BIOL 0004 - MICROBIOLOGY

Catalog Description

Prerequisite: Completion of high school chemistry, CHEM A, or higher level chemistry course with grade of "C" or better
Advisory: Eligibility for ENGL 11 strongly recommended
Hours: 162 (54 lecture, 108 laboratory)
Description: Introduction to the biochemistry, morphology, physiology, genetics, and classification of microorganisms. Emphasis on the significance of microorganisms to human health and global ecology. Laboratory topics include traditional and modern techniques of microbial classification, recombinant DNA technology, and bacteriophage biology. Students enrolling in BIOL 4 after having taken BIOL 8A will lose credit for BIOL 8A. Not open to students that have successfully completed BIOL 8B. (CSU, UC-with unit limitation)

Course Student Learning Outcomes

- CSLO #1: Distinguish the cellular organization of organisms within Domains Archaea, Bacteria, and Eukarya.
- CSLO #2: Distinguish morphological, physiological, and environmental characteristics for, ecological impact of, and taxonomic classification for several representative microorganisms from each Domain of life.
- CSLO #3: Describe the nature of enzymes and their roles in the metabolism of microbial cells.
- CSLO #4: Describe metabolic and genetic pathways of microbial cells.
- CSLO #5: Describe the microscopic structures and replication processes of viruses.
- CSLO #6: Describe the human immune system and the importance of vaccination against microorganisms and viruses to human herd immunity.
- CSLO #7: Perform modern genetic techniques used in the identification of microorganisms and recombinant DNA technology.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

162

Outside of Class Hours

108

Total Student Learning Hours

270

Course Objectives

Lecture Objectives
1. Define and apply terminology used in the discussion of microbial morphology, physiology, genetics, classification, and the scientific method. (Lecture Outline I)
2. Identify individuals recognized as having significantly impacted the science of microbiology, and explain their contributions. (Lecture Outline I)
3. Define protoplasm, describe its composition and explain the important characteristics and functions of water, electrolytes, carbohydrates, proteins, lipids, and nucleic acids within living organisms. (Lecture Outline II)
4. Describe the basic characteristics of all living organisms. (Lecture Outline IIIa)
5. Describe the cell theory. (Lecture Outline IIIa)
6. Use examples to describe how natural selection leads to the evolution of microbes. (Lecture Outline IIIa)
7. Describe the structure of the cell membrane (cytoplasmic membrane) according to the fluid mosaic model and explain the functions of this structure including transport mechanisms, taxis, and quorum sensing. (Lecture Outline IIIb and IIIc)
8. Identify and explain the functional significance of structures associated with eukaryotic cells. (Lecture Outline IIIb)
9. Explain the origins of mitochondria and chloroplasts according to the endosymbiosis theory and describe evidence supporting this theory. (Lecture Outline IIIb)
10. Identify and explain the functional significance of structures associated with prokaryotic cells. (Lecture Outline IIIc)
11. Define taxonomy; explain the classification system used in microbiology and the significance/application of binomial nomenclature. (Lecture Outline IV)
12. Name and explain the contributions made by individuals significantly influencing microbial taxonomy. (Lecture Outline IV)
13. Explain the significance of factors influencing microbial growth and used as criteria in the classification of microorganisms including: nutrition and metabolism, temperature and gas requirements, osmotic pressure and pH requirements, environmental relationships, and biochemical analysis. (Lecture Outline IV)
14. Describe the taxonomic relationships, important features, medical impact and environmental significance of selected prokaryotic organisms from Domains Archaea and Bacteria. (Lecture Outline V)
15. Describe the structure, function, and environmental significance of fungi. (Lecture Outline VI)
16. Describe three categories of mycoses, factors known to increase the incidence of human mycoses, and representative examples of pathogenic fungi. (Lecture Outline VI)
17. Describe the function, unique characteristics and environmental significance of microscopic algae with emphasis on eutrophication and its potential consequences. (Lecture Outline VII)
18. Describe the structure, function, unique features and medical significance of protozoa. (Lecture Outline VIII)
19. Explain why multicellular parasites are significant to microbiology, how helminthes are specialized for life inside a host and the advantages of being monoecious and having both definitive and intermediate hosts. (Lecture Outline IX)
20. Describe the life cycles and mode(s) of transmission for medically significant endoparasites. (Lecture Outline IX)
21. Explain the potential consequences of global climate change on parasite distribution and prevalence. (Lecture Outline IX)
22. Identify physical and chemical requirements for microbial growth and define terms associated with these requirements (e.g., phototroph, halophile, etc..). (Lecture Outline X)
23. Explain the significance of microbes in the major global biogeochemical cycles (e.g., the carbon and nitrogen cycles). (Lecture Outline Xa)

