BIOLOGY 5100: Microbiology in Health and Disease
Department of Biological Sciences: Fall 2022 – Summer 2023

BIO5100: Course Coordinators:
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Course Information

Catalog description: (4 credits, 6 hours). For students preparing for Nursing, Physician's Assistant, and other allied health sciences only. This course examines the role of microbes as infectious agents responsible for a wide variety of diseases and medical conditions. Disease transmission, treatment, and prevent are considered. The laboratory focuses on the basic methods to cultivate, identify and control microbial growth. **This course does not satisfy the Biology major elective requirement.**

Prerequisite: Bio 1200

Co-requisite: Nursing students must take Bio 5100 before or with Nursing 21. Nursing students who withdraw from Bio 51 cannot continue in NUR 2100

Course Overview

- Major diseases caused by microorganisms are considered. These include: HIV, opportunistic and nosocomial infections, tuberculosis, hepatitis, pneumonia, sexually transmitted diseases, and water and foodborne diseases.
- The course has direct application to medical, surgical, and nursing fields.
- Universal precautions, asepsis, and control of microbial growth are emphasized.
- Immune responses to infections are discussed.
- Your knowledge of anatomy and physiology will be applied to understand the effects of microbial infections on various organs systems. If you are unsure of any of the anatomy and physiology principles being discussed, please review them or meet with your instructor.

Course Goals for Student Outcomes

1. Apply the concept of asepsis and its applications to laboratory procedures, hospitals, & medical practices.
2. Employ basic principles of microbial anatomy and physiology to microbial virulence, pathogenicity, and disease establishment.

3. Identify the factors affecting microbial virulence and the responses by the host's defense mechanisms.
4. Determine properties of microorganisms through staining and biochemical testing that can be used for diagnostic microbial identification.
5. Recognize the signs and symptoms of a particular disease and decisions involved in determining antimicrobial therapy.

Recommendations to Students

- Read assigned lecture and laboratory material before coming to class.
- Ask questions and meet your instructor during office hours to clarify any questions you may have.
- Attendance to class is essential. If you do miss class you are responsible for making up the missed work.
- Plan your work and study time. Read over or perhaps rewrite your notes after class. Read the text to supplement your notes. Discuss the material with your classmates. Form study groups.
- Best wishes for your success in the course. If you have any questions, please feel free to meet with your instructor.

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 such accommodations and assistance. Your instructor will be glad to make the accommodations you need, but you must have documentation from the Access-Ability office for any accommodations.

Academic Integrity

Your instructor upholds the KCC policy on academic honesty (see Student Handbook online). There are consequences for cheating on exams or plagiarizing someone else's work (i.e., turning in work copied from another source). These include a reduced grade or zero, suspension, or dismissal. If you are not sure what constitutes academic dishonesty, please check with the instructor.

Plagiarism is the use of others' words and/or ideas without clearly acknowledging their source. As students, you are learning about other people's ideas in your course texts, your instructors' lectures, in-class discussions, and when doing your own research. When you incorporate those words and ideas into your own work, you need to give credit where it is due. Plagiarism, intentional or unintentional, is considered academic dishonesty and all instances can be reported to the Academic Judiciary. To avoid plagiarism, you give the original author credit whenever you use another person's ideas,

opinions, drawings, or theories as well as any facts or any other pieces of information that are not common knowledge. Additionally, quotations of another person's actual spoken or written words, or a close paraphrasing of another person's spoken or written words, need to be referenced. Accurately citing all sources and putting direct quotations – of even a few key words – in quotation marks are required.

Grade Computation

Lecture and laboratory are each 50% of the final grade.

Lecture		**Laboratory**	
Examinations	30%	Quizzes	25%
		Clinical unknowns	15%
Final examination	20%	Practicals	10%

Required Textbook, Laboratory Manual, and Other Materials

This is a Zero Textbook Cost course.

Text: OpenStax. Microbiology by Parker, Schneegurt, Tu, Forster and Lister

Lab manual: Selected exercises of Laboratory Exercises in Microbiology by Brancaccio-Taras will be shared with you via Blackboard course site

Materials: Knee length laboratory coat and safety goggles. These requirements conform to OSHA safety regulation and need to be worn at all times in the microbiology laboratory. You will not be able to remain in the laboratory without a lab coat or safety goggles. After each week's lab, the lab coat should be washed.

