

KINGSBOROUGH COMMUNITY COLLEGE
Of The City University of New York
Department of Biological Sciences

BIO 5000 – GENERAL MICROBIOLOGY
SYLLABUS



Lecture and Laboratory: Professor Grace L. Axler-DiPerte, Ph.D.

Office: S215; **Telephone:** (718) 368-5745; **E-mail:** GAxler-Diperte@kbcc.cuny.edu

Office Hours: Drop in for course questions, help, exam and assignment review and feedback, or any course concern, NO APPOINTMENT NEEDED during office hours (available on the course LMS site). If you would like to meet at a different time, or by Zoom, please email me with at least two available times to schedule a time M-F before 3PM.

Instructor Availability: I will respond to emails within 24 hours M-F, and within 48 hours on weekends and college holidays.

Course Description: Examines the diverse structure & activities of microbes in a wide number of environs. Throughout the course, aspects of microbes beyond their ability to cause disease will be studied. These include the use of microbes in food production, antibiotic production, & bioremediation. Laboratory experiments will be conducted to support the concepts studied in the lecture portion of the course, the textbook readings, & other readings. Basic microbiological techniques, such as staining, aseptic transfer, & pure culture techniques will be conducted. More advanced laboratories designed to demonstrate the interdisciplinary nature of microbiology will include collection of marine water and sediment samples for cultivation of algae and the isolation of antibiotic-producing microbes, and studies of various relationships between microbes and other organisms.

4 credits, 6 hours (3 hours of lecture and 3 hours of laboratory).

Prerequisites: Bio 14, Chm 11

Course Student Learning Outcomes

1. Demonstrate an understanding of the diversity of the microbial world with regard to the structure & function of microbes.
2. Apply the appropriate microbiological technique for a given experimental objective.
3. Explain the positive and negative effects of microbes on communities that have resulted in historically significant events.
4. Describe examples of commensal, mutualistic, and antagonistic microbial relationships.

5. Analyze the contributions microbes make to soil and aquatic environments by their roles in food webs and nutrient cycling.
6. Apply the interdisciplinary nature of microbiology to scientific fields such as genetics, ecology, food production, and waste management.

Skills you will be performing and developing to learn microbiology

1. Evaluation of readings from curated sources and the laboratory manual
2. Theoretical application and interpretation of laboratory data
3. Using Blackboard
4. Communicating through written assignments
5. Solving problems and applying information

Required Materials:

This is a Zero Textbook Cost Course

TEXTBOOK: Readings and videos will be made available weekly in Blackboard.

LAB MANUAL: Selected exercises of Laboratory Exercises in Microbiology 2nd edition (L. Brancaccio-Taras) will be made available in Blackboard. You should bring these as printouts to each lab.

LAB MATERIALS: You are required to bring a knee length lab coat and goggles with you to each laboratory session. You will not be permitted to enter the laboratory without these safety items.

LECTURE

Lecture this semester is hybrid. Since this is a hybrid class you will be responsible for reviewing this material on your own. Our review sessions will include Q and A, discussion and activities with your classmates to help you better understand the topic.

Folders with all readings and assignments will be posted each week in the “Lecture” section of the course Blackboard site. You should review the readings and make an initial annotation on the lecture slides or designated reading before coming to our in-person sessions on Mondays, and complete the annotation assignments before Thursday of that week.

Topic Outline

WEEK 1: INTRODUCTION TO MICROBIOLOGY AND ITS HISTORY

An invisible world: Introduction to the discipline of Microbiology

What our ancestors knew: A history of Microbiology

A systematic approach: How microbes have been classified, both historically and currently

Types of microorganisms: Diversity of Microbes and their defining characteristics

WEEK 2: UNIQUE CHARACTERISTICS OF PROKARYOTIC CELLS

Bacterial morphology

Bacterial structures (nucleoid, plasmids, inclusions, endospores, plasma membrane, cell wall, glycocalyx (capsules/slime layers), appendages (pili/fimbriae) and flagella

