ILLINOIS VALLEY COMMUNITY COLLEGE

COURSE OUTLINE

DIVISION: Natural Science and Business (NSB)

COURSE: BIO 1009 Microbiology

Effective Date: Summer 2025

Submitted Date: Mar-25

Credit Hours: 4 **IAI Number (if applicable): None**

Complete all that apply or mark "None" where appropriate:

Prerequisite(s): None

Enrollment by assessment or other measure? ☐Yes ☒No

If yes, please describe:

Corequisite(s): None

Pre- or Corequisite(s): None

Consent of Instructor: ☐Yes ☒No

Delivery Method:	☒**Lecture**	**2 Contact Hours** (1 contact = 1 credit hour)
	☒**Seminar**	**1 Contact Hours** (1 contact = 1 credit hour)
	☒**Lab**	**3 Contact Hours** (2-3 contact = 1 credit hour)
	☐**Clinical**	**0 Contact Hours** (3 contact = 1 credit hour)
	☐**Practicum**	**0 Contact Hours** (5 contact = 1 credit hour)
	☐**Internship**	**0 Contact Hours** (5 contact = 1 credit hour)

Offered: ☒**Fall** ☒**Spring** ☒**Summer**

CATALOG DESCRIPTION:
An introductory study of the nature and activities of microorganisms and their effect on human affairs. Topics will include functional anatomy of prokaryotic and eukaryotic cells, microbial metabolism, microbial growth, control of microbial growth, survey of the microbial world and microorganisms and disease.
IAI Number (if applicable): None

ACCREDITATION STATEMENTS AND COURSE NOTES:
None

COURSE TOPICS AND CONTENT REQUIREMENTS:

I. The Main Themes of Microbiology
II. The Chemistry of Biology
III. Tools of the Microbiology Laboratory
IV. Functional Anatomy of Bacterial and Archaeal Cells
V. Functional Anatomy of Eukaryotic Cells and Microorganisms
VI. Viruses and Prions
VII. Microbial Nutrition and Growth
VIII. Microbial Metabolism
IX. Microbial Genetics
X. Genetic Analysis and Genetic Engineering
XI. Physical and Chemical Control of Microbes
XII. Antimicrobial Treatment
XIII. Microbe-Human Interactions
XIV. Host Defenses

INSTRUCTIONAL METHODS:

- Lecture - open to question-and-answer dialogue, and discussion.
- Laboratory experiences, both in-person and virtual.
- Visual aids - PowerPoint presentations, videos.
- Online Resources-Course Management System, Online Textbook, Websites, Podcasts.
- Assignments, quizzes, tests, and practicals, online and in lecture and lab.
- In-class assessment software such as Kahoot!
- Supplemental reading - college library and internet

EVALUATION OF STUDENT ACHIEVEMENT:

1. Textbook reading – assignments and SmartBook assignments.
2. Supplemental readings – library or internet.
3. Participation in class discussion.
4. Performing assigned lab exercises.
5. Identification of a bacterial unknowns.
6. Laboratory reports, quizzes, virtual labs, and practical's.
7. Lecture in-class assessments (Kahoot's), quizzes, and 4 major lecture exams.
8. Small cumulative final.
9. Writing assignment on course topics.

INSTRUCTIONAL MATERIALS:

Textbooks

Microbiology: A Systems Approach, Cowan and Smith, McGraw Hill (newest edition)

Resources

1. Lecture PowerPoints, videos, and SmartBook assignments.
2. Laboratory PowerPoints, handouts, and virtual labs.
3. Instructional videos, both made by the instructor and videos produced by the book, and other internet resources.
4. Online Classroom Management.
5. Laboratory Equipment and Supplies-Biology Laboratory.

LEARNING OUTCOMES AND GOALS:

Institutional Learning Outcomes

☐1) Communication – to communicate effectively.

☒2) Inquiry – to apply critical, logical, creative, aesthetic, or quantitative analytical reasoning to formulate a judgement or conclusion.

☐3) Social Consciousness – to understand what it means to be a socially conscious person, locally and globally.

☐4) Responsibility – to recognize how personal choices affect self and society.

Course Outcomes and Competencies

Lecture

1. Define microbiology, identify the major groups of microbes, understand the theory of evolution, the process of science, and classification.

