

The Microbial World and You

Microbes in Our Lives

- Microorganisms are organisms that are too small to be seen with the unaided eye.
- “Germ” refers to a rapidly growing cell.

Microorganisms

- Decompose organic waste
- Are producers in the ecosystem by photosynthesis
- Produce industrial chemicals such as ethanol and acetone
- Produce fermented foods such as vinegar, cheese, and bread
- Produce products used in manufacturing (e.g., cellulase) and treatment (e.g., insulin)
- A few are pathogenic, disease-causing

Knowledge of Microorganisms

- Allows humans to
 - Prevent food spoilage
 - Prevent disease occurrence
- Led to aseptic techniques to prevent contamination in medicine and in microbiology laboratories.

Naming and Classifying Microorganisms

- Linnaeus established the system of scientific nomenclature.
- Each organism has two names: the genus and specific epithet.

Scientific Names

- Are italicized or underlined. The genus is capitalized and the specific epithet is lowercase.
- Are “Latinized” and used worldwide.
- May be descriptive or honor a scientist.
- *Staphylococcus aureus*
 - Describes the clustered arrangement of the cells (*staphylo-*) and the golden color of the colonies (*aureus*).
- *Escherichia coli*
 - Honors the discoverer, Theodor Escherich, and describes the bacterium’s habitat—the large intestine or colon.
- After the first use, scientific names may be abbreviated with the first letter of the genus and the specific epithet:
 - *Staphylococcus aureus* and *Escherichia coli* are found in the human body. *S. aureus* is on skin and *E. coli* in the large intestine.

Bacteria

- Prokaryotes
- Peptidoglycan cell walls
- Binary fission
- For energy, use organic chemicals, inorganic chemicals, or photosynthesis

Viruses

- Acellular
- Consist of DNA or RNA core
- Core is surrounded by a protein coat.
- Coat may be enclosed in a lipid envelope.
- Viruses are replicated only when they are in a living host cell.

Classification of Microorganisms

- Three domains
 - Bacteria
 - Archaea
 - Eukarya
 - Protists
 - Fungi
 - Plants
 - Animals

A Brief History of Microbiology

- Ancestors of bacteria were the first life on Earth.
- The first microbes were observed in 1673.
- Cell theory:
 - All living things are composed of cells.
 - Cells come from preexisting cells.
 - Cell is the smallest unit of life (?).

The Debate over Spontaneous Generation

- The hypothesis that living organisms arise from nonliving matter is called spontaneous generation. According to spontaneous generation, a “vital force” forms life.
- The alternative hypothesis, that the living organisms arise from preexisting life, is called biogenesis.

Evidence Pro and Con

- 1668: Francisco Redi filled six jars with decaying meat.

Conditions	Results
Three jars covered with fine net	No maggots
Three open jars	Maggots appeared

From where did the maggots come?
What was the purpose of the sealed jars?
Spontaneous generation or biogenesis?

- 1745: John Needham put boiled nutrient broth into covered flasks.

Conditions	Results
Nutrient broth heated, then placed in sealed flask	Microbial growth

From where did the microbes come?
Spontaneous generation or biogenesis?

- 1765: Lazzaro Spallanzani boiled nutrient solutions in flasks.

Conditions	Results
Nutrient broth placed in flask, heated, then sealed	No microbial growth

Spontaneous generation or biogenesis?

- 1861: Louis Pasteur demonstrated that microorganisms are present in the air.

Conditions	Results
Nutrient broth placed in flask, heated, not sealed – flask remains upright	No microbial growth
Nutrient broth placed in flask, heated, no sealed – flask tilted	Microbial growth

Spontaneous generation or biogenesis?

- Pasteur's S-shaped flask kept microbes out but let air in.



The Golden Age of Microbiology

- 1857-1914
- Beginning with Pasteur's work, discoveries included the relationship between microbes and disease, immunity, and antimicrobial drugs

Fermentation and Pasteurization

- Pasteur showed that microbes are responsible for fermentation.
- Fermentation is the conversion of sugar to alcohol to make beer and wine.
- Microbial growth is also responsible for spoilage of food.
- Bacteria that use alcohol and produce acetic acid spoil wine by turning it to vinegar (acetic acid).
- Pasteur demonstrated that these spoilage bacteria could be killed by heat that was not hot enough to evaporate the alcohol in wine.
- Pasteurization is the application of a high heat for a short time

The Germ Theory of Disease

- 1860s: Joseph Lister used a chemical disinfectant to prevent surgical wound infections after looking at Pasteur's work showing microbes are in the air, can spoil food, and cause animal diseases.
- 1876: Robert Koch proved that a bacterium causes anthrax and provided the experimental steps, Koch's postulates, to prove that a specific microbe causes a specific disease.

Vaccination

- 1796: Edward Jenner inoculated a person with cowpox virus. The person was then protected from smallpox.
- Vaccination is derived from *vacca* for cow.
- The protection is called immunity.

Microbes and Human Welfare

- Microbial ecology
- Bacteria recycle carbon, nutrients, sulfur, and phosphorus that can be used by plants and animals.

Bioremediation

- Bacteria degrade organic matter in sewage.
- Bacteria degrade or detoxify pollutants such as oil and mercury.

Biological Insecticides

- Microbes that are pathogenic to insects are alternatives to chemical pesticides in preventing insect damage to agricultural crops and disease transmission.
- *Bacillus thuringiensis* infections are fatal in many insects but harmless to other animals, including humans, and to plants.

Modern Biotechnology and Genetic Engineering

- Biotechnology, the use of microbes to produce foods and chemicals, is centuries old.
- Genetic engineering is a new technique for biotechnology. Through genetic engineering, bacteria and fungi can produce a variety of proteins including vaccines and enzymes.

Microbes and Human Disease

- Bacteria were once classified as plants giving rise to use of the term *flora* for microbes.
- This term has been replaced by *microbiota*.
- Microbes normally present in and on the human body are called normal microbiota.
- Normal microbiota prevent growth of pathogens and produce vitamins (examples: K, folic acid).

Infectious Diseases

- When a pathogen overcomes the host's resistance, disease results.
- Emerging infectious diseases (EID): New diseases and diseases increasing in incidence.
 - HIV, Ebola, West Nile, SARS, Avian Influenza etc.

Study Objectives

1. Explain the difference between abiogenesis (spontaneous generation) and biogenesis.
2. Describe Louis Pasteur's swan-necked flask experiment and explain what it proves.
3. Give 5 ways in which microorganisms benefit humankind.
4. Give 2 ways in which microorganisms harm humankind.
5. Describe 3 of Pasteur's accomplishments.