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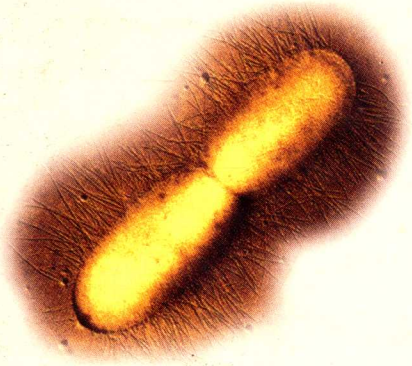

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an electronic companion to

beginning microbiology™

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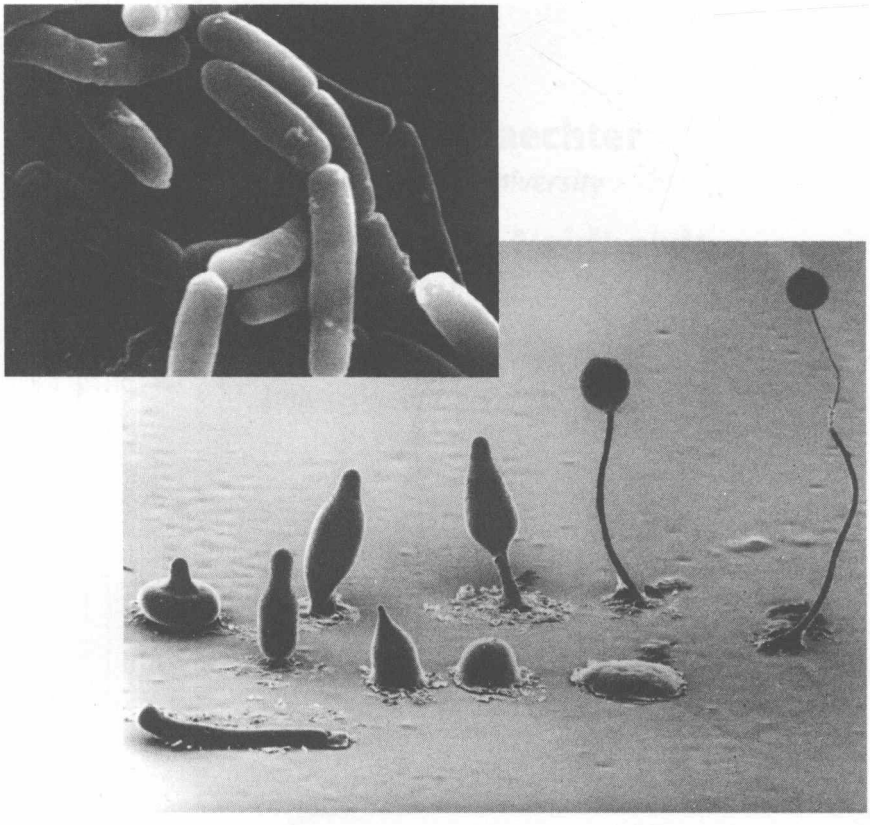

preface

This workbook consists of questions and answers arranged in a sequence similar to that of the CD-ROM topics. Each chapter also includes a self-assessment section.

You may consider using this workbook in two ways. First, you can use it to review the subject matter. The questions were selected to represent problems that are likely to have arisen during your study. Obviously we cannot read your mind, but we hope that we have hit the mark much of the time. Our aim has been to:

- provide simple definitions;
- clarify puzzling terms;
- point out the deeper meaning and relevance of facts and concepts;
- make analogies that are useful for understanding and retention.

Second, you may use the material for self-assessment. Either during a first or a second go-round, you may want to cover up the answers and try your hand at providing them yourself. In addition, at the end of each chapter, you will find a self-assessment section containing short answer and essay questions.

We hope that this workbook will show you what enjoyment we have found in microbiology.

