English for Biology
(3rd year Bachelor of Microbiology)

Pr H. Ouled-Haddar
University of Jijel

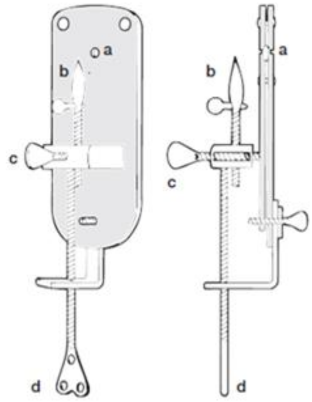
Overview

Microbiology is an exceptionally broad discipline including specialties as diverse as biochemistry, cell biology, genetics, taxonomy, pathogenic bacteriology, food and industrial microbiology, and ecology. A microbiologist must be familiar with many biological disciplines and with all major groups of microorganisms: viruses, bacteria, fungi, algae, and protozoa. The key is balance. Students new to the subject need an introduction to the whole before concentrating on those parts of greatest interest to them.

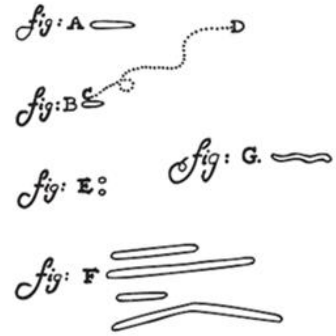
Microbiology often has been defined as the study of organisms and agents too small to be seen clearly by the unaided eye—that is, the study of microorganisms. Because objects less than about one millimetre in diameter cannot be seen clearly and must be examined with a microscope, microbiology is concerned primarily with organisms and agents this small and smaller. Its subjects are viruses, bacteria, many algae and fungi, and protozoa.

Yet other members of these groups, particularly some of the algae and fungi, are larger and quite visible. For example, bread molds and filamentous algae are studied by microbiologists, yet are visible to the naked eye. Two bacteria that are visible without a microscope, *Thiomargarita* and *Epulopiscium*, also have been discovered. The difficulty in setting the boundaries of microbiology led Roger Stanier to suggest that the field be defined not only in terms of the size of its subjects but also in terms of its techniques. A microbiologist usually first isolates a specific microorganism from a population and then cultures it. Thus microbiology employs techniques—such as sterilization and the use of culture media—that are necessary for successful isolation and growth of microorganisms.

(a)



(b)

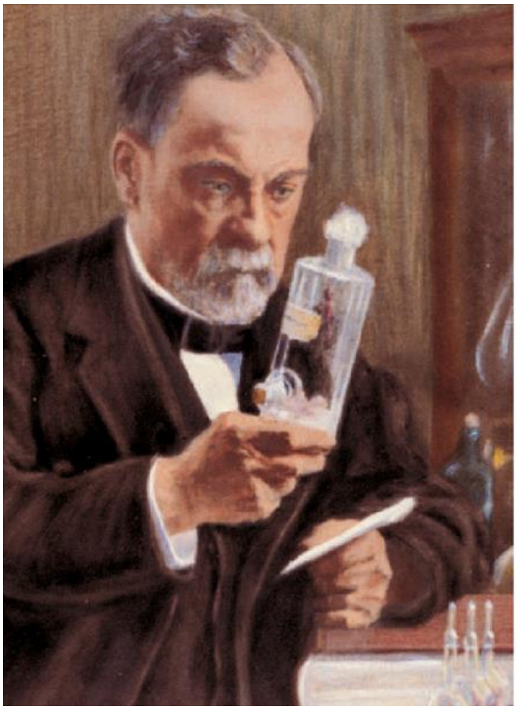


(c)

Figure 1.1 Antony van Leeuwenhoek. Leeuwenhoek (1632–1723) and his microscopes. **(a)** Leeuwenhoek holding a microscope. **(b)** A drawing of one of the microscopes showing the lens, *a;* mounting pin, *b;* and focusing screws, *c* and *d.* **(c)** Leeuwenhoek's drawings of bacteria from the human mouth. (*b*) *Source: C. E. Dobell,* Antony van Leeuwenhoek and His Little Animals *(1932), Russell and Russell, 1958.*

