

# GENERAL MICROBIOLOGY (BIO3302) SYLLABUS



NEW YORK CITY  
COLLEGE OF  
TECHNOLOGY  
The City University Of New  
York

School of Arts and Sciences  
Department of Biological Sciences

## Course Information

<b>Course title:</b>	Microbiology	
<b>Course code:</b>	BIO3302	
<b>Credit Hours:</b>	4 credit hours	
	2 hours lecture and 4 hours lab per week for 15 weeks	
<b>Prerequisite:</b>	BIO 1101, BIO 2311 or Equivalent, CUNY Reading	
<b>Textbooks:</b>	<b>Lecture</b>	Microbiology Fundamentals: A Clinical Approach 4th edition, M. K. Cowan. McGraw Hill Publishing. ISBN: 126070243X/ 9781260786057
	<b>Lab</b>	Laboratory Manual, Microbiology Fundamentals: A Clinical Approach 4th edition, Steven Obenauf, McGraw Hill Publishing. ISBN: 9781260786095

## Grading Procedure (see Grading Policies for details)

Lecture: 50% of the final grade (based on 4 one hour exams)

Lab: 50% of the final grade (based on minimum of 4 written exams and 2 practical exams)

## Course Coordinators

Prof. Rena Dabydeen

Prof. Ralph Alcendor

**Phone:**

Dabydeen: 718-260-5390

Alcendor 718-260-8614

**E-mail:**

[Rdabydeen@citytech.cuny.edu](mailto:Rdabydeen@citytech.cuny.edu)

[RALcendor@citytech.cuny.edu](mailto:RALcendor@citytech.cuny.edu)

## Course Description

The fundamentals of microbiology: Lectures are focused on the structure of prokaryotic and eukaryotic microorganisms, host-microbe interactions, immunity and human infectious diseases. Laboratory sessions are focused on pure culture techniques, methods of staining and the colonial and biochemical identification of microorganisms.

## Learning Objectives – Lecture

After completion of the lecture component of the course, successful students should be able to:

1. Explain the ubiquity and the wide range of ecological habitats of microorganisms in nature.
2. Appreciate the diversity of microorganisms and microbial communities and recognize how microorganisms solve the fundamental problems their environments present.
3. Understand the role microorganisms play in the medicine, biotechnology and other industries, like wine and baking, that are important to human well-being.
4. Identify methods used in the identification of organisms involved in diseases and disease treatment and prevention.
5. Define and explain basic medical terminology as related to Microbiology
6. Recognize how the underlying principles of epidemiology of disease and pathogenicity of specific microbes affect human health.

## CUNY Common Core Learning Outcomes

1. Identify and apply the fundamental concepts and methods in microbiology.
2. Use appropriate technologies to gather, analyze and interpret data and to communicate the findings.
3. Understand the scientific principles underlying matters of policy or public concern in which microbiology plays a role.
4. Demonstrate how tools of science, mathematics, technology, or formal analysis can be used to analyze problems and develop solutions.
5. Identify and apply research ethics and unbiased assessment in gathering and reporting scientific data.

## LECTURE OUTLINE

Week	Topic of Discussion	Reading Assignment
1	<b>Chapter 1 Introduction to Microbes and Their Building Blocks</b>	<ol style="list-style-type: none"><li>1. Microbes: Tiny but Mighty</li><li>2. History of Microbiology</li><li>3. Naming, Classifying and Identifying Microorganisms</li><li>4. Macromolecules: Superstructures of Life</li></ol>
2	<b>Chapter 3 Bacteria Prokaryotic Structure</b>	<ol style="list-style-type: none"><li>1. Form and Function of Bacteria</li><li>2. External Structures</li><li>3. The wall and Membrane(s)</li><li>4. Bacterial Internal Structures</li><li>5. Classification Systems for Bacteria</li></ol>