Moselio Schaechter
Frederick C. Neidhardt

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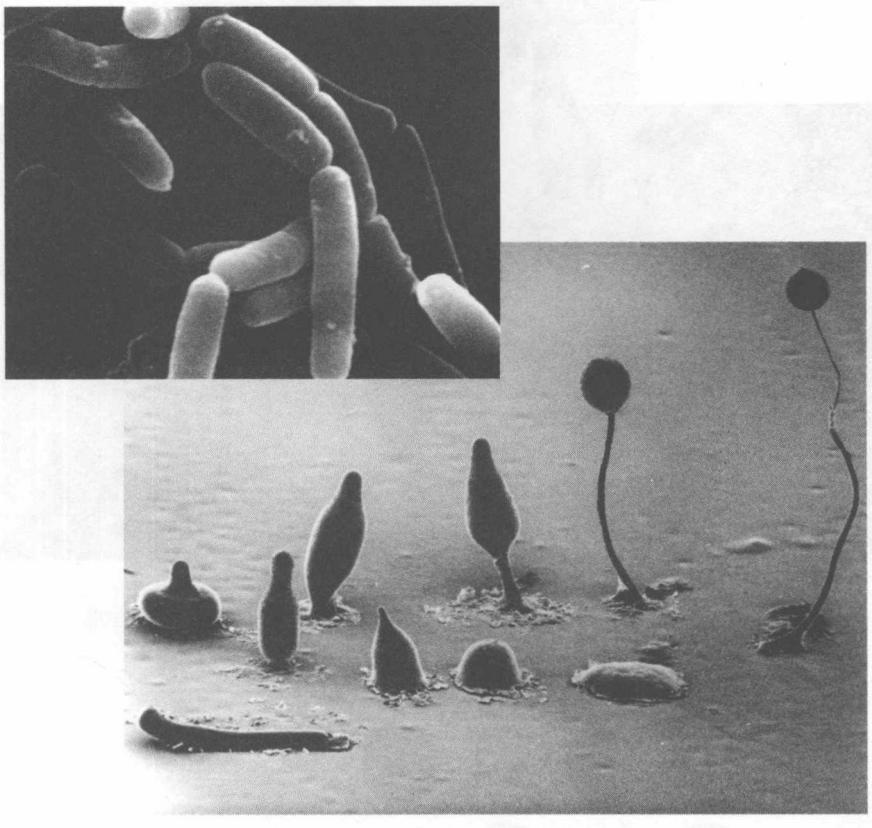
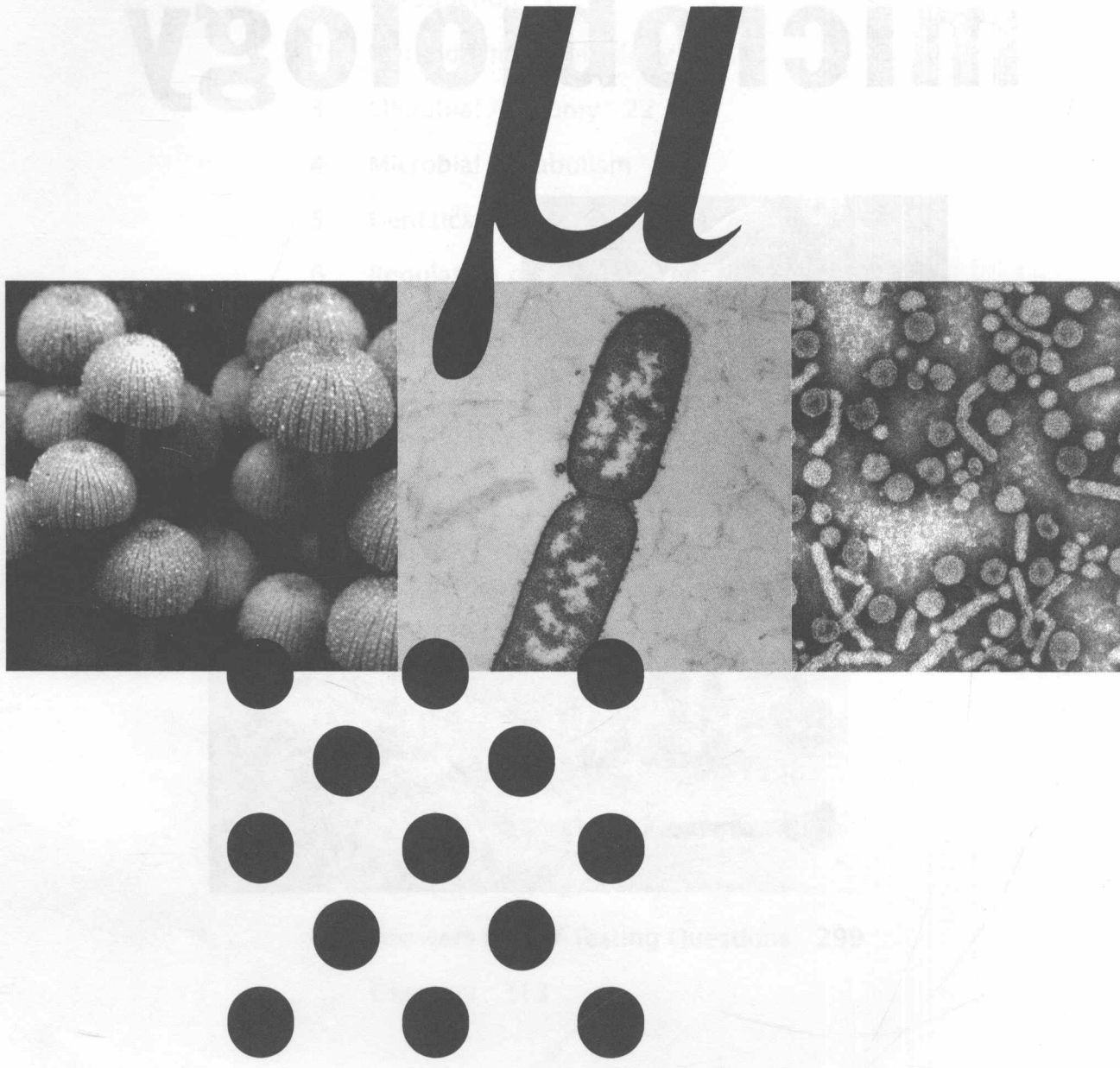
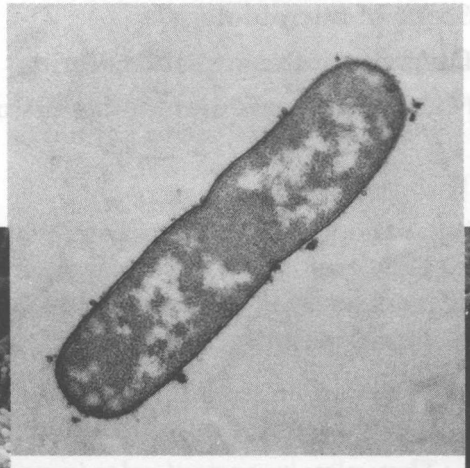
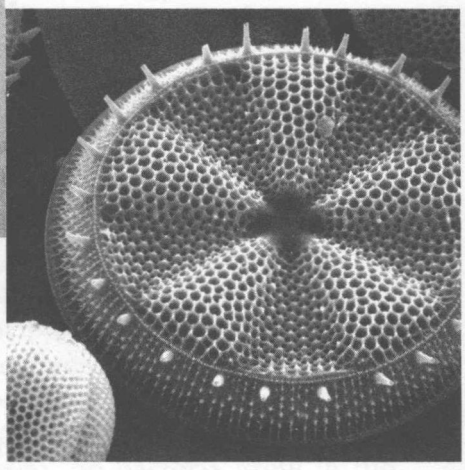




