Lecture: Professor L. Brancaccio-Taras  
Office: L705; Telephone: (718) 368-6651; E-mail: Ltaras@kbcc.cuny.edu  
Lab: Prof. Mary Ortiz (Wednesday); Prof. L. Brancaccio-Taras (Thursday)

Course Description: Examines the diverse structure & activities of microbes in a wide number of environs will be examined. 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

Student Learning Outcomes
1. Demonstrate an appreciation for the diverse microbial world with regard to the structure & function of microbes.  
2. Perform basic microbiological techniques to stain, cultivate, & identify microbes.  
3. Demonstrate the positive & negative effects microbes have on society resulting in historically significant events.  
4. Identify commensal, mutualistic, & 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 the fields of genetics, ecology, food production, and waste management.
Skills you will be performing to learn microbiology
1. Readings from textbook & laboratory manual
2. Lab experiments performed with a partner
3. Use of Blackboard
4. Weekly written assignments
5. Working in a team
6. Solving problems and applying information

OTHER REQUIREMENTS: A knee-length laboratory coat & goggles

LECTURE - Topical Outline
Please bring your textbook to every lecture session.

WEEK 1: INTRODUCTION TO MICROBIOLOGY/ EVOLUTION OF MICROBES AND THE FIELD OF MICROBIOLOGY

Cell types & the organisms studied in microbiology: bacteria, fungi, algae, protists & viruses
History of microbiology: From van Leewenhoek to the present

Text readings: Chapter 1 p. 1-21
Chapter 5 p. 105-106 (section 5.8)
Chapter 6 p. 109-123 & p. 125-131
WEEK 2: BACTERIAL AND ARCHAEL CELL STRUCTURES

Bacterial morphology (size, shapes & arrangements)
Bacterial structures (cell membrane, cell wall, capsules/slime layers, cytoplasm, inclusions, nucleoid, plasmids flagella, pili, and endospores)

Text readings: Chapter 3 p. 42-49 & p. 53-79
Chapter 4 p. 80-89

WEEK 3: BACTERIAL GROWTH

Bacterial cell cycle
Factors affecting microbial growth
Growth of microbes in natural environments
Laboratory growth of microbes
Bacterial growth curve
Culture media and techniques
Microbial Enumeration: direct & indirect methods
Requirements for growth

Text readings: Chapter 7 p. 132-150 & p. 154-171

WEEK 4: MICROBIAL METABOLISM
Principles & requirements for energy production
Aerobic respiration, anaerobic respiration, types of fermentation,
Energy from light

Text readings: Chapter 10 p. 211-220
Chapter 11 p. 227-261
Chapter 12 p. 262-264

WEEK 5: MICROBIAL MOLECULAR BIOLOGY & GENETICS

Gene regulation & levels of regulation (transcriptional/translational)
Regulation of complex cellular processes: catabolite repression, quorum sensing
Mechanisms of genetic variation: mutation, conjugation, transformation & transduction

Text readings: Chapter 14 p. 321-333;
Chapter 16 p. 369-372; p. 384-399
WEEK 6: MICROBIAL MOLECULAR BIOLOGY & GENETICS

- Recombinant DNA techniques: restriction enzymes, genetic cloning and cDNA synthesis gel electrophoresis, Southern Blot, polymerase chain reaction, vectors genomic libraries, introducing and expressing foreign genes in host cells cloning eukaryotic genes in bacteria, generation and purification of a protein product
- Microbial Genomics: DNA sequencing methods, genome sequencing, bioinformatics, functional genomics, proteomics, systems biology, comparative genomics, metagenomics

**Text readings:** Chapter 17 p. 400-418
Chapter 18 p. 419-442

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WEEK 7: DIVERSITY OF MICROBIAL WORLD: PROTISTS AND FUNGI

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

**Text reading:** Chapter 25 p. 563-582
Chapter 26 p. 583-596

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WEEK 8: VIRUSES

- The Baltimore System of Viral Classification
- Lambda virus
- Archaeal viruses
- Herpes viruses
- Nucleocytoplasmic large DNA viruses (NCLD)
  - dsRNA viruses/plus & minus strand RNA viruses
- Polio virus
- Retroviruses

