

# Microbiology

Instructor's Edition

## Principles and Explorations

Fourth Edition

*Jacquelyn G. Black*



**INSTRUCTOR'S EDITION**

# Microbiology

## Principles and Explorations

**Fourth Edition**

INSTRUCTOR'S NOTES WRITTEN BY

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# INTRODUCTION

Good teaching begins with a keen interest in, and an enthusiasm for, the subject you are about to teach. If you are excited about your subject, your students will immediately recognize this and respond accordingly. Furthermore, students tend to respect, admire, and cooperate with instructors who may be considered the “hardest” if they are aware of the needs of those students, if they show that they care about the students, and if they are willing to put forth the effort necessary to help the students achieve their goals. Success still breeds success. With enthusiastic input provided by you, the instructor, your students will, in turn, work hard to attain the desired mastery.

Toward that end, this Instructor's Edition written to accompany the 4th edition of Black's *Microbiology: Principles and Explorations*, is designed to offer several approaches to the teaching process and to support some of the techniques that may already be effective. For the beginning instructor, these ideas and approaches can be melded together to help in the development of an effective teaching style. For the seasoned veteran, these ideas may suggest new methods or perhaps strengthen already existing techniques. In any event, what works for one instructor does not always work for another. The suggestions and ideas provided here can be used to enhance and enliven any type of course and can help students achieve and even surpass their own personal goals.

This Instructor's Edition is designed to aid the microbiology instructor by providing several helpful features described here:

1. In the Introduction, a description is given of the features found in each chapter (Overview, Objectives, and Outline) of the Instructor's Notes.
2. Course outlines with allied health and general emphases are provided to assist in developing a syllabus for the instructor's specific needs.
3. The Introduction concludes with information about audiovisual suppliers and web sites that may provide a wealth of information in the constantly changing world of microbiology.
4. The remainder of the Instructor's Edition is devoted the Instructor's Notes for each of the text's 26 chapters.

## Special Features of the Instructor's Notes

### Chapter Overview

Each chapter of the Instructor's Notes begins with a brief Chapter Overview of the corresponding textbook chapter to help place the chapter material in perspective.

### Chapter Objectives

The Chapter Overview is enhanced by a series of Chapter Objectives that are closely related to the focus questions listed at the beginning of each textbook chapter. These objectives are written in a specific behavioral style to help students identify what will

be expected of them. In many institutions, behavioral objectives are an integral part of the educational process and are required in the course syllabus. These objectives can be reproduced and given individually to the student or combined into a complete set and included with the other information in the course syllabus. If necessary, each of these objectives can be modified to identify more precisely the performance required of the student to show the desired competence level. To assist in this modification, the instructor may wish to consult references such as Robert F. Mager's *Preparing Instructional Objectives*, which can help in preparing specific behavioral objectives in the cognitive, affective, and psychomotor learning domains.

## Chapter Outline

A detailed Chapter Outline is provided to assist in the preparation of lectures and in the development of transparencies and other visuals that may be used during the class presentation.

In the present Instructor's Edition, the Chapter Outline is expanded to include Teaching Tips, Discussion Topics, “Track It Down” (library research topics), and Web Destinations. These features are added at the appropriate points in the outline where their utilization will enhance student learning and may pique student interest enough to initiate lifelong interest in microbiology.

The Teaching Tips include demonstrations, many of which require elaborate equipment and moderately expensive models; others are more easily performed, depending on the time available and the teaching style of the instructor. (Catalogs from biological supply companies such as Carolina and Wards can assist in the purchase of models, slides, and plastic mounted specimens.) Suggestions for field trips are included in this section. Carefully planned trips to such places as hospitals, microbiology laboratories, water or sewage treatment facilities, breweries, wineries, and cheese factories can generate great enthusiasm, reinforce learning of text material, and connect the study of microbiology with the real world.

Interesting analogies and imaginative ideas that may provide alternative approaches to some of the more difficult topics are also included in this section. Many of the Discussion Topics are designed to spark interesting and lively debate on issues that are related to the chapter material. These issues typically have no “right” or “wrong” answers.