topic 1

Introduction





Summary

Microorganisms shape our environment and have profoundly affected human evolution and history, but microbiology is a relatively new science. It is concerned with basic biological phenomena as well as medicinal problems dealing with infectious diseases, the production and storage of food, and the dynamic aspects of our environment.

TOPICS

Scope of microbiology

Diversity of the microbial world

Microbial disease and human history

Things to Know

What about microorganisms as they concern humans?

- They profoundly affect our environment in ways that make plant, animal, and human life possible.
- They cause disease in humans, animals, and plants.
- They can be used for industrial production of foods, fermented beverages, and antibiotics.
- They play important roles in agriculture.
- They serve as models for the study of basic biological processes.

Does microbiology mean "going for biology in a small way"? Not really, microbiology is the study of microorganisms, the unseen world of living things. This includes two kinds of bacteria-like organisms, the bacteria proper and the archaea, plus fungi, protozoa, algae, parasitic worms, and viruses.

What is the biggest division in the biological world? All living things, including microorganisms, are divided into two major groups—the prokaryotes (which are the bacteria and archaea) and the eukaryotes, which are all others. Compared with eukaryotes, prokaryotes have a simpler structure and lack true nuclei.

How long have we been certain that bacteria exist? Although it was suspected as far back as ancient Greece, the existence of bacteria was proven in the second half of the 1600s by a Dutch merchant, Antonie van Leeuwenhoek. He was the first person to convincingly show microorganisms through the microscopes he constructed.

Why did it take so long? Microscopes had been constructed before Leeuwenhoek, but his single lens one was apparently superior to the double lens ones made by others. In addition, it seems that Leeuwenhoek had especially fine powers of observation.

When did it become credible that "germs cause disease"? Again, this had been suspected in Greek antiquity, but the proof had to await experimental work starting in the 1700s. The definitive proof that bacteria cause disease had to await the "golden age" of microbiology, thanks to the pioneering work in the late 1800s of Pasteur and Koch and their schools. Much depended on the ability to make a pure culture of microorganisms and to show that they could cause disease in experimental animals.