WEEK 3: BACTERIAL GROWTH

Bacterial growth curve

Measurement of microbial growth: direct & indirect methods
Alternative patterns of cell division
Factors affecting microbial growth: oxygen, pH, temperature, osmotic/barometric pressure
Media used for bacterial growth

WEEK 4: MICROBIAL METABOLISM

The principles of energy, matter and enzymes
Catabolism of carbohydrates
Aerobic respiration, anaerobic respiration, fermentation
Catabolism of lipids and proteins
Photosynthesis

WEEK 5: MECHANISMS OF MICROBIAL GENETICS AND MODERN APPLICATIONS OF MICROBIAL GENETICS

Review of the basics of DNA replication, transcription and translation
How prokaryotes achieve genetic diversity: conjugation, transformation & transduction
Gene regulation: operon theory

WEEK 6: MICROBIAL MOLECULAR BIOLOGY & GENETICS

Tools of Genetic Engineering: restriction enzymes, ligase, plasmids, and using of genetic transfer mechanisms
Visualizing DNA, RNA and proteins: nucleic acids probes, agarose gel electrophoresis, RFLP, Southern blot, colony situ hybridization, northern blot, microarray analysis, PAGE, PCR, DNA sequencing
Whole genome methods
Gene therapy

WEEK 7: THE EUKARYOTES OF MICROBIOLOGY: PROTISTS AND FUNGI

Protistan classification based on rRNA sequences
Fungal classification based on rRNA sequences

WEEK 8: ACELLULAR PATHOGENS

Viruses and their life cycles
Isolation, culture, and identification of viruses

WEEK 9: MICROBIAL ECOLOGY

Biogeochemical cycling
Microbes in major environments: freshwater, marine, & terrestrial
Microbial Symbioses

WEEKS 10 & 11: INDUSTRIAL MICROBIOLOGY

Microbial products in the health industry
Wastewater treatment
Microbiology of food, food safety and food preservation

WEEK 12: SELECTED TOPICS IN MICROBIOLOGY

LABORATORY

Sequence of Lab Experiments & Assignments

For each week of lab, you will need to consult the appropriate folders on the Blackboard course site for background reading and manuals, videos and simulations for each exercise and technique.

Laboratory is in person.

For safety purposes, students will not be admitted to lab if they are over 30 minutes late, and must wear a knee-length lab coat and goggles at all times. You will need to review the exercises before coming to lab, and bring a copy of the manual exercises with you.

<u>WEEK#</u>	<u>EXERCISE TITLE</u>	<u>EXERCISE #</u>
1	Check In/Safety rules	
	Bright-field microscope (review of parts and focusing procedure)	1
	Smear preparation and simple staining	2
	Negative staining	3
	Gram staining	4
	Culture media & aseptic transfer	10
2	Acid-fast staining	5
	Capsule staining	6
	Endospore staining	7
	Pure culture techniques (streak plate only)	11
3	Bacterial population counts	12
	Selective & differential media	14
	Winogradsky column (setup)	28
4	Factors affecting microbial growth	15-18
	Analysis of the effectiveness of handwashing	22
5	Unknown A: Determination of bacterial properties- Carbohydrate fermentation Parts I-V	23
	Isolation of antibiotic producers Part I	29
6	Unknown B: Determination of bacterial properties - Protein metabolism Part I-VI	24
	Exoenzymes and endoenzymes Parts I-VII	25
	Bioremediation	31 (and worksheet)
7	Identifying an unknown bacterium- Parts I & II	26
	Antagonism- Part II (Begin)	39
	Record Bioremediation Results	
8	Examination of molds	32