The topics included as “Track It Down” generally require the student to seek library assistance in exploring interesting lines of research. Many of these topics can be researched from among the selected references at the end of each chapter. These topics can also be pursued in greater detail, especially if a medical school or hospital library is available. (Permission might be required for use of such libraries.) Frequent references are made to articles found in the *Morbidity and Mortality Weekly Report* (MMWR) and to reports from state and local public health departments. Contact your local health department for information regarding state publications and to inquire about placement on

their mailing lists. To receive MMWR, contact the Centers for Disease Control and Prevention or write to:

Massachusetts Medical Society  
C.S.P.O. Box 9120  
Waltham, MA 02254-9120

Finally, Web Destinations are included, both as instructional resources and as springboards from which instructors might encourage their students to plunge into some of a chapter's more interesting topics.

## The Development of the American Society for Microbiology's Core Themes—and How Your Exploration of this Text Will Help You Weave Them into Your Course

Teaching microbiology to undergraduates is not just a matter of furnishing a series of lectures where tidbits of information about bacteria and other microorganism are dispensed to a seemingly disinterested crowd of students. Students are developing a serious interest in microorganisms. All the recent media coverage of flesh-eating bacteria, fatal cases of meningitis, and epidemics of food poisoning are enlivening public interest in microbiology.

Aside from fostering an interest in the content, microbiology faculty also have the responsibility of representing the discipline. Each discipline has fundamental concepts that mold its present paradigm and govern the direction of inquiry and research. To represent the discipline adequately, faculty need to supply students with the core ideas and fundamental skills that form the infrastructure of modern microbiology.

In 1994, the American Society for Microbiology gathered faculty from a variety of institutions across the United States to develop a document of core themes and concepts for introductory microbiology courses. The document detailed the major ideas driving modern microbiology. A laboratory skills component was identified by the organization in 1997 to complete what the ASM recognizes as recommendations for teaching an undergraduate microbiology curriculum.

The recommended core themes include coverage of microbial cell biology, microbial genetics, the interactions and impact of microorganisms and humans, the interactions and impact of microorganisms in the environment, and integrating themes of microbial evolution and diversity. These core concepts should be the essence of an introductory microbiology course and should be evident in the textbook used for the course.

Laboratory and safety skills are also an important element of the undergraduate curriculum. ASM's laboratory curriculum skills include microscopy and specimen handling techniques. Cognitive skills involving the ability to analyze and communicate information are considered critical components of the laboratory curriculum. Safety has also been viewed as a necessary component of the laboratory experience. It is recommended that

students know how to safely handle and dispose of microorganisms and contaminated materials.

Jacquelyn Black's *Microbiology: Principles and Explorations* textbook satisfies the recommended core themes expounded by the ASM. The laboratory skills component is also covered as discussion and instructional points in the text. In addition, she makes every attempt to capture student interest by presenting over one hundred boxes and essays highlighting contemporary issues in microbiology.

Black incorporates the core themes into relevant chapters of the book. The anatomy aspect of the core theme "microbial cell biology" is covered in detail in Chapter 4, Characteristics of Prokaryotic and Eukaryotic Cells. Physiological coverage is found in Chapter 5, Essential Concepts of Metabolism. Chapter 6, Growth and Culturing Bacteria, and Chapter 7, Microbial Genetics, provide essential information on microbial molecular biology and cellular regulation. The ASM and Black recognized that a thorough understanding of cell biology is needed for students to comprehend how microbes survive and how many of them can cause disease.

Early advances in microbial genetics formed the foundation of modern genetics including prodigious projects such as the Human Genome Project. Microbes were the first models for understanding gene regulation and were the first candidates for genetic engineering. The contents of this core theme "Microbial Genetics" is found in splendid detail in Chapter 7, Microbial Genetics, and Chapter 8, Recombinant DNA and Genetic Engineering.

