

Chapter 30 Microbial Ecology

Summary Outline

19.1 Principles of microbial ecology

- A. Ecosystems vary in their **biodiversity** and **biomass**.
- B. The microenvironment of a microorganism is most important to its survival and growth.
- C. Nutrient acquisition
 - 1. **Primary producers** convert carbon dioxide into organic materials.
 - 2. **Consumers** use the organic materials, either directly or indirectly, produced by plants.
 - 3. **Decomposers** breakdown the remains of primary producers and consumers.
- D. Bacteria in **low nutrient environments** grow in dilute aqueous solutions often in **biofilms**.
- E. Microbial competition and antagonism
 - 1. Microorganisms in the environment compete for the same limited pool of nutrients.
 - 2. One species may competitively exclude others, or produce compounds that inhibit others.
- F. Environmental changes, which are common, cause changes in microorganisms that include induction of enzymes, selection of mutants, and changes in dominance.
- G. Microorganisms often grow in communities attached to a solid substrate or at air-water interfaces.
- H. Microbial ecology is difficult to study because few environmental microorganisms can be grown in the laboratory, but molecular techniques such as **fluorescence *in situ* hybridization, polymerase chain reaction (PCR), denaturing gradient gel electrophoresis (DGGE), and DNA sequencing** are being used to understand complex microbial communities.

19.2 Aquatic habitats

- A. Types of environments
 - 1. **Oligotrophic waters** are nutrient poor.
 - 2. **Eutrophic waters** are nutrient rich.
 - 3. Overgrowth of aerobic heterotrophs can cause an aquatic environment to become **hypoxic** resulting in the death of aquatic animals.
 - 4. Marine environments are usually oligotrophic and aerobic, but inshore areas can be affected by nutrient runoff.
 - 5. Freshwater environments
 - a. Oligotrophic lakes may have anaerobic layers due to thermal stratification.
 - b. Shallow, turbulent streams are generally aerobic.
 - 6. Specialized environments – Salt lakes, mineral-rich and hot springs support the growth of microorganisms that are adapted to survive in these special environments.

19.3 Terrestrial habitats

- A. Soil constitutes an environment that can fluctuate greatly.
- B. The density and composition of soil microorganisms are affected by environmental conditions.
- C. The most important **environmental influences** in soil are: **Moisture, acidity, temperature, and nutrient availability**
- D. The **rhizosphere** is the zone of soil that adheres to plant roots and it contains a much higher concentration of microorganisms than the surrounding soil.

19.4 Biogeochemical cycling and energy flow

- A. All organisms use elements to produce **biomass**, as a **source of energy**, and as a **terminal electron acceptor**.
- B. **Carbon cycle**—The carbon cycle revolves around CO₂, its fixation into organic compounds by primary producers, and its regeneration mostly by microorganisms.
- C. **Nitrogen cycle**—Atmospheric nitrogen is converted to biologically useful forms through the processes of **ammonification, nitrification, denitrification, and nitrogen fixation** by free-living and symbiotic nitrogen fixers.
- D. **Sulfur cycle**—The sulfur cycle is similar to the nitrogen cycle.
- E. **Energy sources** for ecosystems include (1) **sunlight** via photosynthesis and (2) the **chemical synthesis of inorganic and organic materials** by chemoautotrophic microorganisms.

19.5 Mutualistic relationships between microorganisms and eukaryotes

- A. Mycorrhizae are fungi that help plants to take up phosphorus and other substance from the soil while gaining nutrition for their own use.
- B. Symbiotic nitrogen-fixing microorganisms add a significant amount of fixed nitrogen to the soil.
- C. A mutualistic relationship exists between microorganisms and herbivores that aids in the digestion of plant material.