	Isolation of antibiotic producers Part II	29
	Record Unknown Results	
	Record Bioremediation results	
9	Examination of algae	33
	Algal Blooms	handout
	Protozoa and slime molds	34
	Isolation of antibiotic producers Part III	29
10	Commensalism	37
	Mutualism- Parts I, II, and III	38
	Antagonism- Part II (Complete)	39
	Isolation of antibiotic producers Part IV	29
11	Food microbiology- Bacterial counts of food samples	42
	Use of chemical preservatives to increase the shelf life of apple cider	43
12	Analysis of Week 11 Results	
	Isolation of antibiotic producers Part V	29

BIO 5000 POLICIES

ATTENDANCE AND ASSIGNMENTS

Lecture for this course is hybrid, meaning we will meet for an hour, once a week. Attendance at these sessions accounts for your course participation score (5% of total grade).

Laboratory for this course is in-person. These laboratories use live microorganisms, and cannot be repeated if missed. Please contact me in the event of illness or circumstance that would make you unable to attend a laboratory session within 24 hours.

COURSE CALENDARS

Students are urged to become familiar with the course calendars on Blackboard, and the due dates in this document. These calendars indicate the due dates for each assignment, quiz, report, and exam.

Exams, Late Work, Feedback and Make-Up Policies

- Course due dates are firm and necessary to complete the course successfully. Late work will not be accepted without prior agreement between the student and the instructor, and will be subject to a reduction of 5% of the total assignment grade per day. Extensions must be requested via email, up to 24 hours before the due date. Request for an extension does not guarantee it will be approved.
- Exams and Lab Quizzes may not be made up if missed without arrangement within 24 hours of the due date.
 - To schedule a make-up, you must email me within 24 hours of the course meeting time and exam/quiz date. An alternative assessment will be given in person at a time mutually agreed upon by the student and instructor, but not more than one week after the assessment date.
- Once the scores have been given for any graded assignment, no further make-ups are possible.
- I do not return exams or quizzes with answer keys, however, you are always welcome (and strongly encouraged) to stop by my office hours in S-215, or schedule a Zoom appointment with me within **3 weeks of the exam or quiz date** to go over your work. I am happy to provide additional feedback, and help you pinpoint areas for improvement.
- Please reach out to me early and often, especially if you are having difficulty meeting the course requirements. I'm here to help!
- This syllabus is subject to change with notice at the instructors discretion.

ACADEMIC INTEGRITY

CUNY has an Academic Integrity Policy can be found at:

https://www.kbcc.cuny.edu/studentaffairs/student_conduct/academic_integrity.html

The policy specifies definitions of cheating, plagiarism and obtaining unfair advantage and the possible consequences of such actions. More information can also be found on the "Course Information and Policies" portion of our Blackboard site. **Please review the policy and the definitions, particularly since you will be submitting a number of written assignments.**

ACCESS-ABILITY SERVICES

Access-Ability Services (AAS) serves as a liaison and resource to the KCC community regarding disability issues, promotes equal access to all KCC programs and activities, and makes every reasonable effort to provide appropriate accommodations and assistance to students with disabilities. Please contact this office if you require these accommodations and assistance. I will be glad to make the necessary accommodations to make sure you have full access to the course, but you must have documentation from the Access-Ability office for any accommodations. AAS can be found in Room D205 on campus or at <https://www.kbcc.cuny.edu/access-ability/homepage.html>.

GRADING

Your final course grade will be determined as follows:

LECTURE

15% THREE LECTURE EXAMINATIONS

- Exam dates appear on the course schedule, and will be given in person.

10% HYPOTHESIS ANNOTATION ASSIGNMENTS

- Annotations on lecture slides and selected readings are due throughout the week. One annotation is due before the Lecture Review session for that week. The remaining annotations are due on the Thursday of that week before 8PM, except where otherwise noted.

5% PARTICIPATION

- This score accounts for attendance and participation at our Lecture Reviews. See our course Blackboard site for more information.

20% FINAL EXAMINATION

- A cumulative final for this course will be given in-person according to the course schedule.

LABORATORY

25% FIVE LAB QUIZZES

- Lab Quiz dates appear on the course schedule.
- All lab quizzes will be given in person at the beginning of the laboratory session.