Much of the interest students have in microbiology concerns how microorganisms affect humans. The interactions and impact of microorganisms and humans theme recommended by the ASM addresses this need in the curriculum. A variety of chapters cover this core theme. Unit V, Host-Microbe Interactions, and Unit VI, Infectious Diseases of Human Organ Systems, directly satisfy the ASM's recommendations. Chapters 14 through 18 provide excellent detail about the human immune system and its specific responses to microbial invasion. The "Public Health" boxes also provide interesting information related to this core theme.

The natural selection and relationships microbes form with other organisms is covered in the core theme called "Interactions and Impact of Microorganisms in the Environment." Issues such as antibiotic resistance and the use of microbes to clean the environment are part of this theme. These and other topics related to this core theme are found in Chapter 25, Environmental Microbiology, and Chapter 26, Applied Microbiology. Black draws in student interest by including the rationale used by researchers when formulating ways to use microbes to clean the environment.

Microbial evolution and diversity are covered under the integrating themes core concept. This core is a fundamental aspect of biology as discipline and is covered in Unit III, The Roster of Microbes and Multicellular Parasites. The boxes are ideal for presenting everyday applications of microbial diversity. Many students are generally unaware of the roles microbes play in our lives because humans have learned to exploit microbes for

the traits the organisms have evolved to survive in their particular environments.

Although the book is not intended to be a laboratory manual, elements of the recommended laboratory skills are evident in the book. Chapter 3, Microscopy and Staining, and Chapter 6, Growth and Culturing of Bacteria, both provide essential information for fostering an understanding of microbiology laboratory procedures. Boxes within the chapters and the review questions at the end of the chapters fittingly assess and expand upon the student's laboratory skills. Laboratory safety issues can be found in Chapter 12, Sterilization and Disinfection, and Chapter 15, Epidemiology and Nosocomial Infections.

The ASM is also interested in encouraging students to pursue careers in microbiology. Black includes many vignettes that provide a glimpse of the types of jobs in microbiology.

More information about the American Society of Microbiology can be obtained by accessing their Internet site at <http://www.asmusa.org> or by calling 202-942-9329. Information about the undergraduate microbiology core curriculum recommendations can be found at <http://www.asmusa.org/educsrc/edu32a.htm>. Should you wish to discuss the core themes further, feel free

to contact this essay's contributor, Dr. Brian R. Shmaefsky, at [bshmaefs@nhmccd.edu](mailto:bshmaefs@nhmccd.edu).

## Alternative Course Outline

The following course outlines are based on a 15-week semester with three 50-minute lectures per week. The exact time devoted to each topic will vary with the number of student questions, tests, review sessions, demonstrations, and so on. Two lecture sequences are provided—one for an emphasis on allied health topics and one for a more general presentation. Because the text is quite flexible, the basic difference between the two sequences lies in the amount of time devoted to each chapter rather than the omission or addition of chapters. Both are inclusive syllabi, but if you should find that your students have previous coursework in chemistry, you could omit Chapter 2. Assign this chapter for review, and set a particular date when students can bring up specific questions on this material during lecture hour if necessary. Similarly, parts of other chapters could be omitted for those with a good background in anatomy and physiology.