3	<b>Chapter 6 Microbial Nutrition and Growth</b>	<ol style="list-style-type: none"> <li>1. Microbial Nutrition</li> <li>2. Environmental Factors That Influence Microbes</li> <li>3. Bacterial Growth</li> </ol>
4	<b>Chapter 7  Microbial Metabolism</b>	<ol style="list-style-type: none"> <li>1. Metabolism and the Role of Enzymes</li> <li>2. The Pursuit and Utilization of Energy</li> <li>3. Catabolism</li> <li>4. Anabolism and Crossing Pathways of Metabolism</li> </ol>
5	<b><u>Exam 1</u>  Chapter 8 Microbial Genetics</b>	<ol style="list-style-type: none"> <li>1. Introduction to Genetics and Genes</li> <li>2. Transcription and Translation</li> <li>3. Genetic Regulation of Protein Synthesis</li> <li>4. DNA Replication and Recombination events</li> <li>5. Mutations: Changes in the Genetic Code</li> </ol>
6	<b>Chapter 5 Viral Structure and Multiplication</b>	<ol style="list-style-type: none"> <li>1. The Position of Viruses in the Biological Spectrum</li> <li>2. General Structure of Viruses</li> <li>3. Models of Viral Multiplication</li> <li>4. Techniques in Cultivating and Identifying Animal Viruses</li> <li>5. Other Noncellular Infectious Agents</li> <li>6. Viruses and Human Health</li> </ol>

7	<p><b>Chapter 4 Eukaryotic Cells and Microorganisms</b></p>	<ol style="list-style-type: none"> <li>1. Structures of the Eukaryotic Cells</li> <li>2. The Fungi</li> <li>3. The Protozoa</li> </ol>
8	<p><u><b>Exam 2</b></u></p> <p><b>Chapter 11 Interactions Between Microbes and Humans</b></p>	<ol style="list-style-type: none"> <li>1. The Human Host</li> <li>2. Progress of an Infection <ul style="list-style-type: none"> <li>• Portal of Entry</li> <li>• Signs and Symptoms</li> </ul> </li> <li>3. Epidemiology</li> </ol>
9	<p><b>Chapter 12 Host Defenses I: Overview and Nonspecific Defenses</b></p>	<ol style="list-style-type: none"> <li>1. Defense Mechanisms of the Host</li> <li>2. The Second and Third Lines of Defense: An Overview</li> <li>3. The Second Line of Defense</li> </ol>
	<p><b>Chapter 13 Host Defenses II: Specific Immunity and Immunization</b></p>	<ol style="list-style-type: none"> <li>1. Specific Immunity: The Third and Final Line of Defense</li> <li>2. Stage I: Development of Lymphocyte Diversity</li> <li>3. Stage II: Presentation of Antigens</li> </ol>
10	<p><b>Chapter 13 Host Defenses II: Specific Immunity and Immunization (Cont.)</b></p>	<ol style="list-style-type: none"> <li>4. Stages III and IV: T-Cell Response</li> <li>5. Stages III and IV: B-Cell Response</li> <li>6. Vaccination</li> </ol>
	<p><b>Chapter 14 Disorders in Immunity</b></p>	<ol style="list-style-type: none"> <li>1. Types of Allergic Reactions</li> <li>2. Inappropriate Response to Self: Autoimmunity</li> <li>3. Immunodeficiencies</li> </ol>
11	<p><u><b>Exam 3</b></u></p> <p><b>Chapter 19 Infectious Diseases Affecting the Respiratory System</b></p>	<ol style="list-style-type: none"> <li>1. The Respiratory Tract and Its Defenses</li> <li>2. Normal Flora of the Respiratory System</li> <li>3. Microbial Diseases of the Upper Respiratory tract <ul style="list-style-type: none"> <li>• Streptococcal Pharyngitis</li> <li>• Scarlet Fever</li> <li>• Diphtheria</li> <li>• The Common Cold</li> </ul> </li> <li>4. Diseases of the Lower Respiratory Tract <ul style="list-style-type: none"> <li>• Pertussis</li> <li>• Tuberculosis</li> <li>• Pneumonia</li> <li>• Influenza</li> </ul> </li> </ol>