25% LAB WRITTEN PROJECTS (3)

- Identification of an Unknown Bacterium (individual)
- Bioremediation (Group)
- Winogradsky Column Analysis (Group)

BIO 5000 Unit Learning Goals

INTRODUCTION TO MICROBIOLOGY/ EVOLUTION OF MICROBES AND THE FIELD OF MICROBIOLOGY

1. Name and explain the difference between the three domains.
2. Distinguish prokaryotic from eukaryotic cells.
3. Name the 5 classifications of organisms studied in microbiology and explain how they can be distinguished from one another based on the following properties: (a) cell type; (b) size; (c) type of reproduction; (d) cell division; (e) chemical composition & (f) unique structures, organelles, processes.
4. Define spontaneous generation, cell theory and germ theory.
5. In a brief statement, describe the series of experiments disproving spontaneous generation.
6. Describe Robert Koch's experiment proving germ theory.
7. List the 4 criteria of Koch's postulates, and its modern applications.
8. Describe in several sentences the significance of the contributions of the following scientists to the field of microbiology: (a) Woese; (b) Pasteur; (c) Winogradsky; (d) Koch.

BACTERIAL AND ARCHAEL CELL STRUCTURES

1. Define the term morphology.
2. Draw and name the 3 most common bacterial shapes and their arrangements.
3. Describe the chemical composition (structure) and function of the following bacterial structures: (a) cell wall; (b) cell membrane; (c) glycocalyx; (d) endospores; (e) flagella; (f) pili; (g) inclusion bodies; (h) plasmid; and (i) nucleoid.
4. State the chemical differences in the cell walls of Gram-positive, Gram-negative, Acid Fast, Mycoplasma, and Archaea.
5. Name the components of the outer membrane of a Gram-negative cell.
6. Explain the action of penicillin and lysozyme in relation to bacterial cell walls.
7. Draw and name the 4 bacterial flagellar arrangements.
8. Explain the difference between sporulation and germination.

BACTERIAL GROWTH

1. Name the basic elements required for microbial growth.
2. Define each of the following terms with regard to their energy and carbon source: (a) photoautotroph; (b) photoheterotroph; (c) chemoautotroph; and (d) chemoheterotroph.
3. Define the term culture medium.
4. Explain the difference between a chemically defined and a complex culture medium.
5. Explain the purpose of an enrichment culture and give one example of its application.
6. Describe the following processes of cell division: binary fission, budding & fragmentation.
7. Distinguish cell growth from population growth.
8. Define the term generation time.
9. Draw and label the four phases of a typical bacterial growth curve.
10. Describe the phases of a typical bacterial growth curve.
11. Explain the difference between a direct and indirect method for measuring microbial growth.
12. Name one direct method for measuring microbial growth and describe how it is performed.
13. List one advantage and one disadvantage of the method mentioned in objective #12.
14. Name two indirect methods for measuring microbial growth and describe how each is performed.

15. List one advantage and one disadvantage of the methods mentioned in objective #14.
16. Explain the function of a chemostat in maintaining a continuous culture.
17. Describe how each of the following physical factors affect microbial growth: (a) temperature; (b) pH; (c) molecular oxygen; (d) osmotic pressure.

MICROBIAL METABOLISM

1. Define the following terms: (a) metabolism; (b) catabolism; and (c) anabolism.
2. Explain the significance of charge separation in energy generation.
3. Write four chemical reactions to demonstrate the catabolism of the four major macromolecules
4. Name & define the three mechanisms by which Bacteria and Archaea generate ATP.
5. Define the following terms: (a) fermentation; (b) aerobic respiration; and (c) anaerobic respiration.
6. List the end products of: (a) glycolysis; (b) Krebs cycle; (c) electron transport/oxidative phosphorylation.
7. Identify the role and importance of fixed and diffusible electron carriers.
8. Explain the significance of microbial metabolism in the identification of microorganisms.
9. Distinguish each type of fermentation mentioned and name a microbe that carries out each type of fermentation: (a) homolactic (b) mixed acid and (c) alcoholic fermentation.
10. Distinguish oxygenic from anoxygenic photosynthesis.
11. Name the 5 photosynthetic bacteria and distinguish them based on the following: (a) source of reducing power; (b) source of carbon; (c) major electron donor & acceptor.