For a long time, living things were thought to arise spontaneously. How was this notion finally disproved? Several experiments were conducted as early as the late 1600s, but the most definitive ones were conducted by Pasteur in the mid-1800s. He placed meat broth in flasks with a long curved neck, thus allowing air to enter. This was an important point because supporters of spontaneous generation argued that air was needed for life to happen. After boiling the flasks and allowing them to cool down, no bacteria grew in the broth. Bacteria from the air did not enter the flask because they settled on the wall of the neck.

Did the first successful vaccination have to await the "golden age" of microbiology? No, the first vaccine was used in 1796 by a British physician, Edward Jenner. He noticed that dairymaids who naturally contracted a cattle

disease called cowpox seemed to be protected against smallpox. He inoculated an eight-year-old boy with the fluid from a cowpox blister on the hand of a dairymaid. The boy contracted cowpox. Jenner inoculated him with fluid from a smallpox blister, with no reaction. This technique became known as *vaccination* from the Latin, *vacca*, for cow. Too little was known about the process at that time to extend this finding to other infectious diseases, however.

Which has been more important in controlling infectious diseases—vaccination, sanitary measures, or antimicrobial drugs? It's hard to say, because they are all important, depending on the disease and its mode of transmission. Prevention is obviously more effective than treatment. Some of the great infectious diseases, such as smallpox, polio, and diphtheria, have been prevented by vaccination. Typhoid fever and a myriad of other infections can be limited by sanitizing food and the water supply. Malaria, typhus, and the plague have largely disappeared from industrialized countries thanks to insect and/or rodent control. On the other hand, abscesses, wound infections, pneumonia, meningitis, heart infections, and many others require antimicrobial drugs for treatment.

Where do we stand today with regard to the great epidemic diseases? In industrialized countries, we do not face the great plagues of the past. Unfortunately, some of these diseases, e.g., malaria, tuberculosis, and diphtheria, are still prevalent in developing countries. Worldwide, these diseases, plus the highly common diarrheas and respiratory infections of infants, account for the sickness and death of millions of people yearly. Diarrheas alone account for over three million deaths per year. Because most of these diseases are partly preventable, lowering their incidence should be a common goal for all humans.

Are infectious diseases well controlled in the industrialized countries? These diseases still rank high in their ability to cause sickness and are the third underlying cause of death in the United States. The reasons are complex and include the increased number of persons whose immune system has been compromised (including those with AIDS) and

the emergence of new and recurring diseases. It is feared that the increased resistance of microorganisms to antibiotics may further worsen the situation.

Do we know the reasons for the new emergence of infectious diseases? We know in part. In some cases, we can attribute it to changes in human behavior. Thus, the increase in food-borne infections is due to insufficiently safe methods for mass production of beef and poultry. Lyme disease seems to be on the rise because of increased contact of humans with wild animals. Greater international travel contributes to increased encounter with diseases not usually found in the United States.

Are there medical factors involved also? Yes. In an effort to increase the life span of certain patients, we sometimes render them more susceptible to infections. Some examples include cancer patients being treated with chemotherapy or children with cystic fibrosis. In addition, the greater use of antibiotics, sometimes carried out imprudently, leads to increased drug resistance by the microorganisms. This is becoming a critical issue with regard to certain infections and threatens to undermine one of the greatest medical advances of all times.

How about pollution and the protection of the environment? Does microbiology play a role here too? Yes, it most assuredly does. Microorganisms play the major role in the natural recycling of matter. Thus, it becomes important to understand how microbial life is affected by chemical or radioactive pollutants. Microorganisms are naturally involved in the cleaning up of certain kinds of chemical pollution, such as oil spills. We make increased use of microorganisms for this purpose, a process called *bioremediation*.

Do microorganisms play a role in genetic engineering? Indeed, they occupy center stage. Most of the manipulations used in genetic engineering, such as the use of recombinant DNA, are based on work done with bacteria and viruses. Most of the products manufactured by these techniques, such as certain hormones or vaccines, are actually produced by engineered microorganisms.

Self-Testing Questions

SHORT QUESTIONS

1. What property links all microorganisms? _____.

2. All cells are divided into two groups of cells called _____.

3. The prokaryotes are divided into two groups called _____.

4. _____ are non-cellular forms of life.

5. The notion that life could arise from inanimate matter is called _____.

6. _____ is the stimulation of the body's ability to fight infection.