12	<p><b>Chapter 20</b></p> <p><b>Infectious Diseases Affecting the Gastrointestinal Tract</b></p>	<ol style="list-style-type: none"> <li>1. The Gastrointestinal Tract and Its Defenses</li> <li>2. Normal Biota of the Gastrointestinal Tract</li> <li>3. Bacterial Diseases of the Mouth (Oral Cavity) <ul style="list-style-type: none"> <li>• Dental Caries</li> <li>• Periodontal Diseases</li> </ul> </li> <li>4. Bacterial Diseases of the Lower Gastrointestinal Tract <ul style="list-style-type: none"> <li>• Staphylococcal Food Poisoning</li> <li>• Shigellosis (Bacillary Dysentery)</li> <li>• Salmonellosis and Typhoid Fever</li> <li>• Cholera Helicobacter Peptic Ulcer Disease</li> </ul> </li> </ol>
13	<p><b>Chapter 21</b></p> <p><b>Infectious Diseases Affecting the Genitourinary System</b></p>	<ol style="list-style-type: none"> <li>1. The Genitourinary Tract and Its Defenses</li> <li>2. Normal Biota of the Genitourinary Tract</li> <li>3. Urinary Tract Infections (UTI)</li> <li>4. Sexually Transmitted Diseases (STD) <ul style="list-style-type: none"> <li>• Gonorrhea</li> <li>• Syphilis</li> <li>• Trichomoniasis</li> <li>• Genital Herpes</li> <li>• Genital Warts</li> </ul> </li> </ol>
14	<p><b>Chapter 16</b></p> <p><b>Infectious Diseases Affecting the Skin and Eyes</b></p> <p><b>Chapter 18</b></p> <p><b>Infectious Diseases Affecting the Cardiovascular and Lymphatic Systems</b></p>	<ol style="list-style-type: none"> <li>1. The Skin and Its Defenses</li> <li>2. Skin Diseases Caused by Microorganisms: <ul style="list-style-type: none"> <li>• Acne</li> <li>• Measles</li> <li>• Small Pox</li> <li>• Chicken Pox</li> <li>• Rubella</li> <li>• Anthrax</li> <li>• Gangrene</li> </ul> </li> <li>3. Cardiovascular and Lymphatic System Diseases Caused by Microorganisms: <ul style="list-style-type: none"> <li>• Septicemia, Sepsis and Septic Shock</li> <li>• Bacterial Endocarditis</li> <li>• Elephantiasis</li> </ul> </li> </ol>
15	<p><b><u>Final Exam</u></b></p>	

## Laboratory Schedule

EXERCISE	
Week 1	1. Laboratory Safety. The use and care of the microscope. Review of the Metric system. 2. Aseptic Techniques. Inoculation and transfer techniques. Streak plate.
Week 2	3. Introduction to Staining and Simple Stain. Morphological features of bacteria – discussion only. 4. The Gram stain. Bacterial anatomy – discussion only.
Week 3	5. The Acid-fast stain (Ziehl-Neelsen). 6. Endospore and capsule staining. Negative staining.
Week 4	7. Review of Gram Staining and Streak Plate methods. Isolation of pure culture. 8. The use of Enriched, Selective and Differential media – BA, MS, MC, PEA.
Week 5	9. Epidemiology and related topics. Universal Precautions (discussion). 10. Practical Exam 1. Written Exam 1.
Week 6	11. Biochemical Activities – Discussion. Extracellular degradation, Hydrolytic Enzymes. 12. Carbohydrate fermentation: Phenol red broth and Triple Sugar Iron (TSI) agar.
Week 7	13. IMViC test. Multiple Test Systems: SIM, Litmus milk, 14. Urease test, Nitrate reduction test, Catalase and Oxidase test.
Week 8	15. Miniature Systems – Enteropluri Test and API. Review of Biochemical tests. 16. Written Exam 2. The Fungi - Molds, Yeast and Mushrooms.
Week 9	17. The protozoa. 18. The effect of Temperature and pH on microorganisms.
Week 10	19. Atmospheric Oxygen Requirements. Cultivation of Anaerobes. 20. The inhibitory action of heavy metals*. The inhibitory action of disinfectants.

Week 11	<p>21. Antibiotic susceptibility testing: The antibiogram.</p> <p>22. Immunology: Discussion (Antigen-antibody reactions), Agglutination (S t a p h o r e x ), Precipitation and ELISA.</p>
Week 12	<p>23. Written Exam 3. Practical Exam 2 – Cultivation of unknowns.</p> <p>24. Practical Exam 2 continues.</p>
Week 13	<p>25. Practical Exam 2 concludes. Pathogenic Microorganisms of the Skin*.</p> <p>26. Microorganisms of the Mouth and Dental Caries*. Pathogenic microorganisms of the Gastrointestinal Tract. Activities with Blood agar and <i>Sterptococcus mitis/salivarius</i> agar.</p>
Week 14	<p>27. Pathogenic Microorganisms of the Respiratory Tract*.</p> <p>28. Pathogenic Microorganisms of the Urogenital System and Sexually Transmitted Diseases (STDs)*.</p>
Week 15	<p>29. Helminthology.</p> <p>30. Final Written Exam.</p>

\* Discussion or limited exercises. Supplemental materials to be provided. Read Cowan's Textbook.

