

## Ecosystems: What Are They and How Do They Work? Chapter Three

### 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:  $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{solar energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
  - \_\_\_\_\_:  $\text{CO}_2 + \text{O}_2 + 4\text{H}_2\text{S} \rightarrow \text{CH}_2\text{O} + 4\text{S} + 3\text{H}_2\text{O}$
- Heterotrophs, or consumers, feed on other organisms.
  - most consumers exhibit \_\_\_\_\_ respiration:
    - $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{energy}$
  - decomposers exhibit anaerobic respiration, or \_\_\_\_\_.
    - The end products may be methane gas ( $\text{CH}_4$ ), ethyl alcohol ( $\text{C}_2\text{H}_6\text{O}$ ), acetic acid ( $\text{C}_2\text{H}_4\text{O}_2$ ) or hydrogen sulfide ( $\text{H}_2\text{S}$ )

### Energy Flow in Ecosystems

- Food webs are made up of many interwoven \_\_\_\_\_.
- Energy stored in biomass is transferred from one trophic level to another, with some usable energy degraded or lost to the environment as low-quality heat in each transfer. (ecological \_\_\_\_\_)

### Biomass Productivity

- The rate at which an ecosystem's producers convert solar energy into chemical energy as biomass is the ecosystem's \_\_\_\_\_ primary productivity (GPP).
- The GPP does not account for the use of energy by organisms. Therefore, the \_\_\_\_\_ Primary Productivity (NPP) 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 than 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 \_\_\_\_\_

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### **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 five main processes:
  - photosynthesis: plants take  $\text{CO}_2$  from the atmosphere and convert it complex carbohydrates
  - \_\_\_\_\_: consumers take complex carbohydrates and create  $\text{CO}_2$
  - decomposition: decomposers take complex carbohydrates and create  $\text{CO}_2$
  - \_\_\_\_\_: biomass is buried and compressed into fossil fuels
  - combustion: fossil fuels or biomass is burned, releasing  $\text{CO}_2$

### **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  $\text{N}_2$  (atmospheric nitrogen) into  $\text{NH}_3$  (ammonia)
  - Nitrification:  $\text{NH}_3 \rightarrow \text{NO}_2^-$  (nitrite)  $\rightarrow \text{NO}_3^-$  (\_\_\_\_\_)
  - Assimilation: plant roots take up  $\text{NH}_3$ ,  $\text{NH}_4^+$  (ammonium ion) and  $\text{NO}_3^-$  and convert into complex organic molecules
  - Ammonification: decomposers break down complex organic molecules into  $\text{NH}_3$  and  $\text{NH}_4^+$
  - \_\_\_\_\_: bacteria convert  $\text{NH}_3$  and  $\text{NH}_4^+$  into  $\text{NO}_2^-$  and  $\text{NO}_3^-$  then into  $\text{N}_2$  and  $\text{N}_2\text{O}$  (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,  $\text{PO}_4^{3-}$
  - 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  $\text{O}_2$  leads to the release of  $\text{H}_2\text{S}$  (hydrogen sulfide)
  - vulcanism: release of  $\text{SO}_2$  (sulfur dioxide) by volcanoes
  - \_\_\_\_\_: sulfur in the form of  $\text{H}_2\text{SO}_4$  (sulfuric acid)
  - assimilation: organisms take up  $\text{H}_2\text{SO}_4$  and  $\text{SO}_4^{2-}$  (sulfate salts)

### **Human Intervention**

- Humans intervene in the biogeochemical cycles in many ways:
  - 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  $\text{CO}_2$  absorption
    - \_\_\_\_\_ agriculture in tropical rainforests reduces the amount of phosphate in the ecosystem and adds  $\text{CO}_2$  to the atmosphere
  - burning fossil fuels releases  $\text{CO}_2$  (leads to global warming),  $\text{NO}$  (leads to acid rain and tropospheric ozone, and global warming), and  $\text{NO}_2$  (leads to 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