| Chapter | Topic   | Number of Lectures     |                  |
|---------|---|------------------------|------------------|
|         |   | Allied Health Emphasis | General Emphasis |
| —       | Introduction and Orientation                    | 1                      | 1                |
| 1       | Scope and History of Microbiology               | 1                      | 1                |
| 2       | Fundamentals of Chemistry                       | 2                      | 3                |
| 3       | Microscopy and Staining                         | 1                      | 1                |
| 4       | Prokaryotic and Eukaryotic Cells                | 3                      | 3                |
| 5       | Concepts of Metabolism                          | 2.5                    | 3                |
| 6       | Growth and Culturing of Bacteria                | 1                      | 1.5              |
| 7       | Microbial Genetics                              | 2                      | 2                |
| 8       | Recombinant DNA and Genetic Engineering         | 1.5                    | 2                |
| 9       | An Introduction to Taxonomy: The Bacteria       | 2                      | 2                |
| 10      | Viruses   | 1.5                    | 1.5              |
| 11      | Eukaryotic Microorganisms                       | 1                      | 1                |
| 12      | Sterilization and Disinfection                  | 2                      | 2                |
| 13      | Antimicrobial Therapy                           | 1                      | 1                |
| 14      | Host-Microbe Relationships                      | 1.5                    | 1                |
| 15      | Epidemiology and Nosocomial Infections          | 1.5                    | 1                |
| 16      | Host Systems and Nonspecific Defenses           | 2                      | 2                |
| 17      | Immunology I: Basic Principles                  | 3                      | 3                |
| 18      | Immunology II: Disorders and Tests              | 3                      | 3                |
| 19      | Diseases of the Skin and Eyes; Wounds and Bites | 1.5                    | 1                |
| 20      | Urogenital and Sexually Transmitted Diseases    | 1.5                    | 1                |
| 21      | Diseases of the Respiratory System              | 2                      | 1.5              |
| 22      | Oral and Gastrointestinal Diseases              | 2                      | 1.5              |
| 23      | Cardiovascular and Systemic Diseases            | 1.5                    | 1                |
| 24      | Diseases of the Nervous System                  | 1                      | 1                |
| 25      | Environmental Microbiology                      | 1.5                    | 2                |
| 26      | Applied Microbiology                            | 0.5                    | 1                |

## Audiovisual Resources Suppliers

The American Journal of Nursing Co., Educational Services  
Division Film Library, 555 W. 57th St., New York, NY 10019,  
(212) 582-8820.

American Medical Association, 515 N. State St., Chicago, IL  
60610, (312) 464-4579.

American Society of Clinical Pathologists, 2100 W. Harrison  
St., Chicago, IL 60612, (800) 621-4142.

American Society for Microbiology: ASM Press, 1325 Massa-  
chusetts Ave., N.W., Washington, DC 20005, (800) 546-2416.

Carolina Biological Supply Co., 2700 York Rd., Burlington,  
NC 27215, (800) 334-5551.

Centers for Disease Control and Prevention, Instructional Sys-  
tems Division, Atlanta, GA 30333.

Creative Educational Video, 1020 S.E. Loop 289, Lubbock,  
TX 79404 (800) 922-9965.

Ciba-Geigy Corporation, Medical Education Division, P.O.  
Box 18060, Newark, NJ 07191, (800) 631-1181.

Clearvue, 6465 N. Aveondale Ave., Chicago, IL 60631-1996,  
(800) CLEARVU.

Churchill Livingstone, 650 Avenue of the Americas, New  
York, NY 10011, (800) 553-5426.

Coronet MTI Film and Video, 108 Wilmot Rd., Deerfield, IL  
60015, (800) 777-8100.

Concept Media, P.O. Box 19542, Irvine, CA 92714.

CRM Educational Films, 2233 Faraday Ave., Carlsbad, CA  
92008.

Dayton Lab, 3235 Dayton Ave., Lorain, OH 44055,  
(216) 246-1397.

Davis & Geck Surgical Film and Videocassette Library,  
1 Casper St., Danbury, CT 06810, (203) 743-4451.

Encyclopedia Britannica Educational Corp., 425 North  
Michigan Ave., Chicago, IL 60611.

EME, 41 Kenosia Ave., P.O. Box 2805, Danbury, CT 06813-  
2805, (800) 848-2050.

Films for the Humanities and Sciences, Inc., P.O. Box 2053,  
Princeton, NJ 08543-2053 (800) 257-5126.

Frey Scientific, 905 Hickory Lane, P.O. Box 810, Mansfield,  
OH 44901-8101, (800) 225-FREY.

Fisher Scientific Company, Educational Materials Division,  
485 Frontage Rd., Burr Ridge, IL 60521, (800) 955-6644.