### Laboratory Learning Outcomes

#### 1. The Use and Care of the Microscope

- Identify the parts of the microscope, and understand their functions.
- Demonstrate the proper method of focusing, changing objectives, carrying the microscope, and cleaning the microscope.
- Calculate the total magnification of any ocular and objective combination.
- Prepare a temporary wet mount for the examination of a specimen.
- Use the microscope, especially the oil immersion lens, effectively.
- Define and understand the following terms and concepts: resolving power, parfocal, field of view, and magnification.

#### 2. Aseptic Techniques. Transfer and Colony Selection Techniques

- To perform basic bacteriological transfer techniques using broth and agar cultures.
- Handle bacteriological cultures and inoculation loops aseptically.
- Recognize selected properties of bacterial broth and agar slant cultures.
- Distinguish basic features of bacterial colonies, broth cultures, and agar slant growths.

#### 3. Bacterial Smears and Simple Stains

- Effectively perform the appropriate aseptic techniques required in the handling of bacterial cultures.
- Prepare and stain bacterial smears.
- Locate, examine, and interpret stained bacterial smears.
- Distinguish among basic bacterial shapes.
- Develop a perspective on size relationships among bacteria, and blood cells.

#### 4. The Gram Stain

- Carry out the Gram stain procedure correctly.
- Differentiate between Gram-positive and Gram-negative reactions.
- Interpret Gram stain reactions with unknown specimens.
- Recognize the importance of the Gram stain in disease detection and diagnosis.
- List at least two bacterial species to be Gram-positive and two species to be Gram-negative.

#### **5. The Acid-Fast Stain**

- Perform the acid-fast procedure.
- Distinguish between acid-fast and non-acid-fast reactions.
- Interpret acid-fast reactions with unknown specimens.
- Recognize the importance of the acid-fast procedure in disease detection and diagnosis.
- List at least two bacterial species known to be acid-fast positive.

#### **6. Spore and Capsule Stains**

- Carry out a standard procedure for the demonstration of bacterial spores.
- Detect the presence of bacterial spores in a culture.
- Distinguish between vegetative cells and bacterial spores.
- Carry out a negative staining technique.
- Differentiate between bacterial capsules and artifacts.

#### **7. Review of Gram Staining and Streak Plate methods. Isolation of pure culture.**

- Isolate individual colonies from mixed cultures by means of the streak plate
- Recognize selected properties of bacterial colonies on agar plates.
- Recognize the advantages and limitations of culture characteristics in the identification of bacterial species.

#### **8. The Use of Selective and Differential Media**

- Understand the basic differences among differential, enriched, selective, and combined media.
- Recognize the role of such media in the isolation and identification of microorganisms.

#### **9. Epidemiology and Related Topics. Universal Precautions.**

- Recognize the importance of using universal precautions to prevent nosocomial infections.
- Give examples of the applications of universal precautions.
- Discuss the concept of nosocomial infections – Healthcare-associated Infections (HAI).
- Learn about collection and transportation of specimens for microbiological testing.
- Recognize the possibility of transmission of a disease associated with collection and handling of specimens.
- Examine the importance of hand washing for finger prints; Use the “glow” germ lotion.
- Examine the normal flora in the throat, tooth plaque, nose etc.

#### **11. Extracellular Degradation**

- Perform and interpret tests for the hydrolysis of starch and gelatin.
- Explain how these test results can be used in microbial identification.
- Explain the role of extracellular enzymes in providing nutrients for cellular metabolism.

#### **12. Carbohydrate fermentation: Phenol red broth and Triple Sugar-Iron Agar**

- Perform and interpret tests for selected aspects of carbohydrate metabolism.
- Explain the role of the intracellular enzymes involved in carbohydrate metabolism.
- Explain how selected test results can be used in microbial identification.

#### **13. IMViC test, Multiple Test Systems: Litmus milk, SIM**

- Inoculate the various multiple-test media.
- Identify and interpret the characteristic reactions produced by microorganisms in multiple test media.
- Recognize the value of multiple-test media in the identification of microorganisms.