BIO 51 LECTURE OUTLINE AND READING ASSIGNMENTS

Session 1: INTRODUCTION AND HISTORY OF MICROBIOLOGY

Organisms studied in microbiology (prokaryotic and eukaryotic)
The nature microbiological problems
The history of microbiology

Reading Assignment: The Invisible World- Chapter 1; Spontaneous Generation and Germ Theory- 3.1-3.2; Acellular Pathogens- Chapter 6 (overview and life cycle)

Session 2: BACTERIAL ANATOMY

Bacterial shapes and arrangements
Cell wall
Cell membrane
Glycocalyx
Endospores
Flagella
Cytoplasmic inclusions
Cytoplasmic structures/organelles

Reading Assignment: Unique Characteristics of Prokaryotic and Eukaryotic Cells- 3.3-3.4

Session 3: BACTERIAL GENETIC TRANSFER & GROWTH
3 major modes of bacterial genetic transfer: transformation, conjugation, & transduction
Significance of genetic transfer
Bacterial cell division
Bacterial growth curve
Reading Assignment: Mechanisms of Microbial Genetics- 11.6; Microbial Growth- Chapter 9

Session 4: MICROBIAL METABOLISM
Aerobic respiration
Anaerobic respiration
Fermentation and types of fermentation
Use of metabolic properties to identify microorganisms
Industrial uses for microbial metabolism- food, antibiotic, and enzyme production
Antibiotic therapy
Reading Assignment: Microbial Metabolism- 8.1-8.5; Antibiotic Therapy Chapter- 14

Sessions 5 & 6: IMMUNOLOGY
Normal flora, transient flora opportunistic microbes
Pathogenicity, virulence, and factors that increase virulence (enzymes, toxins)
Factors that affect the spread of disease
Nonspecific immune responses
Specific immune responses: humoral and cell mediated immunity
Vaccines
HIV/AIDS
Reading Assignment: Microbial Mechanisms of Pathogenicity- Chapter 15; Disease and Epidemiology- Chapter 16; Innate Nonspecific Host Defenses- Chapter 17; Adaptive Specific Host Defenses- Chapter 18

Session 7: MICROBIAL DISEASES OF THE SKIN AND EYES
Bacterial diseases of the skin
Acne, folliculitis, boils, furuncles, carbuncles, impetigo, cellulitis, & osteomyelitis
Infections of burns and surgical wounds, gangrene
Leprosy
Viral Diseases of the Skin
Warts
Chicken pox and shingles

Herpes (HSV I)
Measles
German measles (Rubella)
Smallpox
Fungal Diseases of the Skin
Dermatophyte infection (Tinea infections)
Candidiasis
Bacterial diseases of the Eyes
Conjunctivitis
Atypical bacterial diseases of the Eyes
Inclusion conjunctivitis
Trachoma
Viral Diseases of the Eyes
Herpetic Keratitis
Reading Assignment: Viral, Bacterial and Fungal Skin and Eye Infections- Chapter 21.1-21.4; Viral Infections Causing Skin Rashes- Chapter 22.3; Gas Gangrene- Chapter 25.2; Hansen's Disease- Chapter 26.2

Sessions 8 & 9: MICROBIAL DISEASES OF THE RESPIRATORY SYSTEM
Bacterial diseases
Group A streptococci, its complications (rheumatic fever, glomerulonephritis) & scarlet fever
Diphtheria
Otitis media
Laryngitis, sinusitis & bronchitis
Bacterial pneumonia
Pertussis
Tuberculosis
Legionnaire's disease
Atypical bacterial diseases
Ornithosis
Mycoplasmal pneumonia
Viral diseases
Common cold
Influenza
Viral pneumonia (Respiratory Syncytial Infection)
Hanta virus pulmonary syndrome
Fungal diseases
Histoplasmosis
Cryptococcosis
Pneumocystis carinii pneumonia

Reading Assignment- Respiratory System Infections Chapter 22

Session 10: MICROBIAL DISEASES OF THE CARDIOVASCULAR & LYMPHATIC SYSTEMS
Bacterial diseases
Bacteremia and septicemia
Acute and subacute bacterial endocarditis
Plague (pneumonic)
Lyme disease
Anthrax
Atypical bacterial diseases
Rocky mountain spotted fever
Viral diseases
Epstein Barr Virus: Infectious mononucleosis/ Burkitt's lymphoma
Ebola virus hemorrhagic fever
West Nile Fever
Protozoan diseases
Malaria
Toxoplasmosis
Reading Assignment: Circulatory and Lymphatic System Infections- Chapter 25; Anthrax- Chapter 21.2