24. Explain the significance of human impact to global biogeochemical cycles and the resulting potential impact to microbial metabolism, prevalence and distribution. (Lecture Outline Xa)
25. Explain the significance of enzymes to living organisms. (Lecture Outline XIa)
26. Describe factors that influence enzyme activity. (Lecture Outline XIa)
27. Define phosphorylation and describe how ATP is made via substrate level, oxidative and photophosphorylation processes. (Lecture Outline XIa)
28. Identify and discuss the significance of major catabolic biochemical pathways used by microbes. (Lecture Outline XIb)
29. Identify and discuss the significance of major anabolic biochemical pathways used by microbes. (Lecture Outline XIc)
30. Describe the composition and function of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). (Lecture Outline XIIa)
31. Explain the process of semi-conservative DNA replication. Include discussion of the major enzymes involved in the process and how and where the process is initiated. (Lecture Outline XIIa)
32. Explain the process of transcription. Include discussion of the major enzymes involved in the process and how and where the process is initiated. (Lecture Outline XIIb)
33. Explain post-transcriptional modification and polycistronic transcription. (Lecture Outline XIIb)
34. Explain the process of translation. Include discussion of the structures involved and how and where the process is initiated. (Lecture Outline XIIb)
35. Given a DNA nucleotide sequence, transcribe and translate that sequence using the genetic code (on paper). (Lecture Outline XIIb)
36. Describe operons and their significance to genetic control in prokaryotes. (Lecture Outline XIIc)
37. Describe the lactose and tryptophan operons. (Lecture Outline XIIc)
38. Define mutation and describe the effects of mutations on proteins and the cells in which they are found. (Lecture Outline XIId)
39. Describe physical and chemical mutagenic agents and the types of mutations they cause. (Lecture Outline XIId)
40. Explain the relationship between mutation, natural selection and the development of antibiotic resistance in pathogenic bacteria. (Lecture Outline XIId)
41. Compare and contrast three different mechanisms of horizontal genetic exchange occurring in prokaryotes. (Lecture Outline XIIe)
42. Define recombinant DNA technology and explain the importance of mutations in its scientific application. (Lecture Outline XIIe)
43. Compare and contrast viruses, viroids and prions and the potential hazards of these non-cellular infectious agents. (Lecture Outline XIII)
44. Compare and contrast the structures and life cycles of lytic bacteriophage with temperate bacteriophage. (Lecture Outline XIII)
45. Describe the common structures and life cycles of animal viruses. (Lecture Outline XIII)
46. Describe the life cycle of the human immunodeficiency virus (HIV), and explain the potential consequences of infection with this virus. (Lecture Outline XIII)
47. Name and describe representative animal viruses known to cause human diseases and briefly describe the disease symptoms they cause. (Lecture Outline XIII)
48. Name and explain the mechanisms of action for representative antimicrobial agents. (Lecture Outline XIV)
49. Explain the relationships between zones of inhibition, minimal inhibitory concentrations, MIC breakpoints and therapeutic doses for antimicrobial agents. (Lecture Outline XIV)
50. Describe human innate immune response. (Lecture Outline XVa)
51. Describe the importance of normal flora to innate immune response and the potential consequences to human health when these organisms are disrupted. (Lecture Outline XVa)
52. Describe human acquired immune response. (Lecture Outline XVb)
53. Define immunization and vaccination. (Lecture Outline XVc)
54. Compare and contrast the composition, health benefits, and potential risks associated with the different types of vaccines. (Lecture Outline XVc)
55. Define epidemiology and explain methods employed by government agencies (e.g., the CDC) in the prevention of epidemics. (Lecture Outline XVI)
56. Explain the significance of endemic, sporadic, zoonotic, epidemic and pandemic diseases on human populations. (Lecture Outline XVI)
57. Describe mechanisms of pathogenicity common to human pathogens. Discussion may include, but is not limited to: portals of entry and exit, reservoirs of infection, adhesins, avoidance of immune mechanisms, enzyme production, types and actions of toxins produced. (Lecture Outline XVII)