- 1.1 List the six types of microorganisms.
- 1.2 Identify multiple professions using microbiology.
- 1.3 Describe the role and impact of microbes on the earth.
- 1.4 Explain the theory of evolution.
- 1.5 Explain ways that humans manipulate organisms for their own uses.
- 1.6 Summarize the burden of human disease caused by microbes.
- 1.7 Be able to summarize the history of microbiology.
- 1.8 Explain what is important about the scientific method.
- 1.9 Differentiate among the terms nomenclature, taxonomy, and classification.
- 1.10 List the taxonomic categories.
- 1.11 Be able to correctly write the binomial name for a microorganism.
- 1.12 Describe the three major domains of life.

2. Be able to describe the essential chemistry of the cell.

2.1 Explain the relationship between atoms and elements.
2.2 List and define four types of chemical bonds.
2.3 Differentiate between a solute and a solvent.
2.4 Provide a brief definition of pH.
2.5 Name the four main families of biochemicals.
2.6 Provide examples of cell components made from each of the families of biochemicals.
2.7 Differentiate among primary, secondary, tertiary, and quaternary levels of protein structure.
2.8 List the three components of nucleotides.
2.9 Name the nitrogen bases of DNA and of RNA.
2.10 List the three components of ATP.
2.11 Recall three characteristics common to all cells.

3. Chapter 3 is covered in the Laboratory section.

4. Be able to describe the structure and function of the parts of a bacterial or archaeal cell.

4.1 List the structures all bacteria possess.
4.2 Identify at least four structures that some, but not all, bacteria possess.
4.3 Describe the three major shapes of bacteria.
4.4 Describe other more unusual shapes of bacteria.
4.5 Provide at least four terms to describe bacterial arrangements.
4.6 Describe the structure and function of six different types of bacterial external structures.
4.7 Explain how a flagellum works in the presence of attractant.
4.8 Explain the structure of the glycocalyx, and the function of the slime layer and envelope.
4.9 Explain the structure of the gram-positive cell walls and gram-negative cell walls.
4.10 Describe the structure of atypical bacterial cell walls.
4.11 Identify common structures that may be contained in bacterial cytoplasm.
4.12 Detail the structure and function of endospores, and the causes and mechanisms of sporulation and germination.
4.13 List some differences between archaea and bacteria.
4.14 List some properties and examples of members of the archaeal domain.
4.15 Define a species in terms of bacteria.

5. Describe the endosymbiotic theory, the structure and function of eukaryotic cells, and types of eukaryotic microbes.

- 5.1 Relate bacterial archaeal, and eukaryotic cells to the last common ancestor.
- 5.2 Be able to describe the endosymbiotic theory.
- 5.3 List the types of eukaryotic organisms and denote which are unicellular and which are multicellular.
- 5.4 Describe the external and boundary structures of eukaryotic cells including flagella, cilia, glycocalyces, cell walls, and cell membranes.
- 5.5 Describe the main structural components of a nucleus.
- 5.6 Diagram how the nucleus, endoplasmic reticulum, and Golgi apparatus act together with vesicles during the transport process.
- 5.7 Explain the function of the mitochondrion and chloroplast.
- 5.8 Explain the importance of ribosomes and differentiate between eukaryotic and bacterial types.
- 5.9 List and describe the three main fibers of the cytoskeleton.
- 5.10 List the general features of fungal anatomy.
- 5.11 Differentiate among the terms heterotroph, saprobe, and parasite.
- 5.12 List detrimental and beneficial activities of fungi.
- 5.13 List the general characteristics of protozoa.
- 5.14 List three means of locomotion exhibited by protozoa.
- 5.15 Explain why a cyst stage may be useful in a protozoan.
- 5.16 Given an example of a human disease caused by each of the four types of protozoa.
- 5.17 List the major groups of helminths.
- 5.18 Summarize the stages of a typical helminth life cycle.

6. Explain the nature of viruses and how they reproduce.

- 6.1 Explain the history of viruses and their discovery.
- 6.2 Explain the position of viruses in the biological spectrum.
- 6.3 List characteristics of viruses that distinguish them from cellular life.
- 6.4 Discuss the size of viruses relative to other organisms.
- 6.5 Describe the function and structure of viral capsids.
- 6.6 Distinguish between enveloped and naked viruses.
- 6.7 Explain the importance of viral surface proteins, or spikes.
- 6.8 Explain the possible nucleic acid configurations exhibited by viruses.
- 6.9 Demonstrate how viruses are classified and named.
- 6.10 Diagram the multiplication cycle of animal viruses.
- 6.11 Define the term cytopathic effect and provide examples.
- 6.12 Provide examples of persistent and transforming infections, describing their effects on the host.