**Text readings:** Chapter 27 p. 597-598;
  p. 602-606; p. 607-610;
  p. 611-622
WEEKS 8 & 9: MICROBIAL ECOLOGY

Biogeochemical cycling
Carbon, Nitrogen, Sulfur, and Iron cycles
Global climate change
Methods in microbial ecology: culturing techniques, assessing diversity, assessing microbial community activity

Text reading: Chapter 28 p. 623-629; 
              p. 632-636
              Chapter 29 p. 637-649

WEEK 10: ECOSYSTEMS AND MICROBIAL INTERACTIONS

Microbes in major environments: freshwater, marine, & terrestrial
Microbial interactions

Text readings: Chapter 30 p. 650-666;
               Chapter 31 p. 667-684
               Chapter 32 p. 685-706

WEEKS 11 & 12: APPLIED MICROBIOLOGY
Microbiology of Food: food spoilage and control of spoilage; food-borne illnesses and detection of pathogens; microbiology of fermented foods; probiotics
Industrial Microbiology: antibiotic production, amino acids; biofuel production; agricultural biotechnology; microbes as products
Applied Environmental Microbiology: water purification; wastewater treatment; microbial fuel cells; bioremediation; bioaugmentation; bioleaching

**Text reading:** Chapter 41 p. 927-946;
Chapter 42 p. 947-963;
Chapter 43 p. 964-980
LABORATORY
Sequence of Lab Experiments & Assignment
Lab Manual: Laboratory Exercises in Microbiology 2nd edition by L. Brancaccio-Taras
**Please read lab exercises prior to coming to each lab session.**
Labs cannot be made up due to the complicated cultures and chemicals involved.

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BIO 50 Unit Reviews

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 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.
8. Describe in several sentences the significance of the contributions of the following scientists to the field of microbiology: (a) van Leewenhoek; (b) Pasteur; (c) Jenner; (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 organelles: (a) cell wall; (b) cell membrane; (c) glycolocalyx; (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-positives, Gram-negatives, and archaeobacteria
5. Name the components of the outer membrane of a Gram-negative.
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) chemautotroph; 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 1 direct method for measuring microbial growth and describe how it is performed.
13. List 1 advantage and 1 disadvantage of the method mentioned in objective #12.
14. Name 2 indirect methods for measuring microbial growth and describe how each is performed.
15. List 1 advantage and 1 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 4 chemical reactions demonstrate the anabolism of the 4 major macromolecules
4. Write 4 chemical reactions demonstrate the catabolism of the 4 major macromolecules
5. Name & define the 3 mechanisms by which Bacteria and Archaea generate ATP.
6. Define the following terms: (a) fermentation; (b) aerobic respiration; and (c) anaerobic respiration.
7. List the end products of: (a) glycolysis; (b) Krebs cycle; (c) electron transport/oxidative phosphorylation.
8. Differentiate fixed and diffusible electron carriers.
9. Explain the significance of microbial metabolism in the identification of microorganisms.
10. Write a chemical reaction for each type of fermentation mentioned and name a microbe that carries out each type of fermentation: (a) homolactic fermentation; (b) mixed acid fermentation; and (c) alcoholic fermentation.
11. Distinguish oxygenic from anoxygenic photosynthesis
12. 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;
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.
4. Explain RNA processing in eukaryotes.
5. Define the term operon and describe the different genes and regulatory regions found in an operon.
6. Explain the difference between negative and positive regulation and describe an example of each.
7. Define the following terms: (a) plasmid; (b) incompatibility group; and (c) curing.
8. Distinguish between transformation, transduction, and conjugation.
9. Define the term competency.
10. Explain the difference between specialized and generalized transduction.
11. Explain the difference between an F+ cell, Hfr cell, and F’ cell.
12. Explain how genetic transfer increases the ability of bacterial cells to survive under adverse conditions such as exposure to antibiotics or heavy metals.
13. Name and describe three different types of plasmids.
14. Explain three mechanisms of plasmid-encoded antibiotic resistance.
15. List two advantages and two disadvantages of using human cloning products.
16. 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; and (h) polymerase chain reaction (PCR).
17. Name the bacterium commonly used to transfer genes to plants and explain the steps involved in creating recombinant plants.
18. Describe the Sanger method of nucleotide sequencing.
19. Describe the significance and applications of microbial genomics.