Laboratory Objectives

1. Explain proper procedures and safety regulations relating to laboratory equipment, storage and discard of microbial cultures, including Bunsen burners, eye-wash stations, fire extinguishers, incubators, refrigerators and discard containers. (Lab Outline I)
2. Read and comply with proper laboratory procedures and safety regulations. (Lab Outline I)
3. Investigate the effectiveness of hand-washing using culture plates, various washing techniques/materials and student fingers; analyze the results and observe normal flora. (Lab Outline I)
4. Demonstrate proper transport and use of a compound light microscope including focus techniques, light adjustment, slide placement/positioning, application and removal of immersion oil, clean-up and return to cabinet. (Lab Outline II)
5. Calibrate the ocular micrometer using a stage micrometer and correctly determine the dimensions of specified microorganisms. (Lab Outline II)
6. Define culture medium and describe its basic constituents. (Lab Outline III)
7. Compare and contrast the different types of culture media. (Lab Outline III)
8. Make 100ml of culture medium using dry ingredients and deionized water. Use this to prepare agar plates and slants. (Lab Outline III)
9. Apply aseptic technique in a laboratory setting in order to prepare and maintain microbial cultures using a variety of culture media. (Lab Outline III-V)
10. Define pure culture and demonstrate pure culture technique by isolating individual types of bacteria from mixed cultures. (Lab Outline V)
11. Describe the cultural characteristics of bacterial colonies. (Lab Outline V)
12. Explain the significance of staining microorganisms. (Lab Outline VI)
13. Compare and contrast direct and indirect (negative) stains. Prepare a direct stain of cells taken from inside the mouth and identify the eukaryotic and prokaryotic cells present. (Lab Outline VI)
14. Prepare bacteria for microscopic examination using a variety of stain techniques including indirect, Gram, endospore, capsule, and acid-fast stains. Use a compound light microscope to identify cells and structures prepared using these stain techniques. (Lab Outline VI)
15. Identify the morphological features (cell and colony) of an unknown type of bacteria using stain techniques, microscopy and careful observation of colony morphology. (Lab Outline VI)
16. Prepare enrichments to grow microorganisms from air, soil and/or water. Use laboratory techniques to describe the morphological features of the organism(s) isolated. These techniques can include, but are not

