as a result of:
    - 1) a change in earth's features (after a major disaster, for example) or
    - 2) movement of a species to a geographically isolated place (like an island)

- Realize that if a small number of members from one species is separated from the main group, that small group may follow its own and unique evolutionary course…what will happen then?
    - This small group will look less and less like the main population and may eventually develop into a new species.

  - Also realize that for every small population that successfully survives and becomes a new species, many more small populations die off (life in isolation proves too harsh, etc.).

- Why are islands such ideal locations for studying speciation?
  - Islands are isolated BUT have great geographical diversity in a small space (mountains, valleys, lakes, etc. all in one small space); this geographical diversity favors the survival of multiple kinds of species.

- **Adaptive Radiation:** Evolution from a common ancestor; results in multiple, diverse species adapted to different environments.

- **Punctated Equilibrium:** a phrase used to describe the timing of speciation; long periods of time go by with little change (equilibrium) BUT these long periods are broken up (punctated) by short periods of speciation.

- **Refinement of Existing Adaptations:**

  - Complex characteristics/structures most likely evolved by small steps of adaptation. With each adaptation, a structure was refined/changed to work best for *that particular species.*

- **Adaptation of Existing Structures to New Functions:**
  - Examples:
    - Chitin on insects: originally protected insects from predators in ocean; now also protects insects from dehydration on land.
    - Penguin's "wings": do not help penguins fly; instead are built for swimming, since penguins' food sources live in water.

- **Embryology:** literally, study of embryos, so that logically means it is the study of the development of organisms from the one-celled zygote stage to the fully-formed organism stage (when birth occurs).
  - Genes control the development of an organism.
  - Recall the "homeotic" genes (also known as "homeobox" or "hox" genes) that help program the correct placement of body parts (so that legs and antennae go in the correct locations in a fly, for example).

- **FOSSILS =** preserved markings or remains left by an organism.
  - **What are the most common parts of an organism found as fossils?**
    - Hard parts (shells, bones, teeth)

- **Fossil Record:** Understand that each layer of rock contains organisms that lived in that area *at the time the sediment was deposited*. (And so, the layers of rock contain a historical record of life on earth.)

- **Geologic Time Scale:** This time scale was created by scientists and divides Earth's history into three distinct time periods:
  - **1) PALEOZOIC ERA –** multicellular organisms with hard parts begin appearing.
  - **2) MESOZOIC ERA –** cone bearing/flower bearing plans begin appearing.
  - **3) CENOZOIC ERA –** mammals begin to appear.

- (Note: Each era contains several *periods*; in turn, one period contains several *epochs*.)

- **Dating Fossils: Two methods:**
  - **1) Relative Dating –** this method does NOT assign an actual number/year date to a fossil. Instead, this method just compares one fossil's placement in the soil to another fossil's location. *Relative dating determines which fossil is older based on the fossil's relative position in the ground.* (Younger fossils sit on top of older fossils.)
  - **2) Absolute dating –** this method DOES assign an actual number age in years to a fossil by using radioactive dating. Realize that radioactive dating utilizes **half-life.**
    - **Half-life –** number of years it takes for 50% of a sample to decay.
      - Scientists use radioactive elements with known, long half-lives to date fossils. Our more recent fossils are dated with C14 (which has a relatively short half life of 5,730 years).

- **Continental Drift**: Occurs when land masses change position relative to each other.
  - **Why is this important**?
    - *Because continental drift helps explain how the same species can live in two completely separate parts of the world.*

- **Mass Extinctions:** brief episodes of great species lost (the dinosaurs were completely gone in a relative short time of 10 million years, due in part to a meteor).
  - Mass extinction provides surviving organisms with new opportunities and often, adaptive radiation will occur. (Once the dinosaurs were gone, many organisms were no longer in fear of being hunted and so could move around more freely to different locations, for example.)

- **Taxonomy:** Science of identification, naming, and classification of species.
  - **Linnaen System of Classification** – uses a **binomial** (two part Latin name) to identify an organism:
    - *Escherichia coli (E. coli)* – common bacterial organism; the first part of name (Escherichia) is the genus and the second part (coli) is the species. The genus is always capitalized while the species is not.
    - The Linnaen System has seven groupings for organisms:
    - **K**ingdom – **P**hylum – **C**lass – **O**rder – **F**amily – **G**enus – **S**pecies ("**K**ings **P**lay **C**ards **O**n **F**at **G**reen **S**tools")

- **Phylogeny:** Evolutionary history
  - **Phylogenetic tree:** a diagram that shows the evolutionary history among groups of organisms.

- What is a **homologous structure?**
  - Structure/body part shared by two different species that helps determine how closely related different species are; homologous structures reflect evolutionary relationships.
  - For instance, a whale's flipper and a bat's wing have different specific functions and appear different externally; HOWEVER, the *internal structure* (the anatomy or the nerves/vessels/muscles) of the whale's flipper and the bat's wing is very similar and so indicates that the whale and the bat share a common ancestor.

- What is an **analogous structure?**
  - Structure/body part shared by two different species
  - The FUNCTION of the body part is the same or similar in both the species BUT the anatomy (the internal nerves/vessels, etc.) is different.
  - Analogous structures do NOT reflect evolutionary relationships.
  - Example: Fly wing and bird wing.
  - Analogous structures illustrate the concept of **convergent evolution**, where unrelated species living in similar environments have similar adaptations/structures.

- **Molecular/Biochemical Data as a Classification Tool:**
  - The more similar the genes between two species, the more closely the species are related. (For example, the gene for hemoglobin in chimpanzees is 99% identical to the gene for hemoglobin in humans and therefore indicates how closely we are related to chimps.)

- What is a **clade?**
  - A clade is an evolutionary branch in the phylogenetic tree. It consists of an ancestral species and all its descendants.
    - **Cladistics:** all organisms within one clade MUST share homologous structures that do NOT occur outside the clade; these unique characteristics are called ***derived characters***.
    - See the cladogram on page 346 of your textbook.

- **Five Kingdom System of Classification:**
  - **Monera** (bacteria)
  - **Protists** (all eukaryotes that do not fit into plant/animal/fungus; example is amoeba)
  - **Plants**
  - **Fungus**
  - **Animals**

- **Three Domain System of Classification – a newer approach:**
  - **Bacteria (prokaryote)**
  - **Archaea (prokaryote)**
  - **Eukaryotes**