6.13 Provide a thorough description of lysogenic and lytic bacteriophage infections.
6.14 List the principal purpose for cultivating viruses.
6.15 Describe the ways in which viruses are cultivated.
6.16 Analyze the relative importance of viruses in human infection and disease.
6.17 Discuss the primary reason that antiviral drugs are more difficult to design than antibacterial drugs.
6.18 Describe prions, satellite viruses, and viroids.

7. Describe the general nutritional requirements of microbes, the environmental impact on microbial growth, the microbial growth curve, and the methods in which we measure microbial growth.

7.1 List the essential nutrients of a bacterial cell.
7.2 Differentiate between macronutrients and micronutrients.
7.3 List and define four different terms that describe an organism's sources of carbon and energy.
7.4 Define saprobe and parasite and explain why these terms can be an oversimplification.
7.5 Compare and contrast the process of diffusion and osmosis.
7.6 Identify the effects of isotonic, hypotonic, and hypertonic conditions on a cell.
7.7 Name two types of passive transport and three types of active transport.
7.8 List and define five terms used to express the temperature-related growth capabilities of microbes.
7.9 Summarize the ways in which microorganisms function in the presence of oxygen.
7.10 Identify other physical factors that microbes must contend with in the environment.
7.11 List and describe the five major types of microbial association.
7.12 Discuss characteristics of biofilms that differentiate them from planktonic bacteria and their infections.
7.13 Summarize the steps of binary fission.
7.14 Define doubling time and describe how it leads to exponential growth.
7.15 Compare and contrast the four phases of growth in a bacterial growth curve.
7.16 Describe culture-based and non-culture-based methods for analyzing bacterial growth.

8. Describe the method in which microbes metabolizes, including enzymes, aerobic respiration, anaerobic respiration, fermentation, amphibolic reactions, and photosynthesis.

- 8.1 Describe the relationship among metabolism, catabolism, and anabolism.
- 8.2 Fully discuss the structure and function of enzymes.
- 8.3 Differentiate between an apoenzyme and a holoenzyme.
- 8.4 Differentiate between and endoenzyme and an exoenzyme, and between constitutive and regulated enzymes.
- 8.5 Name the chemical in which energy is stored in cells.
- 8.6 Create a general diagram of a redox reaction.
- 8.7 Identify electron carriers used by cells.
- 8.8 Summarize glycolysis.
- 8.9 Describe the Krebs cycle.
- 8.10 Discuss the significance of the electron transport system.
- 8.11 State ways in which anaerobic respiration differs from aerobic respiration.
- 8.12 Summarize the steps of microbial fermentation, and list useful products it can create.
- 8.13 Describe how noncarbohydrate compounds are catabolized.
- 8.14 Proved an overview of the anabolic stages of metabolism.
- 8.15 Define amphibolism.
- 8.16 Summarize the overall process of photosynthesis.
- 8.17 Discuss the relationship between light-dependent and light-independent reactions.
- 8.18 Explain the role of the Calvin cycle in the process of photosynthesis.

9. Explain the genetic mechanisms microbes use to replicate, transcribe, translate, perform horizontal gene transfer, and the effects mutations have on microbes.

- 9.1 Define the terms genome and gene.
- 9.2 Differentiate between genotype and phenotype.
- 9.3 Diagram a segment of DNA, labeling all important chemical groups within the molecule.
- 9.4 Summarize the steps of bacterial DNA replication and the enzymes used in this process.
- 9.5 Compare and contrast the synthesis of leading and lagging strands during DNA replication.
- 9.6 Explain the classical view of the “central dogma” has been changed by recent science.
- 9.7 Identify important structural and functional differences between the RNA and DNA.

9.8 Illustrate the steps of transcription, noting the key elements and the outcome of mRNA synthesis.
9.9 List the three types of RNA directly involved in translation.
9.10 Define the terms codon and anticodon and list the four known start and stop codons.
9.11 Identify the locations of the promoter, the start codon, and the A and P sites during translation.
9.12 Indicate how eukaryotic transcription and translation differ from these processes in bacteria and archaea.
9.13 Explain the relationship between genomics and proteomics.
9.14 Define the term operon and explain one advantage it provides to a bacterial cell.
9.15 Differentiate between repressible and inducible operons and provide an example of each.
9.16 Explain the defining characteristics of a recombinant organism.
9.17 Describe three forms of horizontal gene transfer used in bacteria.
9.18 Define the term mutation and discuss one positive and one negative example of it in microorganisms.
9.19 Differentiate among frameshift, nonsense, silent, and missense mutations.