limited to, staining, testing for motility, testing for growth in differential and/or selective media.(Lab Outline IV-VI)
17. Identify (visually using a compound microscope) microscopic preparations of representative cyanobacteria. List Genus name, taxonomic organization, and identify structures of each species observed. (Lab Outline VII)
18. Explain ecological significance of cyanobacteria and their impact on human health. (Lab Outline VII)
19. Identify (visually using a compound microscope) representative examples of microscopic fungi. List Genus name, taxonomic organization, and identify structures of each species observed. (Lab Outline VIII)
20. Identify fungal species recognized as opportunistic pathogens, true pathogens, and those responsible for mycotoxicosis. (Lab Outline VIII)
21. Explain the ecological significance of fungi and their impact on human health. (Lab Outline VIII)
22. Identify (visually using a compound microscope) representative examples of microscopic algae. List Genus name, taxonomic organization, and identify structures of each species observed. (Lab Outline IX)
23. Explain the ecological significance of algae and their impact on human health. (Lab Outline IX)
24. Identify (visually using a compound microscope) representative examples of protozoa. List Genus name, taxonomic organization, and identify structures of each species observed. (Lab Outline X)
25. Explain the ecological significance of protozoa and their impact on human health. (Lab Outline X)
26. Describe the life cycle of Plasmodium and its impact on worldwide human health. (Lab Outline X)
27. Identify (visually using a compound microscope) representative examples of endoparasites. List Genus name, taxonomic organization, and identify structures of each species observed. (Lab Outline XI)
28. Identify (visually using a compound microscope) representative examples of ectoparasites. List Genus name, taxonomic organization, and identify structures of each species observed. (Lab Outline XI)
29. Use a representative endoparasite (e.g., Shistosoma) as an example to describe the complex life cycle that exists for many parasites that cause chronic health conditions. (Lab Outline XI)
30. Identify parasite species that also act as vectors for microbial pathogens. (Lab Outline XI)
31. Distinguish between definitive and intermediate hosts. (Lab Outline XI)
32. Compare and contrast homofermentative and heterofermentative processes, their end products, and the microorganisms involved. (Lab Outline XII)
33. Explain the differences between fermented and cultured foods and prepare both types in the laboratory. (Lab Outline XII)
34. Name and explain the significance of representative food-borne pathogens. (Lab Outline XII)
35. Prepare serial dilutions of microbial cultures and calculate the degree of dilution as necessary to perform viable cell counts and/or to determine the number of plaque forming units present in a viral culture. (Lab Outline XIII and XXIV)
36. Compare and contrast selective and differential media. (Lab Outline XIV)
37. Perform replica plating technique using a collection of various bacteria on selective and differential media. Interpret data/results from the technique to determine physiological characteristics of the bacteria used. (Lab Outline XIV and XIVa)
38. Perform and interpret the results of several enzymatic tests used to determine the physiological characteristics of bacteria. (Lab Outline XV)
39. Apply a series of enzymatic testing to the identification of two different types of bacteria. Interpret the data obtained, and record the results. (Lab Outline XV)
40. Describe the polymerase chain reaction. (Lab Outline XVI)
41. Extract chromosomal DNA from bacterial cultures and amplify the genes encoding 16S ribosomal-RNA using the polymerase chain reaction (PCR). (Lab Outline XVI)
42. Describe the Sanger method of DNA sequencing. (Lab Outline XVII)
43. Using a computer with appropriate software (e.g., 4-Peaks, ChromasLite, or equivalent), evaluate, edit and combine the nucleotide sequence information contained in multiple electropherograms to form a contiguous sequences for the 16S r-RNA gene of an assigned bacterium. (Lab Outline XVII)
44. Using a computer with internet access and a web browser, access NCBI and apply the BLAST algorithm to compare specific nucleotide sequences with those available in public databases. Use this information to identify a specific type of microorganism, record its lineage and record closely-related forms as indicated in the phylogenetic tree available. (Lab Outline XVIII)
45. Define Genomics, Proteomics and Bioinformatics. (Lab Outline XVIII)
46. Compare and contrast the features of cloning and expression vectors. (Lab Outline XIX)
47. Extract plasmid DNA from live cultures of Escherichia coli using high speed centrifuges (microfuges), digital pipettes, and the appropriate chemicals. (Lab Outline XIX)
48. Prepare agarose gels and perform electrophoresis with samples of PCR product and plasmid DNA; interpret the data obtained and record the results. (Lab Outline XX)
49. Describe a DNA ladder and explain its purpose. (Lab Outline XX)
50. Describe the importance of recombinant DNA technology in modern biology and health care. (Lab Outline XVI-XXII)
51. Transform samples of Escherichia coli (using competent cells prepared by students or staff) with plasmid DNA and calculate the efficiency of transformation. (Lab Outline XXI)
52. Describe restriction endonucleases, how they are named and their function in recombinant DNA technology. (Lab Outline XXII)
53. On a computer equipped with word processing software and the text of a DNA sequence, determine the fragments that would result from digestion of the DNA with a particular restriction endonuclease. Use the results of this analysis to draw a picture of what it would look like if these fragments were subjected to gel electrophoresis. (Lab Outline XX and XXII)
54. Load samples of PCR product DNA digested with specific enzymes into electrophoresis gels and generate RFLP patterns; analyze these patterns and compare them to recorded samples to identify unknown types of bacteria. (Lab Outline XXII)
55. Identify strains of live Escherichia coli using a simple phage-typing method. (Lab Outline XXIII)
56. Define and explain the application of phage-typing. (Lab Outline XXIII)
57. Isolate a coliphage from an infected Escherichia coli culture using a wire needle. Determine the number of plaque forming units (PFU) isolated by performing a serial dilution. (Lab Outline XXIV)
58. Prepare or obtain plate cultures of Escherichia coli infected with coliphage, count the plaques present and use the data obtained to calculate the latent period and burst size (number) for the virus culture being tested. (Lab Outline XXV)
59. Define latent period and burst size. (Lab Outline XXV)
60. Describe microbial control methods (chemical and physical) used to control potentially pathogenic microorganisms outside the body. (Lab Outline XXVI)
61. Test the effectiveness of microbial control methods including but not limited to temperature, ultraviolet light, disinfectants and antiseptics on