#### **14. Urease test, Nitrate Reduction test, Catalase and Oxidase test**

- Learn to perform and interpret results for Urease test and Nitrate Reduction.



- Perform and interpret test for catalase function.
- Recognize the respective values of the oxidase and catalase tests in the identification of bacterial species.

#### **15. Miniature Systems – Enteropluri Test and API. Review of Biochemical tests.**

- Recognize the role and advantages of using miniature systems in microbiology diagnostics
- Inoculate Enterotube (one per table) with an unknown bacterial strain.
- Demonstrate the use of API
- Understand the use of all biochemical tests for identification of bacteria.

#### **16. The Fungus**

- Recognize the macroscopic (mycelial phase) and microscopic features of common molds and yeasts.
- Recognize the major structures of fleshy mushrooms.
- Identify fungal structures in foods and other materials.
- Learn the importance of fungi for causing infectious diseases in humans and especially in immunocompromised individuals, most common pathogens and their diagnosis.
- Identify fungi and spores in permanent smears.

#### **17. The Protozoa**

- Recognize characteristic properties of protozoa.
- Learn to prepare wet mount with different live protozoa from pond water.
- Distinguish between prokaryotic and eukaryotic cellular organization in microorganisms.
- Observe food vacuole formation in certain protozoa.
- Discuss diseases caused by Protozoa.
- Identify pathogenic protozoa in permanent smears.

#### **18. The Effect of Temperature and pH on Microorganisms**

- Compare the effectiveness of dry-heating processes and moist-heating methods.
- List the advantages and disadvantages of methods using high temperatures for microbial killing.
- Give examples of the application of high-temperature methods for control of microorganisms.
- Discuss the concept of autoclave, being the most efficient method of sterilization.
- Recognize the influence of the hydrogen ion concentration (pH) on microbial growth.
- Recognize that an optimum concentration of hydrogen ions exists for each organism in which it grows best.
- Identify the general pH range in which microbial growth can occur.

#### **19. Atmospheric Oxygen Requirement**

- Discuss the different types of oxygen requirements (aerobic and anaerobic respiration and fermentation).
- Discuss oxidative and anaerobic metabolism.

#### **20. The Inhibitory Action of Heavy Metals, and Disinfectants**

- Recognize the inhibitory actions of heavy metals (oligodynamic action).
- Compare the inhibitory effects of heavy metal compounds and disinfectants.
- Use a filter paper disk diffusion method for testing purposes.

#### **21. Antibiotic Susceptibility Testing**

- Perform an antibiotic sensitivity test on a bacterial culture, by using the Kirby-Bauer disc diffusion technique.
- Measure the zone of inhibition and interpret the results, using a table for different antibiotics.
- Distinguish the relative resistance and sensitivity of bacterial cultures to selected antibiotics.
- Discuss the emergence of multi-drug resistance.

#### **22. Immunology**

- Discuss the main components of immune reactions – antigens and antibodies.
- Perform microbial slide agglutination test (Staphorex) and interpret typical test results.
- Recognize the value of agglutination tests in the diagnosis of certain microbial diseases.
- Understand the basis of blood typing.
- Recognize the major differentiating features between precipitation and agglutination reactions.
- Discuss different type of precipitation tests.
- Define ELISA and understand how an ELISA can be used to detect both antigen and antibodies.

## 25. Microorganisms of the Skin

- List several common microbial infections of the skin.
- Recognize the significance of the intact skin as a barrier to microbial disease agents.
- Distinguish between various microbial pathogens of the skin.
- Interpret specific diagnostic tests for *Staphylococcus aureus*, including coagulase, mannitol fermentation and DNase tests.
- Interpret specific tests used for the identification of *Streptococcus* species, including bacitracin sensitivity, CAMP reaction, Bi le -esculin test and growth in 6.6% sodium chloride.

