

# Study Outline Chapter 1

## Microbes in Our Lives (pp. 2-3)

- Living things too small to be seen with the unaided eye are called microorganisms.
- Microorganisms are important in the maintenance of an ecological balance on Earth.
- Some microorganisms live in humans and other animals and are needed to maintain the animal's health.
- Some microorganisms are used to produce foods and chemicals.
- Some microorganisms cause disease.

## A Brief History of Microbiology

### The First Observations (p. 3)

- Robert Hooke observed that plant material was composed of "little boxes"; he introduced the term cell (1665).
- Hooke's observations laid the groundwork for development of the cell theory, the concept that all living things are composed of cells.
- Antoni van Leeuwenhoek, using a simple microscope, was the first to observe microorganisms (1673).
- The Debate Over Spontaneous Generation (pp. 3-7)
- Until the mid-1880s, many people believed in spontaneous generation, the idea that living organisms could arise from nonliving matter.
- Francesco Redi demonstrated that maggots appear on decaying meat only when flies are able to lay eggs on the meat (1668).
- John Needham claimed that microorganisms could arise spontaneously from heated nutrient broth (1745).
- Lazzaro Spallanzani repeated Needham's experiments and suggested that Needham's results were due to microorganisms in the air entering his broth (1765).
- Rudolf Virchow introduced the concept of biogenesis: Living cells can arise only from preexisting cells (1858).
- Louis Pasteur demonstrated that microorganisms are in the air everywhere and offered proof of biogenesis (1861).
- Pasteur's discoveries led to the development of aseptic techniques used in laboratory and medical procedures to prevent contamination by microorganisms in the air.

### The Golden Age of Microbiology (pp. 7-10)

- Rapid advances in the science of microbiology were made between 1857 and 1914.
- Fermentation and Pasteurization (p. 7)
- Pasteur found that yeast ferment sugars to alcohol and that bacteria can oxidize the alcohol to acetic acid.

- A heating process called pasteurization is used to kill bacteria in some alcoholic beverages and milk.

#### The Germ Theory of Disease (pp. 7-9)

- Agostino Bassi (1835) and Pasteur (1865) showed a causal relationship between microorganisms and disease.
- Joseph Lister introduced the use of a disinfectant to clean surgical dressings in order to control infections in humans (1860s).
- Robert Koch proved that microorganisms cause disease. He used a sequence of procedures called Koch's postulates (1876), which are used today to prove that a particular microorganism causes a particular disease.

#### Vaccination (pp. 9-10)

- In a vaccination, immunity (resistance to a particular disease) is conferred by inoculation with a vaccine.
- In 1798, Edward Jenner demonstrated that inoculation with cowpox material provides humans with immunity from smallpox.
- About 1880, Pasteur discovered that avirulent bacteria could be used as a vaccine for fowl cholera; he coined the word vaccine.
- Modern vaccines are prepared from living avirulent microorganisms or killed pathogens, from isolated components of pathogens, and by recombinant DNA techniques.

#### The Birth of Modern Chemotherapy: Dreams of a "Magic Bullet" (pp. 10-11)

- Chemotherapy is the chemical treatment of a disease.
- Two types of chemotherapeutic agents are synthetic drugs (chemically prepared in the laboratory) and antibiotics (substances produced naturally by bacteria and fungi to inhibit the growth of other microorganisms).
- Paul Ehrlich introduced an arsenic-containing chemical called salvarsan to treat syphilis (1910).
- Alexander Fleming observed that the mold (fungus) *Penicillium* inhibited the growth of a bacterial culture. He named the active ingredient penicillin (1928).
- Penicillin has been used clinically as an antibiotic since the 1940s.
- In 1939, René Dubos discovered two antibiotics produced by the bacterium *Bacillus*.
- Researchers are tackling the problem of drug-resistant microbes.
- Modern Developments in Microbiology (pp. 11-14)

#### Modern Developments in Microbiology (pp. 11-14)

- Bacteriology is the study of bacteria, mycology is the study of fungi, and parasitology is the study of parasitic protozoa and worms.
- The study of AIDS, analysis of the action of interferons, and the development of new vaccines are among the current research interests in immunology.
- New techniques in molecular biology and electron microscopy have provided tools for advancement of our knowledge of virology.
- The development of recombinant DNA technology has helped advance all areas of microbiology.

## **Naming and Classifying**

### Microorganisms (pp. 14-15)

- In a nomenclature system designed by Carolus Linnaeus (1735), each living organism is assigned two names.
- The two names consist of a genus and a specific epithet, both of which are underlined or italicized.
- All organisms are classified into Eubacteria, Archaea, and Eucarya. Eucarya includes Protista, Fungi, Plantae, and Animalia.

## **The Diversity of Microorganisms (pp. 15-17)**

### Bacteria (p. 15)

- Bacteria are unicellular organisms. Because they have no nucleus, the cells are described as procaryotic.
- The three major basic shapes of bacteria are bacillus, coccus, and spiral.
- Most bacteria have a peptidoglycan cell wall, they divide by binary fission, and they may possess flagella.
- Bacteria can use a wide range of chemical substances for their nutrition.

### Fungi (p. 15)

- Fungi (mushrooms, molds, and yeasts) have eucaryotic cells (with a true nucleus). Most fungi are multicellular.
- Fungi obtain nutrients by absorbing organic material from their environment.

### Protozoa (p. 15)

- Protozoa are unicellular eucaryotes and are classified according to their means of locomotion.
- Protozoa obtain nourishment by absorption or ingestion through specialized structures.

### Algae (p. 17)

- Algae are unicellular or multicellular eucaryotes that obtain nourishment by photosynthesis.
- Algae produce oxygen and carbohydrates that are used by other organisms.

### Viruses (p. 17)

- Viruses are noncellular entities that are parasites of cells.
- Viruses consist of a nucleic acid core (DNA or RNA) surrounded by a protein coat. An envelope may surround the coat.

### Multicellular Animal Parasites (p. 17)

- The principal groups of multicellular animal parasites are flatworms and roundworms, collectively called helminths.
- The microscopic states in the life cycle of helminths are identified by traditional microbiological procedures.

### Microbes and Human Welfare (pp. 17-19)

- Microorganisms degrade dead plants and animals and recycle chemical elements to be used by living plants and animals.
- Bacteria are used to decompose organic matter in sewage.
- Bioremediation processes use bacteria to clean up toxic wastes.

- Bacteria that cause diseases in insects are being used as biological controls of insect pests. Biological controls are specific for the pest and do not harm the environment.
- Using microbes to make products such as foods and chemicals is called biotechnology.
- Using recombinant DNA, bacteria can produce important substances such as proteins, vaccines, and enzymes.
- In gene therapy, viruses are used to carry replacements for defective or missing genes into human cells.
- Genetically engineered bacteria are used in agriculture to protect plants from frost and insects and to improve the shelf life of produce.

#### Microbes and Human Disease (pp. 19-22)

- Everyone has microorganisms in and on the body; these make up the normal microbiota or flora.
- The disease-producing properties of a species of microbe and the host's resistance are important factors in determining whether a person will contract a disease.
- An infectious disease is one in which pathogens invade a susceptible host.
- An emerging infectious disease (EID) is a new or changing disease, showing an increase in incidence in the recent past or a potential to increase in the near future.