7. Match the term with its property.

1. Bacteria	A. Photosynthetic eukaryotes
2. Algae	B. Prokaryotes
3. Protozoa	C. Multicellular animals
4. Fungi	D. Often motile, nonphotosynthetic unicellular eukaryotes
5. Helminths	E. Main eukaryotic decomposers in nature

8. Match name of the discoverer with the discovery for which he is famous.

1. Pasteur	A. Rationale to prove that a germ causes disease
2. Leeuwenhoek	B. First successful vaccination
3. Koch	C. First synthetic chemotherapeutic agents
4. Jenner	D. Disproved spontaneous generation
5. Ehrlich	E. First convincing microscopic observations of microorganisms

ESSAYS

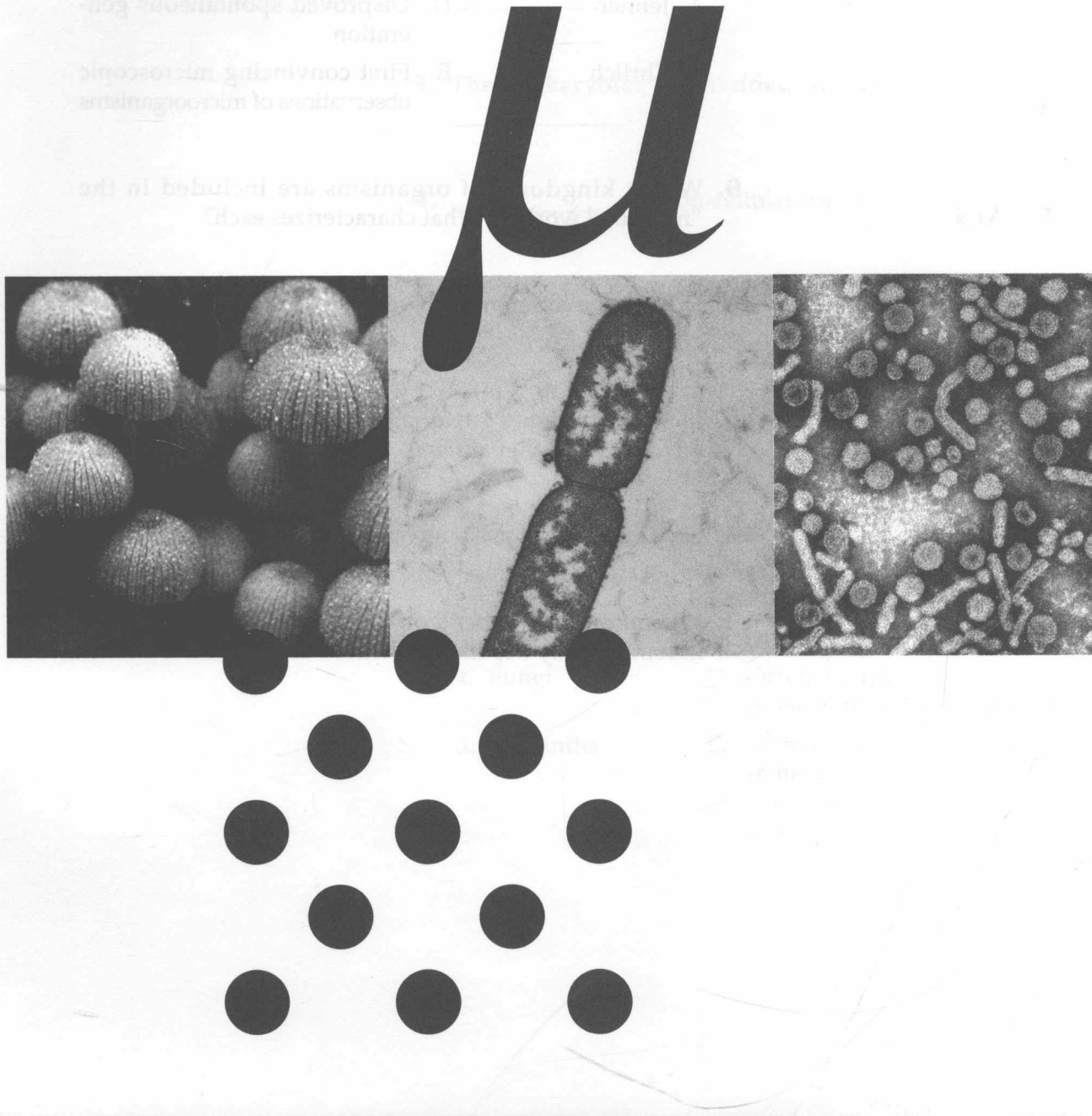
9. Which kingdoms of organisms are included in the "microbial world"? What characterizes each?

10. Explain the difference between prokaryotes and eukaryotes.

11. In what ways are bacteria and archaea similar and in what ways do they differ?

12. Give examples of major advances in medical microbiology.

13. What industries depend on microorganisms now? What industries may depend on them in the future?



topic 2

Methods in Microbiology