representative bacteria under laboratory conditions; interpret the results of these tests. (Lab Outline XXVI)
62. Perform and interpret the results of antimicrobial sensitivity tests using the agar-diffusion method or Kirby-Bauer test, representative bacterial cultures and several different types of antimicrobial drugs. (Lab Outline XXVII)
63. Perform and interpret the results of laboratory techniques used in diagnostic immunology and/or epidemiology. This may include, but is not limited to precipitation (Ouchterlony test), lateral flow immunochromatographic assay (Rapid Strep test), and ELISA. (Lab Outline XXVIII)
64. Initiate and complete a semester-long project involving both research and hands-on laboratory activity with the purpose of identifying an organism from an environment of the student's choice. Use peer-reviewed literature to formulate a hypothesis. Test hypothesis using methods learned in the laboratory. Prepare a written report following the format of articles published in the Journal of Bacteriology and submit this report for inclusion in the Sierra College Journal of Microbiology. (Lab Outline I-V and XIV-XVIII)

General Education Information

- Approved College Associate Degree GE Applicability
  - AA/AS - Life Sciences
  - AS - Life Science Lab
- CSU GE Applicability (Recommended-requires CSU approval)
  - CSUGE - B2 Life Science
  - CSUGE - B3 Lab Activity
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)
  - IGETC - 5B Biological Science
  - IGETC - 5C Laboratory Science

Articulation Information

- CSU Transferable
- UC Transferable

Methods of Evaluation

- Essay Examinations
  - Example: Would a cloning vector still be useful if it was missing a marker gene? Explain your answer. Students will be graded on the accuracy of their answers. Rubric grading. Objective Examination: a) The mitochondrion is found in which type(s) of cell? b) What is the function of this organelle? Students will be graded on the accuracy of their answers.
- Projects
  - Example: Microbiology Term Project: Working in small groups, students will use the length of the term to complete a project involving both library-based research and hands-on laboratory activity. At the end of the project, the students will collaborate to complete a written report summarizing what was found. This report will include the following: Title, Abstract, Introduction, Materials and Methods, Data and Results, Discussion, and Literature Cited. The written portion must be typed and must include appropriate notations for information quoted from outside sources using CSE format. Successful completion of this project will require that students collaborate to create a plan for completion of the project, perform the required study, analyze their data, and draw reasonable conclusions. Student grades will include an instructor-derived score of their written report (based on the completion of all required elements and the logic of the conclusions) and a composite score of evaluations from their group peers. Instructors may also choose to include small assessments of steps made along the way in completion of the final report (i.e. a rough draft). Rubric grading. An example topic of investigation: Isolate an organism from an environment of the students' choosing (i.e. the body, soil, a cultured food product). Use morphological characteristics, physiological characteristics, and/or genetic analysis to identify the organism that was isolated.
- Reports
  - Example: Use the DNA sequence to determine the most-likely identity of the unknown organism by searching the database at NCBI with BLAST. Complete a written report on your findings that includes the following: the name of the database searched, the number of sequences and nucleotides compared, the Genus, specific epithet, taxonomic lineage, nucleotide length, and accession number of the closest matching organism(s) in the database, and the details of the match (score in bits, ratio of identical matching nucleotides, and percent identity). In addition, using the information found in the taxonomic lineage, include the names of 3 closely related species. Finally, include a detailed defense of the rationale you used to determine the most likely identity of the unknown organism.
- Skill Demonstrations
  - Example: Using any of the procedures that were learned in the lab, determine the cell shape and arrangement of the organism given. Students will be graded on the accuracy of their answers.