10. Describe ways microbes are used in biotechnology, and other bioengineering applications.

10.1 Provide examples of practical applications of modern genetic technologies.
10.2 Explain the role of restriction endonucleases in the process of genetic engineering.
10.3 Describe how gel electrophoresis is used to analyze DNA.
10.4 List the steps in the polymerase chain reaction.
10.5 Describe how recombinant DNA is created and provide several examples of recombinant products have contributed to human health.
10.6 Describe gene therapy.
10.7 Outline in general terms the process of DNA sequencing.
10.8 Describe the utility of microarray technology.

11. Describe how microbial growth can be controlled both with physical and chemical methods.

11.1 Distinguish among the terms sterilization, disinfection, antisepsis, and decontamination.
11.2 Identify the types of microorganisms that are most resistant to and least resistant to control measures.
11.3 Compare the action of microbicidal and microbistatic agents.

11.4 Name four categories of cellular targets for physical and chemical agents.
11.5 Name methods of physical control of microorganisms.
11.6 Compare and contrast moist and dry heat methods of control and identify multiple examples of each.
11.7 Define thermal death time and thermal death point and describe their role in proper sterilization.
11.8 Be able to give examples of moist and dry heat control.
11.9 Describe using cold treatment and desiccation to control microbial growth.
11.10 Differentiate between the two types of radiation control methods, providing an application of each.
11.11 Outline the process of filtration and describe its advantages in microbial control.
11.12 Identify some common uses of osmotic pressure as a control method.
11.13 Name the desirable characteristics of chemical control agents.
11.14 Discuss several different halogen agents and their uses in microbial control.
11.15 List advantages and disadvantages to the use of phenolic compounds as control agents.
11.16 Pinpoint the appropriate applications of oxidizing agents.
11.17 Define the term surfactant and explain this antimicrobial's mode of action.
11.18 Identify examples of some heavy metal control agents and their most common applications.
11.19 Discuss the advantages and disadvantages of aldehyde agents in microbial control.
11.20 Identify applications for ethylene oxide sterilization.

12. Describe antimicrobial treatment, and the risk we face from antibiotic resistance.

12.1 State the main goal of antimicrobial treatment.
12.2 Identify sources of the most used antimicrobial drugs.
12.3 Summarize two methods for testing antimicrobial susceptibility.
12.4 Define therapeutic index and identify whether a high or low index is preferable in a drug.
12.5 Explain the concept of selective toxicity.
12.6 Describe the major targets of current antimicrobial agents, and list major drugs associated with each.
12.7 Distinguish between broad-spectrum and narrow-spectrum antimicrobials.
12.8 Trace the history of the development of antimicrobial agents.

12.9 Describe the action of beta-lactamases.
12.10 Identify antibiotics that target the cell wall.
12.11 Identify the targets of antibiotics that inhibit protein synthesis.
12.12 Identify the cellular target of quinolones.
12.13 Name some drugs that target the microbial cellular membrane.
12.14 List some antiprotozoal and anthelminthic drugs used today.
12.15 Describe major modes of action of antiviral drugs.
12.16 Discuss two possible ways that microbes acquire antimicrobial resistance.
12.17 List five cellular or structural mechanisms that microbes use to resist antimicrobials.
12.18 Discuss novel antimicrobial strategies that are under investigation.

13. Define terms involved with disease cause by microbes, describe pathogen interactions with the body, and explain what epidemiology means.

13.1 Differentiate among the terms colonization, infection, and disease.
13.2 Identify the sites where normal biota is found in humans.
13.3 Discuss how the Human Microbiome our understanding of normal biota.
13.4 Explain some of the variables that influence whether a microbe will cause disease in a particular host.
13.5 Differentiate between a microbe's pathogenicity and its virulence.
13.6 List the steps a microbe must take to get to the point where it can cause disease.
13.7 List several portals of entry and exit.
13.8 Define infectious dose and explain its role in establishing infection.
13.9 Describe ways microbes can use exoenzymes to cause tissue damage.
13.10 Compare and contrast major characteristics of exotoxins and endotoxins.
13.11 Explain other virulence factors such as epigenetic changes and superantigens.
13.12 Draw and label a curve representing the course of clinical infection.
13.13 Summarize the goals of epidemiology and the role of the CDC.
13.14 Differentiate among the various types of reservoirs of disease.
13.15 List different modes of horizontal transmission.
13.16 Define health-associated infection.
13.17 List Koch's postulates and explain alternative methods for identifying an etiologic agent.
13.18 Define incidence, prevalence, mortality rate, and what a notifiable disease is.
13.19 Discuss the three major types of epidemics, and what a pandemic is.
13.20 List examples of emerging and reemerging infectious diseases.