MICROBIAL MOLECULAR BIOLOGY & GENETICS

1. Define the following terms: (a) gene; (b) genotype; (c) phenotype; and (d) mutation.
2. Distinguish between the processes of DNA replication, transcription and translation.
3. Explain RNA processing in prokaryotes and in eukaryotes.
4. Define the term operon and describe the different genes and regulatory regions found in an operon.
5. Distinguish between transformation, transduction and conjugation.
6. Define the term competency.
7. Explain the difference between specialized and generalized transduction.
8. Explain the difference between a F⁺ cell, Hfr cell, and F' cell.
9. Explain how genetic transfer increases the ability of bacterial cells to survive under adverse conditions such as exposure to antibiotics or heavy metals.
10. List two advantages and two disadvantages of using products of microbial cloning.
11. Define the following terms and state how they are used in genetic engineering: (a) restriction enzyme; (b) agarose gel electrophoresis; (c) Southern blotting cDNA; (d) DNA library; (e) nucleic acid probe; (f) colony hybridization; (g) radioactive antibodies; (h) polymerase chain reaction (PCR).
12. Name the bacterium commonly used to transfer genes to plants and explain the steps involved in creating recombinant plants.
13. Describe the Sanger method of nucleotide sequencing.
14. Describe the significance and applications of microbial genomics.

DIVERSITY OF MICROBIAL WORLD: PROTISTS AND FUNGI

1. List 3 characteristics of eukaryotic cells.
2. Name and distinguish the 2 major groups of flagellated protists.
3. Compare and contrast the aerobic protists (euglenoids, kinetoplastids, & heterobasilians).

4. Compare and contrast the stramenopiles (chrysophytes, zanthophytes, diatoms, brown algae, & oomycetes).
5. Explain the differences in the life cycles of cellular & acellular slime molds,
6. Compare and contrast the major fungal groups.

VIRUSES

1. Explain why viruses are considered obligate intracellular parasites. Define the following parts of a virus: (a) capsid; (b) capsomere; (c) nucleocapsid; (d) envelope; & (e) spikes.
2. Explain each of the following viral replication strategies: (a) double-stranded DNA; (b) single stranded DNA; (c) positive strand RNA; (d) negative strand RNA; and (e) retroviruses.

MICROBIAL ECOLOGY

1. Explain the following cycles, including the specific microbes involved: (a) Carbon cycle; (b) Nitrogen cycle; & (c) Sulfur cycle.
2. Describe a technique you could use to identify microbes in their natural habitat.

ECOSYSTEMS AND MICROBIAL INTERACTIONS

1. Define the following types of symbiosis: (a) commensalism; (b) mutualism; and (c) antagonism.
2. Describe the following microbe-plant symbioses: (a) rhizosphere; (b) mycorrhizae; & (c) legumes-*Rhizobium*.
3. Explain the microbe-invertebrate interactions in a hydrothermal vent.
4. Explain the interaction between microbes & ruminant animals.

APPLIED MICROBIOLOGY

1. Distinguish primary metabolites from secondary metabolites.
2. Name and describe the production of two foods through fermentation.
3. Name and describe the production of two beverages through fermentation.
4. Name and describe three methods used to preserve food.
5. List two specific examples of how microbes in food negatively impact the health of humans.
6. Describe the steps involved in primary, secondary, and tertiary wastewater treatment.
7. Describe the steps involved in the treatment of drinking water.
8. Define the term bioremediation and state one application.
9. State one advantage and one disadvantage of bioremediation.