Repeatable

No

Methods of Instruction

- Laboratory
- Lecture/Discussion
- Distance Learning

Lab:

1. Teaching methodology: Students are broken into groups of three and given a stage micrometer. The instructor demonstrates the basic calibration procedure using an artificial view of the stage micrometer projected on a screen while the students follow along in groups on actual microscopes. This process is used to walk the class through the calibration of one objective lens and then students are asked to continue the process as a group for the other objective lenses. At this point, the instructor is free to move about the room and provide individual help to groups/students that need it.

Lecture:

1. Following discussion of the topic, the instructor demonstrates the phenomenon using students in the class as a population of bacteria. The instructor first identifies one or two students ("bacteria") as individuals with mutations that allow those individuals to survive in the presence of an antibiotic. The instructor has the students all stand up. The instructor explains that the environment that they have been living in has changed and now includes an antibiotic, and instructs the susceptible "bacteria" to "die" (sit down). The instructor then facilitates a discussion in which the students are asked questions regarding the nature of the remaining population

versus the original population. For example: What is the genetic nature of the remaining population (those that are standing)? If this room represented the only remaining individuals of this species, is the species the same or different from the population that existed before the environmental change? How would the outcome be different if the population did not contain any mutants? Based on this demonstration, explain how a person can "suddenly" develop antibiotic resistant bacteria on their body?

Distance Learning

1. Teaching methodology: On the LMS, the instructor will include a video describing the background for the topic and a demonstration of how to use the materials in the at-home lab kit to sample an environment of their choice and then perform the streak plate technique to obtain a pure culture. Students will start by sampling an environment of their choice, following the instructions presented in the video. Once the organisms from this environment have grown, the students will share an image of their petri plate with other students on the LMS Discussion board. Students will have a chance to comment on each other's work and help each other decide which organism from their mixed culture should be isolated in pure culture. Each student then performs the streak plate method to isolate one organism from their plate onto a new petri plate. Once these new cultures have grown, the students will submit an image of their petri plate to an assignment in the LMS. This allows the instructor to give individual feedback to each student on their technique, but also makes sure that students do not proceed with a new attempt until they have received this feedback. This is important in the at-home environment, as student lab supplies are limited. This assignment is repeated until the student masters the technique, with the instructor giving feedback on each attempt.

Typical Out of Class Assignments Reading Assignments

Example 1 Read Chapter 2 - "The Chemistry of Microbiology" in preparation for the lecture on Biochemistry. Complete the Chapter 2 Practice Quiz located in the Study Guide. Check answers with those located at the back of the Study Guide. Example 2 Read exercises 1-2 in the Laboratory Manual and answer the questions at the end of each exercise in preparation for laboratory quiz 1. Check answers with those found at the back of the Laboratory Manual.