14. Describe the immune system as a whole and explain how the innate immune system works.

14.1 Summarize the three lines of host defense.
14.2 Describe the structure and function of the lymphatic system.
14.3 Connect the mononuclear phagocyte system to innate immunity.
14.4 Describe how and where T and B lymphocytes mature.
14.5 Summarize the importance of cytokines.
14.6 Identify the major components of the first line of defense of the immune system.
14.7 Describe two examples of how the normal microbiota contribute to the first line of defense.
14.8 List the major categories of nonspecific (innate) immunity.
14.9 Outline the steps of inflammation.
14.10 Discuss the mechanism of fever and how it helps defend the body.
14.11 Name the types of antimicrobial host-derived products.
14.12 Describe the complement system.

15. Describe the adaptive immune system, and describe how vaccines work.

15.1 Compare and contrast the third line of defense to the first and second.
15.2 Define the role of the major histocompatibility complex.
15.3 Compare and contrast the process of antigen recognition in T cells and B cells.
15.4 Outline the processes of clonal deletion and clonal selection.
15.5 Compare the terms antigen, immunogen, and epitope.
15.6 Summarize the process of B and T-cell activation.
15.7 Describe the main functions of the major T-cell types.
15.8 List the five types of antibodies and important characteristics of each.
15.9 Describe the role of memory in adaptive immunity.
15.10 List the four categories of acquired immunity and provide examples of each.
15.11 Discuss the qualities of an effective vaccine.
15.12 List several types of vaccines and discuss how they are utilized today.
15.13 Explain the principle of herd immunity.

Laboratory

16.1 Learn how to use the compound light microscope.
16.2 Utilize microscope components to achieve a good image. Including: light source, eye pieces, coarse and fine focus knobs, stage adjustment knobs, nosepiece with objective lenses (4X, 10X, 40X).
16.3 Identify factors affected by lighting while using the microscope.
16.4 Identify how the coarse and fine focus knobs on a microscope work.

16.5 Recognize proper usage of the fine and coarse focus knobs with different objective lenses.
16.6 Calculate total magnification.
16.7 Recognize how objective lenses correlate to field of view and ability to focus.
16.8 Perform proper steps to focus a microscope using the 100X objective lens.
16.9 Perform proper steps to remove oil from 100X objective after use.
16.10 Recognize proper usage of lens oil. (Phase 1 pop-up question).
16.11 Perform a wet mount of pond water.

17. Master the techniques of aseptic technique.

17.1 Recall the definition of aseptic technique.
17.2 Explain the importance and implications of aseptic technique in experiments.
17.3 Discuss what is meant by the term bacterial culture.
17.4 Discuss what microbiology equipment is necessary to perform an aseptic transfer between growth medias.
17.5 Order the steps of bacterial culturing.
17.6 Practice the correct steps of aseptic transfer of a bacterial broth culture to an agar plate.
17.7 Evaluate the success of a bacterial transfer between growth media.
17.8 Understand the roles of heat for sterilization during aseptic transfer.
17.9 Recall safe and correct plate labeling.
17.10 Practice the correct steps of aseptic transfer of a bacterial agar slant to another agar slant.
17.11 Practice the steps of aseptic transfer of a bacterial broth culture to a new, sterile broth tube.
17.12 Demonstrate proper hand washing procedure.
17.13 Recognize importance of proper hand washing.

18. Be able to prepare smears and perform common microbial stains.

18.1 Recall the rationale and background of why smear preps are done.
18.2 Identify common microbiology laboratory equipment.
18.3 Practice the preparation of smear samples from bacteria grown in liquid media and agar plates.
18.4 Interpret the role of heat fixation.
18.5 Sequence the steps of smear preparation.
18.6 Apply how correct smear preparation affects microscopic outcomes.
18.7 Recall the basics of acid-fast cell wall composition.
18.8 Practice the technique of acid-fast staining.
18.9 Sequence the steps of acid-fast staining.