Guidance Associates, P.O. Box 1000, Mount Kisco, NY  
10549-0010, (800) 431-1242.

Health Euctech, (612) 881-1926.

Human Relations Media, 175 Tompkins Ave., Pleasantville,  
NY 10570, (800) 431-2050.

International Film Bureau, 332 S. Michigan Ave., Chicago, IL  
60604.

Insight Media, 2162 Broadway, New York, NY 10024,  
(212) 721-6316.

JLM Visuals, 1208 Bridge St., Grafton, WI 53024-1946,  
(414) 377-7775.

LOGAL Science and Mathematics Software, P.O. Box 1499,  
East Arlington, MA 02174-0022, (800) 564-2587.

McGraw-Hill Home Video, 11 W. 19th St., New York, NY  
10011, (212) 337-5065.

Media Design Associates, Dept. PO, P.O. Box 3189, Boulder,  
CO 80307-3189.

Milner Fenwick, Inc., 2125 Greenspring Dr., Timonium, MD  
21093, (800) 432-8433.

Media Guild, 11722 Sorrento Valley Rd., Suite E, San Diego,  
CA 92121, (800) 886-9191.

NCCLS, 771 Lancaster Ave., Villanova, PA 19085-1596,  
(610) 525-4383.

National Geographic Society, Educational Services, P.O. Box  
98019, Washington, DC 20090-8019, (800) 368-2728.

NIMCO, 117 Hwy. 815, P.O. Box 9, Calhoun, KY 42327-  
0009, (800) 962-6662.

National Teaching Aids, 1845 Highland Ave., New Hyde Park,  
NY 11040, (516) 326-2555.

Opportunities For Learning, Inc., Dept. XN89, 941 Hickory  
Lane, P.O. Box 8103, Mansfield, OH 44901-8103,  
(419) 589-1700.

PBS Video, 1320 Braddock Pl., Alexandria, VA 22314-1698.

Prentice Hall General Reference, 15 Columbus Circle, New  
York, NY 10023, (800) 223-2348.

Projected Learning Programs, Inc., P.O. Box 3008, Paradise,  
CA 95967-3008, (800) 248-0757.

Pyramid Films, P.O. Box 1048, Santa Monica, CA 90406.

Queue, 338 Commerce Dr., Fairfield, CT 06430,  
(800) 232-2224.

Texas Department of Health, Audiovisual Library, 1100 W.  
49th St., Austin, TX 78756, (512) 458-7260.

Teaching Films, Inc., 930 Pitner Ave., Evanston, IL 60202.

Time-Life Education, P.O. Box 85026, Richmond, VA 23285-  
5026, (800) 449-2011.

Times Mirror International Publishers, 200 N. La Salle St.,  
Chicago, IL 60601-1080.

University of California Extension Media Center, 2000 Center  
St., Berkeley, CA 94704, (800) 876-2447.

University of Minnesota: Film and Video, 1313 Fifth St. S.E.,  
Suite 108, Minneapolis, MN 55414-1524, (800) 542-0013.

University of Pennsylvania, The Wharton School, Center of  
Human Resources, Vance Hall, 3733 Spruce St., Philadelphia,  
PA 19104, (215) 898-5606.

University of Washington, School of Medicine, Seattle, WA  
98105, (206) 545-1161.

ZTEK Co., P.O. Box 1055, Louisville, KY 40201,  
(800) 247-1603.

## World Wide Web Site Supplement

The following is a list of helpful web sites that should enhance any instructor's preparation, and any student's further understanding, of the practical and applied aspects of microbiology. Although not an exhaustive list, these are web sites that provide useful information such as research findings, epidemiological updates, user groups (for educators, researchers, students, etc.), and links to other sites. In addition, since the World Wide Web is constantly expanding and being updated, it would be helpful to use search engines often to find new web sites in the area of microbiology.

