APES Chapter 3-4 Supplemental Notes
Ecosystems and Evolution

- *ERT-1.D. Explain the steps and reservoir interactions in the carbon cycle.*
    - The carbon cycle is the movement of atoms and molecules containing the element carbon between sources and sinks.
    - Some of the reservoirs in which carbon compounds occur in the carbon cycle hold those compounds for long periods of time, while some hold them for relatively short periods of time.
    - Carbon cycles between photosynthesis and cellular respiration in living things.
    - Plant and animal decomposition have led to the storage of carbon over millions of years. The burning of fossil fuels quickly moves that stored carbon into atmospheric carbon, in the form of carbon dioxide.

- *ERT-1.E. Explain the steps and reservoir interactions in the nitrogen cycle.*
    - The nitrogen cycle is the movement of atoms and molecules containing the element nitrogen between sources and sinks.
    - Most of the reservoirs in which nitrogen compounds occur in the nitrogen cycle hold those compounds for relatively short periods of time.
    - Nitrogen fixation is the process in which atmospheric nitrogen is converted into a form of nitrogen (primarily ammonia) that is available for uptake by plants and that can be synthesized into plant tissue.
    - The atmosphere is the major reservoir of nitrogen.

- *ERT-1.F. Explain the steps and reservoir interactions in the phosphorus cycle.*
    - The phosphorus cycle is the movement of atoms and molecules containing the element phosphorus between sources and sinks.
    - The major reservoirs of phosphorus in the phosphorus cycle are rock and sediments that contain phosphorus-bearing minerals.
    - There is no atmospheric component in the phosphorus cycle, and the limitations this imposes on the return of phosphorus from the ocean to land make phosphorus naturally scarce in aquatic and many terrestrial ecosystems. In undisturbed ecosystems, phosphorus is the limiting factor in biological systems.

- *ERT-1.G. Explain the steps and reservoir interactions in the hydrologic cycle.*
    - The hydrologic cycle, which is powered by the sun, is the movement of water in its various solid, liquid, and gaseous phases between sources and sinks.
    - The oceans are the primary reservoir of water at the Earth's surface, with ice caps and groundwater acting as much smaller reservoirs.

- *ENG-1.A. Explain how solar energy is acquired and transferred by living organisms.*
    - Primary productivity is the rate at which solar energy (sunlight) is converted into organic compounds via photosynthesis over a unit of time.
    - Gross primary productivity is the total rate of photosynthesis in a given area.
    - Net primary productivity is the rate of energy storage by photosynthesizers in a given area, after subtracting the energy lost to respiration.
    - Productivity is measured in units of energy per unit area per unit time (e.g., kcal/m2/yr).

- *ERT-1.B. Explain how energy flows and matter cycles through trophic levels.*
    - All ecosystems depend on a continuous inflow of high-quality energy in order to maintain their structure and function of transferring matter between the environment and organisms via biogeochemical cycles.
    - Biogeochemical cycles are essential for life and each cycle demonstrates the conservation of matter.
    - In terrestrial and near-surface marine communities, energy flows from the sun to producers in the lowest trophic levels and then upward to higher trophic levels.

- *ENG-1.C. Determine how the energy decreases as it flows through ecosystems.*
    - The 10% rule approximates that in the transfer of energy from one trophic level to the next, only about 10% of the energy is passed on.
    - The loss of energy that occurs when energy moves from lower to higher trophic levels can be explained through the laws of thermodynamics.

- *ENG-1.D. Describe food chains and food webs, and their constituent members by trophic level.*
    - A food web is a model of an interlocking pattern of food chains that depicts the flow of energy and nutrients in two or more food chains.
    - Positive and negative feedback loops can each play a role in food webs. When one species is removed from or added to a specific food web, the rest of the food web can be affected.

- *ERT-2.A. Explain levels of biodiversity and their importance to ecosystems.*
    - Biodiversity in an ecosystem includes genetic, species, and habitat diversity.
    - The more genetically diverse a population is, the better it can respond to environmental stressors. Additionally, a population bottleneck can lead to a loss of genetic diversity.
    - Ecosystems that have a larger number of species are more likely to recover from disruptions.
    - Loss of habitat leads to a loss of specialist species, followed by a loss of generalist species. It also leads to reduced numbers of species that have large territorial requirements.
    - Species richness refers to the number of different species found in an ecosystem.

- *ERT-2.D. Describe island biogeography.*
    - Island biogeography is the study of the ecological relationships and distribution of organisms on islands, and of these organisms' community structures.
    - Islands have been colonized in the past by new species arriving from elsewhere.

- *ERT-2.E. Describe the role of island biogeography in evolution.*
    - Many island species have evolved to be specialists versus generalists because of the limited resources, such as food and territory, on most islands. The long-term survival of specialists may be jeopardized if and when invasive species, typically generalists, are introduced and outcompete the specialists.

- *ERT-2.H. Describe how organisms adapt to their environment.*
    - Organisms adapt to their environment over time, both in short- and long-term scales, via incremental changes at the genetic level.
    - Environmental changes, either sudden or gradual, may threaten a species' survival, requiring individuals to alter behaviors, move, or perish.
    - A keystone species in an ecosystem is a species whose activities have a particularly significant role in determining community structure.
    - An indicator species is a plant or animal that, by its presence, abundance, scarcity, or chemical composition, demonstrates that some distinctive aspect of the character or quality of an ecosystem is present.

- *ERT-3.A. Identify differences between generalist and specialist species.*
    - Specialist species tend to be advantaged in habitats that remain constant, while generalist species tend to be advantaged in habitats that are changing.

- *EIN-2.A. Explain the concept of the tragedy of the commons.*
    - The tragedy of the commons suggests that individuals will use shared resources in their own self-interest rather than in keeping with the common good, thereby depleting the resources.
    - A radioactive element's half-life can be used to calculate a variety of things, including the rate of decay and the radioactivity level at specific points in time.

- *STB-4.H. Explain the causes and effects of ocean acidification.*
    - Ocean acidification is the decrease in pH of the oceans, primarily due to increased CO2 concentrations in the atmosphere, and can be expressed as chemical equations.
    - As more CO2 is released into the atmosphere, the oceans, which absorb a large part of that CO2, become more acidic.
    - Selective pressures are any factors that change the behaviors and fitness of organisms within an environment.