DIVERSITY OF MICROBIAL WORLD: PROTISTS AND FUNGI
1. List three characteristics of eukaryotic cells.
2. Name and distinguish the two major groups of flagellated protists.
3. Compare and contrast the aerobic protists (euglenoids, kinetoplastids, & heterobasalians).
4. Compare and contrast the heterokonts (chrysophytes, zanophytes, 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 (ascomycetes, basidiomycetes, zygomycetes, & deuteromycetes).
7. State the evolutionary significance of choanoflagellates.

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; and (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.

ECOSYSTEMS AND MICROBIAL INTERACTIONS
1. State four functions of beneficial symbiotic associations.
2. Define the following types of symbiosis: (a) commensalism; (b) mutualism; and (c) antagonism.
3. Describe the following microbe-plant symbioses: (a) rhizosphere; (b) mycorrhizae; and (c) legumes-Rhizobium.
4. Explain the microbe-invertebrates interactions in a hydrothermal vent.
5. Explain the interaction between microbes & ruminant animals.

MICROBIAL ECOLOGY
1. Name & describe two techniques used to identify microbes in their natural habitat.
2. Name & describe two techniques used to quantify microbes in an environmental sample.
3. Name & describe two techniques used to identify metabolically active microbes in an environmental sample.
4. Distinguish biomass from biomarkers.
5. Describe the significance of primary production in a marine environment & its relationship to microbial cloud formation.
6. Explain the following cycles, including the specific microbes involved: (a) C cycle; (b) N cycle; and (c) S cycle.

APPLIED MICROBIOLOGY
1. Distinguish primary metabolites from secondary metabolites.
2. Describe the components of a fermentor used for antibiotic production.
3. Name and describe the production of two foods through fermentation.
4. Name and describe the production of two beverages through fermentation.
5. Describe the steps involved in primary, secondary, and tertiary wastewater treatment.
6. Describe the steps involved in the treatment of drinking water.
7. Define the term bioremediation and state one application.
8. State one advantage and one disadvantage of bioremediation.
BIO 50 POLICY

ATTENDANCE
Attendance is taken at the beginning of each class. Students arriving late must verify their presence in class before leaving that session. No attendance adjustments will be made at a later date. If you miss a class, you are responsible for obtaining notes and/or handouts from their fellow students. The College attendance policy is for a class that meets 6 hours per week, you are allowed 12 hours of absence. You cannot miss more than 2 labs.

ACADEMIC INTEGRITY
CUNY has an Academic Integrity Policy can be found at: http://www.kbcc.cuny.edu/sub-about/policies_reports/Pages/welcome.aspx
The policy specifies definitions of cheating, plagiarism and obtaining unfair advantage and the possible consequences of such actions.
This policy will be followed and enforced. 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. Your instructor will make the accommodations you need once you provide documentation from the Access-Ability office (D-205). Please contact AAS for assistance.

Your final course grade will be determined as follows:
LECTURE
15%  THREE LECTURE EXAMINATIONS
Exam dates appear on the course calendar. Dates will remain as indicated unless a change of date is discussed and announced in lecture.
If you miss an exam, you must make it up. The format of make-up exams will be a series of essay questions. A doctor’s note is required in order to take a make-up exam. You should notify (email or call) the instructor that you will be missing an exam prior to the class when the exam is being given.

15%  WEEKLY HOMEWORK -WRITING ASSIGNMENTS
Teams will work on homework problems and submit one set of answers. You will email your answers to me. They will be graded and then you will have the opportunity to resubmit your answers. The final grade for the homework will be the average of the original grade and the resubmitted grade. Since you have the opportunity to resubmit your answers, no late homework assignments will be accepted.

20%  FINAL EXAMINATION
A cumulative final for this course will be given (date to be announced).

LAB
25%  LAB QUIZ AVERAGE
Lab quizzes will be given in the beginning of the lab session.

25%  LAB WRITTEN PROJECTS
Three lab reports on identification of an unknown bacterium, bioremediation and Winodgrasky column will be submitted.