The Conflict over Spontaneous Generation

- From earliest times, people had believed in spontaneous generation—that living organisms could develop from non-living matter. Even the great Aristotle (384–322 B.C.) thought some of the simpler invertebrates could arise by spontaneous generation. This view finally was challenged by the Italian physician Francesco Redi (1626–1697), who carried out a series of experiments on decaying meat and its ability to produce maggots spontaneously. Redi placed meat in three containers. One was uncovered, a second was covered with paper, and the third was covered with a fine gauze that would exclude flies. Flies laid their eggs on the uncovered meat and maggots developed. The other two pieces of meat did not produce maggots spontaneously. However, flies were attracted to the gauze-covered container and laid their eggs on the gauze; these eggs produced maggots.
- Pasteur first filtered air through cotton and found that objects resembling plant spores had been trapped. If a piece of the cotton was placed in sterile medium after air had been filtered through it, microbial growth appeared. Next he placed nutrient solutions in flasks, heated their necks in a flame, and drew them out into a variety of curves, while keeping the ends of the necks open to the atmosphere. Pasteur then boiled the solutions for a few minutes and allowed them to cool. No growth took place even though the contents of the flasks were exposed to the air. Pasteur pointed out that no growth occurred because dust and germs had been trapped on the walls of the curved necks. If the necks were broken, growth commenced immediately. Pasteur had not only resolved the controversy by 1861 but also had shown how to keep solutions sterile. The English physicist John Tyndall (1820–1893) dealt a final blow to spontaneous generation in 1877 by demonstrating that dust did indeed carry germs and that if dust was absent, broth remained sterile even if directly exposed to air. During the course of his studies, Tyndall provided evidence for the existence of exceptionally heat-resistant forms of bacteria. Working independently, the German botanist Ferdinand Cohn (1828–1898) discovered the existence of heat-resistant bacterial endospores.



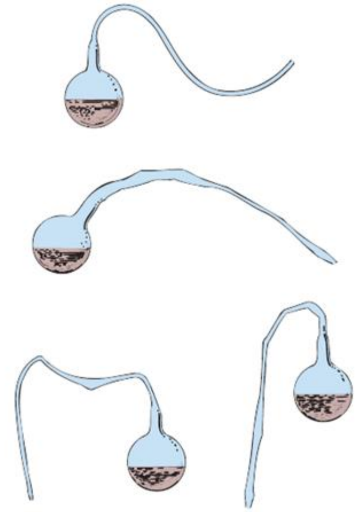


Figure 1.3 The Spontaneous Generation Experiment. Pasteur's swan neck flasks used in his experiments on the spontaneous generation of microorganisms. *Source:* Annales Sciences Naturelle, *4th Series, Vol. 16, pp.1–98, Pasteur, L., 1861, "Mémoire sur les Corpuscules Organisés Qui Existent Dans L'Atmosphère: Examen de la Doctrine des Générations Spontanées."*

Vital Activities of Microorganisms

The activities of microorganisms are responsible for the survival of all other organisms, including humans. A few examples prove this point. Nitrogen is an essential part of most of the important molecules in our bodies, such as nucleic acids and proteins. Nitrogen is also the most common gas in the atmosphere. Neither plants nor animals, however, can use nitrogen gas. Without certain bacteria that are able to convert the nitrogen in air into a chemical form that plants can use, life as we know it would not exist on Earth. All animals including humans require oxygen (O_2) to breathe. The supply of O_2 in the atmosphere, however, would be depleted in about 20 years, were it not replenished. On land, plants are important producers of O_2, but when all land and aquatic environments are considered, microorganisms are primarily responsible for continually replenishing the supply of O_2.

Microorganisms can also break down a wide variety of materials that no other forms of life can degrade. For example, the bulk of the carbohydrate in terrestrial (land) plants is in the form of cellulose, which humans and most animals cannot digest. Certain microorganisms can, however. As a result, leaves and downed trees do not pile up in the environment.

Cellulose is also degraded by billions of microorganisms in the digestive tracts of cattle, sheep, deer, and other ruminants. The digestion products are used by the cattle for energy. Without these bacteria, ruminants would not survive. Microorganisms also play an indispensable role in degrading a wide variety of materials in sewage and wastewater.