<http://www.asmusa.org/>  
[American Society for Microbiology]  
<http://ama-assn.org/>  
[American Medical Association]  
<http://www.scienceXchange.com/aai/>  
[American Association of Immunologists]  
<http://www-museum.unl.edu/asp/>  
[American Society of Parasitologists]  
<http://www.erin.utoronto.ca/~w3msa/index.html>  
[Mycological Society of America]

<http://www.cdc.gov/>  
[Centers for Disease Control]  
<http://www.cdc.gov/epo/mmwr/mmwr.html>  
[*Morbidity and Mortality Weekly Report*]  
<http://www.nih.gov/>  
[National Institutes of Health]  
<http://www4.ncbi.nlm.nih.gov/PubMed/>  
[PubMed MEDLINE search engine]  
<http://www.ncbi.nlm.nih.gov/>  
[National Center for Biotechnology Info]  
<http://www.tulane.edu/~dmsander/garryfavweb.html>  
[All the Virology on the WWW]  
<http://www.sciam.com/>  
[*Scientific American* online]  
<http://www.lsumc.edu/campus/micr/mirror/public-html/microbio.html>  
[The Microbial Underground's Guide to the World Wide Web]  
<http://www.ncbi.nlm.nih.gov/Pubmed/fulltext.html>  
[MEDLINE online journal links]

# Scope and History of Microbiology



**M**icrobiology is a science course that most students are required to take to fulfill a prerequisite for a particular program or major, yet few students know what the course encompasses or what a microbiologist does. In fact, few students even know why they need to study microbiology at all!

In view of this, the first part of this chapter is devoted to a presentation of how microbiology relates to all our lives, which microbes we need to be aware of and why, and what kinds of work microbiologists normally do.

The second part of this chapter provides a brief historical presentation of the most important developments that transformed microbiology into a “true” science. By studying only the most significant events along with interesting anecdotes, the student is provided with a fascinating journey through time without being encumbered with excessive dates and events. Beginning with the first Biblical accounts, the Greek and Roman contributions, and the events leading to the first observations of microbes, the student is given the opportunity to understand how difficult it was to believe in the presence and importance of these microorganisms.

The chapter describes the observation and documentation of microbes by Leeuwenhoek. It then presents the major contributors to the development of the germ theory of disease, the problems of the spontaneous generation theory, the work of Louis Pasteur, and the contributions of Robert Koch. Next comes a brief and fascinating review of the emergence of the many special fields of microbiology and how they are continually changing and expanding.

In summary, this first chapter provides an excellent opportunity for the instructor to set the stage for the many exciting and relevant topics that will be discussed in the later chapters.

- A. Describe the scope of microbiology, noting especially the variety of microbes and the kinds of work that microbiologists do.
- B. Identify two reasons for studying microbiology and explain why each is important.
- C. Summarize the early history of microbiology, noting especially the development of the microscope.
- D. State the germ theory of disease and summarize the historical developments that led to its formulation.
- E. Cite major events in the development of immunology, virology, chemotherapy, microbial genetics, and molecular biology.

## Chapter Objectives

## Keys to Exploration

**Discussion Topics**

1. Discuss why it should be important for the companies that make products such as Campbell's soup, Jimmy Dean sausage, and Blue Bell ice cream to hire microbiologists.
2. Discuss the pros and cons of the Human Genome Project.

**Teaching Tips**

1. Check out some periodicals (such as *Scientific American*, *Science*, *ASM journals*, and *MMWR*) from the library that relate to microbiology, and have them available for demonstration.
2. Have students cut out articles from the local newspaper that relate to microbiology or infectious diseases.
3. *Louis Pasteur: Germs Cause Disease* (18 min, C, VHS) Examines contributions of Louis Pasteur to the fields of microbiology and medicine. (BN496, IM)
4. Bring several issues of the *American Society of Microbiology* journals that highlight jobs available to microbiologists.
5. *Maps of Life: Science, Society, and the Human Genome Project* (46 min, C, VHS) Dr. James Watson narrates the activities of the Human Genome Project. (53-6500-UJ, CAR)