18.10 Recall the basics of bacterial cell and bacterial capsule composition.
18.11 Describe and interpret negative (background) staining.
18.12 Practice the technique of capsule staining.
18.13 Sequence the steps of capsule staining.
18.14 Recall the basics of bacterial cell wall composition.
18.15 Contrast the differences of simple versus differential staining.
18.16 Practice the technique of Gram staining.
18.17 Sequence the steps of Gram staining.
18.18 Apply how correct Gram staining techniques affect microscopic outcomes.
18.19 Predict how correct staining identification can assist in antibiotic therapy selection.
18.20 Recall the basics of bacterial cell and bacterial spore composition.
18.21 Contrast the differences of simple versus differential staining.
18.22 Practice the technique of spore staining.
18.23 Sequence the steps of spore staining.

19. Perform environmental sampling for microbes and understand the concept of the ubiquity microbes.

19.1 Define ubiquity and understand its importance to microbiology.
19.2 Recognize that bacteria are found in different amounts in different environments.
19.3 Define sterile.
19.4 Connect the importance of proper aseptic techniques to sterile environments.
19.5 List factors and conditions impacting microbial growth.
19.6 Investigate the amount of microbial life from different environmental samples.
19.7 Practice techniques used for sampling of surfaces and microbial growth
19.8 Compare microbial growth amounts before and after disinfection or handwashing.

20. Be able to isolate and quantify microbes.

20.1 Calculate a number of bacteria from a dilution method.
20.2 Predict how a dilution will change numbers of bacteria in the sample.
20.3 Recall that isolation methodology helps to select or identify a specific organism from a mixture.
20.4 Order the steps in a pour plate isolation.
20.5 Recognize the difference between surface and subsurface colonies.
20.6 Understand the use of liquid agar in a pour plate technique.
20.7 Define colony and colony forming unit (CFU).

20.8 Practice separating organisms using the pour plate technique.
20.9 Explain the need for dilution techniques to accurately estimate bacteria in a sample.
20.10 Observe how a quadrant streak reduces a number of bacteria as a dilution method.
20.11 Order the steps in a quadrant streak.
20.12 Explain why returning into a previous dilution is an error in the quadrant streak method.
20.13 Practice separating organisms using the quadrant streak technique.
20.14 Observe how subculturing of bacteria is used for both isolation and dilution.
20.15 Order the steps in a subculture.
20.16 Explain why growth and subculture are necessary microbiological techniques.
20.17 Recall that colony counting directly enumerates organism amounts.
20.18 Apply how a colony count and dilution can be used to mathematically estimate numbers of bacteria in the original culture.
20.19 Consider the impact of plating a volume of less than 1.0mL to require a correction factor for accurate estimates.
20.20 Explain why not every plate grown is usable in a colony count.
20.21 Practice counting organisms using the colony count technique.

21. Learn how to culture microbes and what factors impact their growth.

21.1 Explain the different categories of microbes based on their temperature requirements.
21.2 Demonstrate the effect of temperature on microbial growth.
21.3 Be able to determine thermal death point and thermal death time experimentally.
21.4 Explain the different categories of microbes based on their oxygen requirements.
21.5 Test the oxygen requirements for microbes using fluid thioglycolate medium.
21.6 Test the oxygen requirements for microbes using anaerobic jars and candle jars.

22. Be able to test disinfectants, antiseptics, and antibiotics effects on microbial growth.

22.1 Recall what antibiotics are.
22.2 Understand the effects antibiotics can have on the growth of microbes including, sensitive, intermediate, and resistant.
22.3 Understand the difference between broad and narrow-spectrum antibiotics.

22.4 Know how to use the Kirby-Bauer test to determine the effectiveness of antibiotics.
22.5 Know the difference between disinfectants and antibiotics.
22.6 Be able to use the filter paper disk method to evaluate the effectiveness of an antimicrobial chemical.
22.7 Define zone of inhibition.

23. Know common biochemical tests used to identify microbes.

23.1 Understand the clinical importance of identifying unknown microbes, both clinically and scientifically.
23.2 Understand the various methods of identifying unknown microbes, including genetic, immunologic, and phenotypic.
23.3 Understand the various methods of phenotypic testing, such as morphological, cultural, and biochemical means.
23.4 Understand and perform various biochemical tests to identify unknown gram-negative bacteria.
23.5 Understand and perform various biochemical tests to identify unknown.

24. Use laboratory techniques to alter the genetics of a microbes, and methods used to genetically identify microbes.

24.1 Understand what a transformation is and perform an artificial transformation using a plasmid containing the GFP gene.
24.2 Understand what a plasmid is and the genes on the plasmid used for transforming Escherichia coli.
24.3 Understand the heat shock method and how it is used to make E. coli competent.
24.4 Explain how the selective media is used to grow transformed colonies.
24.5 Explain how the arabinose operon is used to control the expression of GFP.