## 26. Microorganisms of the Mouth and Dental Caries. Microorganisms of the Gastrointestinal Tract

- List several common microbial infections of the gastrointestinal tract.
- Describe different mechanisms of resistance in the digestive tract
- Interpret standard procedures used in the identification of selected gastrointestinal pathogens.
- Differentiate between *S. mitis* and *S. Salivarius*

## 27. Microorganisms of the Respiratory Tract

- List several common infections of the respiratory tract.
- Recognize general cultural characteristics of selected potential bacterial pathogens.
- Interpret the results of the optochin test for *Streptococcus pneumoniae*.
- Identify selected fungal pathogens that cause respiratory infections
- Discuss viruses that cause respiratory diseases

## 28. Pathogens of the Urogenital System and STD's

- Recall the anatomy of the Urogenital System.
- Explain the types of urinary-tract infections (UTI).
- List common microbial pathogens and diseases of the genitourinary tract.
- Describe the general features of representative sexually transmitted diseases.
- List diagnostic features of selected STD's.

## 29. Helminthology

- Distinguish the adult tapeworms, roundworms and flukes.
- List the most common diseases from each type.
- Prophylaxis and treatment.

---

## Necessary Materials

In addition to the lecture textbook and the lab manual, you will need additional materials. For the lab, you will need pencils, a pen, a lab coat, goggles and a sharpie. Long hair must be tied back. No high heels or open toed shoes are permitted. Lab coats must be worn.

Purchasing options and costs: this may vary

### Lecture textbook (Cowan) at the Bookstore:

\$78 for renting 1 term

\$136 to purchase NEW Loosleaf; Here is the ISBN for that: 9781264028399

The direct purchase link for the publisher McGraw Hills:

<http://shop.mheducation.com/mhshop/productDetails?isbn=1264028393>

The price is \$80 on the link.

Laboratory Manual, Microbiology Fundamentals: A Clinical Approach 3rd edition, Steven Obenauf.

\$132 directly from the website

<https://www.mheducation.com/highered/product/9781260163483.html?exactisbn=true#buying-options>

### **Attendance and Lateness**

Students must attend both lecture and lab. This means that no more than 2 lecture or 3 lab absences will be tolerated. It is expected that you will be in your seat and ready to work at the start of each period. Any 2 latenesses will be considered to be equal to 1 absence.

### **Temporary Conditions and Medical Reasons for Absence**

According to the CUNY Policy, faculty should never review medical documentation from a student. Instead, the student should go to the Student Accessibility Center (SAC) in L-237 (on the second floor where the Library and General buildings meet). The SAC will review the documentation and give the student a letter to share with faculty if accommodations should be made.

### **Accessibility Statement**

City Tech is committed to supporting the educational goals of enrolled students with disabilities in the areas of enrollment, academic advisement, tutoring, assistive technologies and testing accommodations. If you have or think you may have a disability, you may be eligible for reasonable accommodations or academic adjustments as provided under applicable federal, state and city laws. You may also request services for temporary conditions or medical issues under certain circumstances. If you have questions about your eligibility or would like to seek accommodation services or academic adjustments, please contact the Center for Student Accessibility at 300 Jay Street room L-237, Phone: 718-260-5143 or <http://www.citytech.cuny.edu/accessibility/>.

### **Grading Policy**

The grade for the Microbiology course is computed by adding 50% of your lecture grade to 50% of your lab grade. There are 4 lecture examinations, which each cover roughly one quarter of the lecture work as indicated in the outline. For the lab, there are four written exams and two practical exams. There are also written assignments (suggestion: 4). Each of the written exams count for 15%, the two practical exams each count for 10% and the written assignments count for 20%.

**ALL GRADES ARE COUNTED; NONE ARE DROPPED NOR ARE THEY CURVED.**

Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

### **Plagiarism**

Students must write their own assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge that, both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. For the CityTech policies on plagiarism, see the following link: <http://library.citytech.cuny.edu/instruction/pdf/plagiarismtips.pdf>  
For the CityTech policies on academic integrity see the following link [http://www.citytech.cuny.edu/aboutus/docs/policies/CT\\_PolicyManual11\\_12\\_](http://www.citytech.cuny.edu/aboutus/docs/policies/CT_PolicyManual11_12_)

### **Options for Book**

OPTION 1 (LooseLeaf Physical Version): 9781260786057 Loose Leaf for Microbiology Fundamentals: A Clinical Approach 4th Edition, Cowan NET PRICE \$98

OPTION 2 (eBook Only): McGraw Hill eBook Access Card 180 days for Microbiology Fundamentals: A Clinical Approach 9781266661013 NET PRICE \$49.50

OPTION 3 (Connect Access, Includes eBook): [COWAN CNCT ACCSS CRD MCRB FNDMNTL 4th Edition 9781260786033](#) NET PRICE \$95