## Chapter Outline

## I. Why Study Microbiology

- A. Microbes have a major impact on human health
- B. Microbes help maintain the balance of nature
- C. Microorganisms are essential to many human endeavors
- D. Microbiology provides insight into life processes in all life forms

**Teaching Tip 1**

## II. Scope of Microbiology

**Teaching Tip 2**

## A. The microbes

1. Bacteria
2. Algae
3. Fungi
4. Viruses
5. Protozoa
6. Others

## B. The microbiologists

**Discussion Topic 1**

1. Fields of microbiology

**Track It Down 1****Web Destination 1**

2. Settings of microbiology
3. Current areas of research

**Track It Down 2 and 3**

## III. Historical Roots

- A. Biblical accounts
- B. Greek and Roman contributions
- C. Bubonic plague
- D. Development of microscopy
  1. Robert Hooke
  2. Anton van Leeuwenhoek

## IV. The Germ Theory of Disease

**Web Destination 2**

- A. Spontaneous generation theory
- B. Early studies

1. Aristotle
2. Francesco Redi
3. John Needham
4. Lazzaro Spallanzani
5. Louis Pasteur

**Web Destination 5**

6. John Tyndall
- C. Pasteur's further contributions
- D. Koch's contributions
- E. Work toward controlling infections
  1. Ignaz Semmelweis
  2. Joseph Lister

## V. Emergency of Special Fields of Microbiology

## A. Immunology

1. Development of vaccinations
2. Edward Jenner and smallpox

**Web Destination 3**

3. Louis Pasteur and cholera

**Teaching Tip 3**

4. Elie Metchnikoff

## B. Virology

1. Charles Chamberland and infectious filtrates
2. Martinus Beijerinck
3. Wendell Stanley
4. Alfred Hershey and Martha Chase
5. James Watson and Francis Crick and DNA

## C. Chemotherapy

1. Development of herbal medicines
2. Paul Ehrlich and the "magic bullet"
3. Alexander Fleming and penicillin
4. Gerhard Domagk and sulfa drugs
5. Selman Waksman and antibiotics

## D. Genetics and molecular biology

1. Gregor Mendel and the principles of genetics
2. Frederick Griffith and transformation
3. Edward Tatum and George Beadle and genetic variations

## VI. Tomorrow's History

**Teaching Tip 4**

1. Early microbiologists
2. Nobel Prize winners
3. Human Genome Project

**Teaching Tip 5****Discussion Topic 2****Web Destination 4****Track It Down**

1. Identify several areas of industry in which microbes or microbial research is very important.
2. Several companies have been "born" on the basis of discoveries in areas of microbiology such as genetic recombination. Using *The Wall Street Journal*, *Value Line*, and other sources, try to identify several of these companies. Find out their current areas of research and how the company is faring financially.
3. The development of immunotoxins has led to their potential use as "magic bullets" in cancer therapy. Find articles that relate to this exciting area of research.

**Web Destinations**

1. <http://www.asmtusa.org/edusrc/edu21.htm>
2. <http://www-micro.msb.le.ac.uk/109/History.html>
3. <http://www.connaught.com/english/explore/history.html>
4. <http://www.tigr.org/>
5. [http://www.ambafrance.org/HYPERLAB/PEOPLE/\\_pasteur.html](http://www.ambafrance.org/HYPERLAB/PEOPLE/_pasteur.html)



CHAPTER  
2  
TWO

# Fundamentals of Chemistry

Chemistry has never been a very popular subject among beginning students of microbiology. It is often initially difficult for students to understand that a knowledge of basic and especially organic and biochemical chemistry is fundamental to a functional understanding of the many structures that bacteria possess. Without a knowledge of chemistry, the basis for the Gram stain, the role of the bacterial cell membrane, the action of antibiotics, the mechanisms of fermentation, and countless other processes could not be understood.