Writing, Problem Solving or Performance

Example 1 Having obtained a culture containing organisms of a specific type, each student will be expected to determine and record the following: 1. The cell size expressed in micrometers (both width and length for bacilli or spirilla). 2. The cell shape - rods (bacilli), cocci, spirilla or other. 3. The cell arrangement - diplo, strepto, staphylo, tetrads, sarcinae, etc.. 4. Gram stain quality (Gram-positive or Gram-negative); check with a KOH test. 5. Whether or not the organisms in the culture are acid-fast. 6. The presence and appearance of special structures such as capsules or endospores. If endospores are present, record their shape (ellipsoidal or spherical), location (central or terminal) and whether or not the sporangium is swollen. 7. Whether or not the organisms are motile. 8. The colony morphology as recorded from a properly-streaked plate. Cultural characteristics of colonies include form (shape), margin (edge), elevation (height), surface texture, optical character (light transfer or refraction), pigmentation (color in colonies or in the medium), size (in mm) and any other distinguishing characteristics noted. Please specify the type of medium used. In addition to the above information, each student will be required to include an illustrated record of cell morphology as determined during the observation of stained preparations. Illustrations must be in color and must accurately indicate the size, shape and arrangement of the cells as magnified 5000X. At the completion of this exercise, each student will be required to submit the following: 1. A one-page written documentation of the morphological characteristics as indicated above. 2. A one-page color illustration indicating the morphological characteristics of the culture as determined with a Gram-stain, an indirect stain, an acid-fast stain, and endospore stain (malachite green method), and a capsule stain. 3. One properly-streaked plate of agar medium (appropriately labeled), containing a pure culture with well-isolated colonies. Example 2 When students have completed the identification of physiological unknown #1, they will be expected to turn in a written description of cell and colony morphology for both organism types present, as obtained from stained smears and the colonies growing on selective and differential media plates (be sure to specify which types of media were used in each case); a written report giving the technical names of both cultures present (genus and specific epithet); and an explanation of the tests used in the identification of these organisms. This explanation must include the name of each test used, what each test is designed to show (i.e., what is being tested for), how the test works (e.g., reagents used, color changes in specific pH indicators, presence of black precipitate, etc.), descriptions or pictures of the data (e.g., tubes, slides, plates etc.); and the results, i.e., the interpretation of the data collected. Although illustrations of the data are not required, they are highly recommended as they will increase understanding and can serve as an excellent study guide.

Other (Term projects, research papers, portfolios, etc.)

Microbiology Term Project: Working in small groups, students will use the length of the term to complete a project involving both library-based research and hands-on laboratory activity. At the end of the project, the students will collaborate to complete a written report summarizing what was found. This report will include the following: Title, Abstract, Introduction, Materials and Methods, Data and Results, Discussion, and Literature Cited. The written portion must be typed and must include appropriate notations for information quoted from outside sources using CSE format. Successful completion of this project will require that students collaborate to create a plan for completion of the project, perform the required study, analyze their data, and draw reasonable conclusions. Student grades will include an instructor-derived score of their written report (based on the completion of all required elements and the logic of the conclusions) and a composite score of evaluations from their group peers. Instructors may also choose to include small assessments of steps made along the way in completion of the final report (i.e. a rough draft). An example topic of investigation: Isolate an organism from an environment of the students' choosing (i.e. the body, soil, a cultured food product). Use morphological characteristics, physiological characteristics, and/or genetic analysis to identify the organism that was isolated.

Required Materials

- Microbiology an Introduction
  - Author: Tortora, Funke, Case, Weber and Bair
  - Publisher: Pearson
  - Publication Date: 2019
  - Text Edition: 13th
  - Classic Textbook?:

    - OER Link:
    - OER:
- Microbiology with Diseases by Taxonomy
    - Author: Robert W. Bauman
    - Publisher: Pearson
    - Publication Date: 2020
    - Text Edition: 6th
    - Classic Textbook?:
    - OER Link:
    - OER:

Other materials and-or supplies required of students that contribute to the cost of the course.

Microbiology Laboratory Manual: Bio. Sci. 4 & 8A/8B (course pack) Study Guide: Biological Sciences 4 - Microbiology (course pack)