CH3 - Ecosystems: What Are They and How Do They Work?

Ecological Terminology

- _____ is the study of how organisms interact with each other and their nonliving environment.
- Ecological Levels of Organization: organism → species → _____ → community → _____

Ecosystem Concepts

- _____ are large regions characterized by a distinct climate and specific life forms
  - Biomes may consist of many ecosystems
  - Aquatic biomes are also called Aquatic Life Zones
- _____ are regions where one ecosystem merges with another, and show characteristics of both ecosystems

Autotrophs & Heterotrophs

- Autotrophs, or producers, make their own food.
  - photosynthesis: $6CO_2 + 6H_2O + \text{solar energy} \rightarrow C_6H_{12}O_6 + 6O_2$
  - _____: $CO_2 + O_2 + 4H_2S \rightarrow CH_2O + 4S + 3H_2O$
- Heterotrophs, or consumers, feed on other organisms.
  - most consumers exhibit _____ respiration: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$
  - decomposers exhibit anaerobic respiration, or _____. The end products may be methane gas (CH_4), ethyl alcohol (C_2H_6O), acetic acid ($C_2H_4O_2$) or hydrogen sulfide (H_2S)

Energy Flow in Ecosystems

- Food webs are made up of many interlocking _____ _____.
- Energy stored in biomass is transferred from one trophic level to another, with most (90%) being degraded or lost to the environment as low-quality heat in each transfer. This _____ efficiency is explained through the laws of thermodynamics.

Biomass Productivity

- The rate at which an ecosystem's producers convert solar energy into chemical energy as biomass is the ecosystem's _____ primary productivity.
- The GPP does not account for the use of energy by organisms. Therefore, the _____ Primary Productivity is the rate at which producers store chemical energy minus the rate at which producers use chemical energy.

The Limiting Factor Principle

- Within the law of _____, one factor often turns out to be more important that others in regulating population growth. This is described in the Limiting Factor Principle:
  - Too much or too little of any _____ factor can limit or prevent growth of a population, even if all other factors are at or near the optimum range of tolerance

Biogeochemical Cycles

- Biogeochemical cycles are natural processes that recycle nutrients in various chemical forms from the nonliving environment to living organisms and back again.
  - In hydrologic cycles, _____ cycles through the biosphere.
  - In atmospheric cycles, a large portion of a given element exists in gaseous form in the atmosphere.
  - In sedimentary cycles, elements do not have a significant gaseous phase and occur primarily in the _____

The Hydrologic Cycle

- The main processes of the hydrologic cycle (water cycle):
  - evaporation: water to water vapor
  - transpiration: evaporation from leaves of water extracted from soil
  - _____: water vapor to water
  - precipitation: rain, sleet, hail and snow
  - infiltration: movement of water into soil
  - _____: downward flow of water through soil into groundwater storage areas called aquifers
  - runoff: downslope surface movement back to the sea

The Carbon Cycle

- The carbon cycle is based primarily on carbon _____ gas, and has six main processes:
  - photosynthesis: plants take CO_2 from the atmosphere and convert it complex carbohydrates
  - _____: consumers take complex carbohydrates and create CO_2
  - decomposition: decomposers take complex carbohydrates and create CO_2
  - _____: biomass is buried and compressed into fossil fuels
  - combustion: fossil fuels or biomass is burned, releasing CO_2
  - absorption: the oceans absorb massive amounts of CO2, converting to _____ acid and lowering the pH of oceans

The Nitrogen Cycle

- Nitrogen gas makes up _____% of the atmosphere. Multicellular plants and animals cannot take this up, however, lightning and certain bacteria can convert it to other compounds as part of the nitrogen cycle.
  - Nitrogen fixation: bacteria convert N_2 (atmospheric nitrogen) into NH_3 (ammonia)
  - Nitrification: $NH_3 \rightarrow NO_2^-$ (nitrite) $\rightarrow NO_3^-$ (_____)
  - Assimilation: plant roots take up NH_3, NH_4^+ (ammonium ion) and NO_3^- and convert into complex organic molecules
  - Ammonification: decomposers break down complex organic molecules into NH_3 and NH_4^+
  - _____: bacteria convert NH_3 and NH_4^+ into NO_2^- and NO_3^- then into N_2 and N_2O (nitrous oxide)

The Phosphorus Cycle

- Phosphorus cycles through water, the earth's crust, and living organisms. The cycling is much quicker through the living components than through geological formations.
  - _____: slow breakdown of terrestrial phosphate, PO_4^{3-}
  - runoff: flow of phosphate into aquatic systems via precipitation
  - _____: take up of phosphorus by producers, and, in turn, consumers
  - deposition: return of phosphorus to soil and rock through decay and waste products of organisms

The Sulfur Cycle

- Most of the earth's sulfur is tied up in underground rocks, however, it is found in organic compounds.
  - _____ decomposition: breakdown of organic matter in the absence of O_2 leads to the release of H_2S (hydrogen sulfide)
  - vulcanism: release of SO_2 (sulfur dioxide) by volcanoes
  - _____: sulfur in the form of H_2SO_4 (sulfuric acid)
  - assimilation: organisms take up H_2SO_4 and SO_4^{-2} (sulfate salts)

Human Intervention

- There are many _____ influences on biogeochemical cycles:
  - withdrawing large quantities of fresh water from streams, lakes, and underground sources
  - runoff of phosphate and nitrogen to aquatic systems from _____ and livestock
  - clearing vegetation from land, which increases runoff, reduces infiltration, and decreases atmospheric CO_2 absorption. _____agriculture in tropical rainforests reduces the amount of phosphate in the ecosystem and adds CO_2 to the atmosphere
  - burning fossil fuels releases CO_2 (global warming & ocean acidification), NO_x (acid rain, tropospheric ozone and global warming), and NO_2 (depletion of stratospheric ozone)
  - _____ of large quantities of phosphate for detergents and fertilizers disrupts ecosystems
  - smelting metallic minerals to free metals such as copper and lead

Tragedy of the Commons

- Tragedy of the Commons is the depletion or degradation of a potentially _____ resource to which people have free and unmanaged access. It suggests that individuals will use shared resources in their own self-interest rather than in keeping with the common good, thereby depleting the resources.