This chapter begins with an attempt to instill in the student a need and desire to seek out this basic chemical knowledge. A foundation is provided by presenting the structure of the atom and discussing the important features of chemical bonding and reactions. Because water is one of the fundamental molecules in living systems, a thorough analysis of this marvelous substance is provided along with important terms and concepts that will help the student relate to mechanisms such as active transport and osmosis that will be covered later in the textbook.

The last part of the chapter is devoted to a presentation of the complex molecules of organisms: carbohydrates, lipids, proteins, and nucleotides. Numerous examples are provided to help the student see how these molecules relate to living systems, especially to bacteria.

Considering that some students may have had prior experience with the concepts of chemistry, this chapter may be omitted. However, it can be used as an excellent reference chapter.

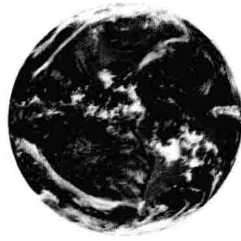
## Chapter Objectives

- A. Explain why knowledge of basic chemistry is necessary to understand microbiology.
- B. Define the terms *atom*, *element*, *molecule*, and *compound*; list the most common elements (and their symbols) found in living organisms.
- C. Describe the structure of an atom, noting especially the characteristics of protons, neutrons, and electrons; explain the formation and structure of ions and isotopes.
- D. Provide several distinguishing characteristics for ionic, covalent, and hydrogen bonds, and show how they are involved in holding atoms together.
- E. List and describe the characteristics of chemical reactions.
- F. List and describe at least four properties of water that are important to its function in living systems.

## CLASS PREP NOTES

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# Microbiology





## Jacquelyn G. Black

**MARYMOUNT UNIVERSITY, ARLINGTON,  
VIRGINIA**

Jacquelyn Black received her B.A., B.S., and M.S. from the University of Chicago and her Ph.D. from Catholic University of America. She has been teaching microbiology to undergraduates since 1970. She is a member of the American Society for Microbiology, and she has received grants for conducting teacher-training programs.

In addition to her extensive teaching experience, Dr. Black has engaged in fieldwork and studies throughout the globe. Her travels have taken her from the interior of Iceland to Belgium and Portugal to the barrier reef of Belize.

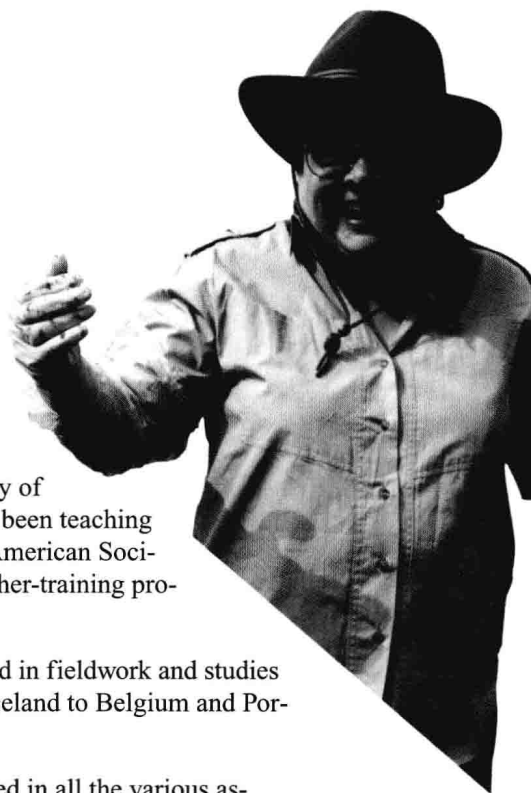
Dr. Black describes herself as an “incorrigible snoop” who is interested in all the various aspects and applications of microbiology. This natural curiosity, coupled with her classroom and laboratory experience, make her uniquely qualified to author an introductory microbiology textbook. This book conveys her sense of excitement for microbiology and offers the most current information on developments and applications within this field.

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### ***Dedication***

To Laura—for sharing her mother and much of her childhood with “the book.”

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4TH EDITION

# Microbiology

## Principles and Explorations

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