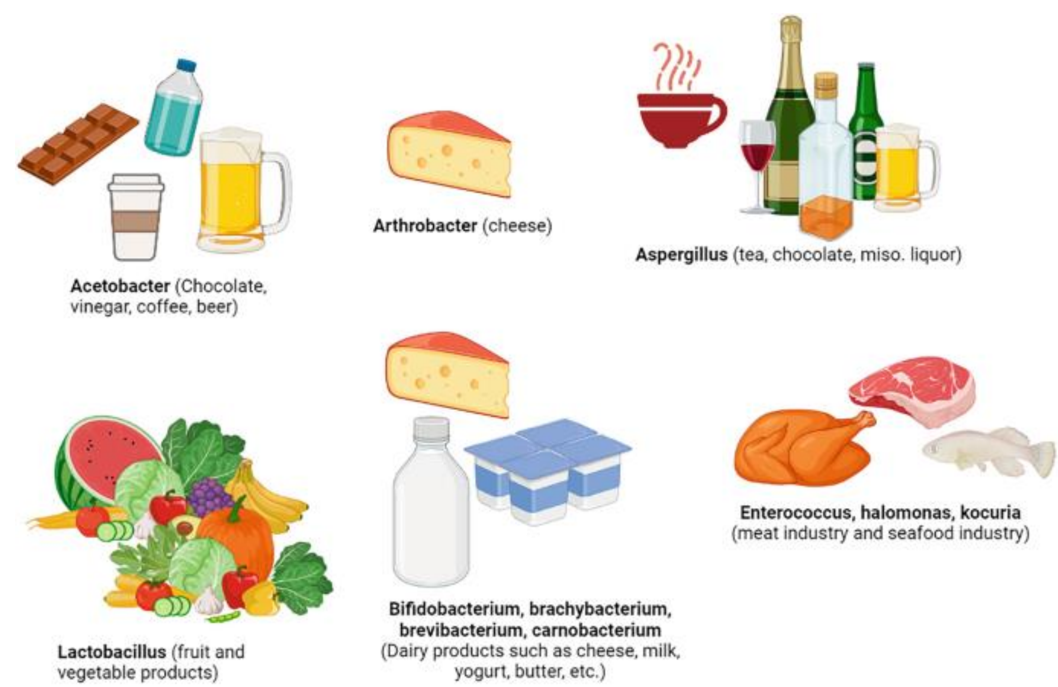
Applications of Microbiology

In addition to the crucial roles that microorganisms play in maintaining all life on earth, they also have made life more comfortable for humans over the centuries. Biotechnology is the application of biology to solve practical problems and produce useful products economically.

Food Production

By taking advantage of what microorganisms do naturally, Egyptian bakers as early as 2100 B.C. used yeast to make bread. Today, bakeries use essentially the same technology. The excavation of early tombs in Egypt revealed that by 1500 B.C., Egyptians employed a highly complex procedure for fermenting cereal grains to produce beer. Today, brewers use the same fundamental techniques to make beer and other fermented drinks.

Virtually every human culture that has domesticated milk-producing animals such as cows and goats also has developed the technology to ferment milk to produce foods such as yogurt, cheeses, and buttermilk. Today, the bacteria added to some fermented milk products are being touted by nutritionists as protecting against intestinal infections and bowel cancer, the field of probiotics.



Bioremediation

The use of living organisms to degrade environmental pollutants is termed bioremediation. Bacteria are being used to destroy such dangerous chemical pollutants as polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), and trichloroethylene, a highly toxic solvent used in dry cleaning. All three organic compounds and many more have been detected in soil and water. Bacteria are also being used to degrade oil, assist in the clean-up of oil spills, and treat radioactive wastes. A bacterium was discovered that can live on trinitrotoluene (TNT).

Useful Products from Bacteria

Bacteria can synthesize a wide variety of different products in the course of their metabolism. Many of these products have great commercial value. Although these same products can be synthesized in factories, bacteria often can do it faster and cheaper. For example, different bacteria produce:

- Cellulose used in stereo headsets
- Hydroxybutyric acid used in the manufacture of disposable diapers and plastics
- Ethanol, which is added to gasoline to make it burn cleaner
- Chemicals poisonous to insects (biopesticides)
- Antibiotics used in the treatment of disease
- Amino acids, which are used as dietary supplements

Industrial bioreactors

Genetic Engineering

It is now possible to introduce genes from one organism into a related or an unrelated organism and confer new properties on that organism. This is the process of genetic engineering.

Genetically engineered microorganisms often appear in the popular press because they are being used to solve many problems associated with an industrial society. Genetic engineering has expanded the power of biotechnology enormously. Here are examples of the roles that microorganisms play in this new biotechnology:

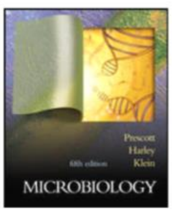
- Microorganisms can be genetically engineered to produce a variety of medically important products. These include interferon, insulin, human growth hormone, blood clotting factors, and enzymes that dissolve blood clots.
- Microorganisms are being modified so that they will produce vaccines against rabies, gonorrhea, herpes, leprosy, malaria, and hepatitis.
- A bacterium can be used to genetically engineer plants so they become resistant to insect attacks and viral diseases, and produce large amounts of b-carotene.
- A bacterium can be used to transfer antibody-eliciting genes into bananas which then confer resistance to certain diarrheal diseases.
- Viruses are being studied as a means of delivering genes into humans to correct conditions such as cystic fibrosis, heart disease, and cancer. This is the process of gene therapy.

Scientists are now better able to understand how bacteria can live in widely diverse environments and their relationships to other organisms thanks to genomics. This will allow scientists to improve organisms' usefulness in biotechnology.

Medical Microbiology

In addition to the important roles that microorganisms play in our daily lives, some also play a sinister role. For example, more Americans died of influenza in 1918–1919 than were killed in World War I, World War II, the Korean War, and the Vietnam War combined. Modern sanitation, vaccination, and effective antibiotic treatments have reduced the incidence of some of the worst diseases, such as smallpox, bubonic plague, and influenza, to a small fraction of their former numbers. Another disease, acquired immunodeficiency syndrome (AIDS), however, has risen as a modern-day plague.

References

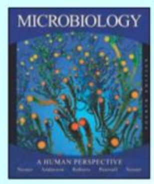


Microbiology

5th Edition

Lansing M. Prescott

ISBN: 0-07-282905-2
Description: ©2002 / Hardcover with CDROM
Publication Date: October 2002



Microbiology: A Human Perspective

4th edition

Eugene W. Nester, University of Washington
Denise G. Anderson, University of Washington
C. Evans Roberts, Jr., University of Washington
Nancy N. Pearsall
Martha T. Nester

ISBN: 0072919248
Copyright year: 2004