Session 10: MICROBIAL DISEASES OF THE NERVOUS SYSTEM
Bacterial diseases
Meningitis
Tetanus
Botulism
Viral diseases
Polio
Rabies
Encephalitis
West Nile Fever
Cytomegalovirus infection
Creutzfeldt-Jakob disease (CJD)
Protozoan diseases
Trypanosomiasis/ Chagas' Disease
Reading Assignment: Nervous System Infections- Chapter 26; Chagas' Disease- Chapter 25.4

Session 11: MICROBIAL DISEASES OF THE DIGESTIVE SYSTEM
Bacterial diseases
Dental caries
Food poisonings
Cholera
Gastroenteritis
Bacterial Dysentery
Peptic Ulcers
Fungal diseases
Thrush
Aflatoxin poisoning
Ergot poisoning
Viral diseases
Mumps
Hepatitis A-E
Protozoan diseases
Amebic dysentery
Giardiasis
Cryptosporidosis
Reading Assignment: Digestive System Infections: Chapter 24.1-24.5

Session 12: MICROBIAL DISEASES OF THE URINARY/REPRODUCTIVE SYSTEMS
Bacterial diseases
Urinary tract infections
Vaginitis
Toxic Shock Syndrome
Syphilis
Gonorrhea
Atypical bacterial diseases
Nongonococcal urethritis
Viral diseases
Genital herpes
Genital warts
Protozoan diseases
Trichomoniasis
Fungal diseases
Vaginitis
Reading Assignment: Urogenital System Infections- Chapter 23; HIV- Chapter 25.3

OBJECTIVES

The objectives listed can be used as guidelines for studying each topic discussed in the course.

Introduction and History of Microbiology

1. Describe in one or two sentences the significance of the contributions of the following scientists to the field of microbiology:(a) van Leewenhoek; (b) Pasteur; (c) Semmelweis; (d) Lister; (e)Koch; (f) Ehrlich; & (g) Fleming.
2. Define spontaneous generation.
3. In a brief statement, describe the series of experiments disproving spontaneous generation.
4. List 3 major concerns regarding the spread and treatment of diseases caused by microorganisms.

Bacterial Anatomy

1. Draw and describe common bacterial shapes and their arrangements.
2. Describe the structure and function of the following: (a)cell wall; (b) cell membrane; (c) glycocalyx; (d)endospores; (e) flagella; (f) inclusion bodies
3. For each of the structures mentioned in objective 2, describe how each is involved in disease processes.

Genetic Transfer

1. Distinguish between transformation, transduction and conjugation.
2. Explain the medical significance of the 3 modes of genetic transfer mentioned in objective 1.

Growth and Factors Affecting Growth

1. Draw and label the four phases of a typical bacterial growth curve.
2. Describe the phases of a typical bacterial growth curve.
3. List and describe four physical factors affecting microbial growth.
4. Explain why physical factors affecting growth can be used to demonstrate the human body is an excellent environment for growth of a variety of microorganisms.

Microbial Metabolism

1. Define the following terms: (a) fermentation; (b) aerobic respiration; & (c) anaerobic respiration.
2. List the end products of (a) glycolysis; (b) Krebs cycle; (c) electron transport/oxidative phosphorylation.
3. Explain how proteins and lipids are metabolized to generate ATP.
4. Explain the significance of microbial metabolism in the identification of microorganisms.
5. List three organisms and their fermentation products used in food production.

Immunology

1. Distinguish between contamination, infection and disease.
2. Define each of the following terms: (a) normal flora; (b) transient flora & (c) opportunistic organisms.
3. Describe the stages and infectious disease establishment.

4. The list and describe the significance of three virulence factors.
5. List and describe the significance of five bacterial enzymes serving as virulence factors.
6. Distinguish between exotoxins and endotoxins.
7. Distinguish between nonspecific resistance and specific resistance.
8. Distinguish between portal of entry and portal of exit.
9. List and describe three examples of nonspecific resistance.
10. Describe the stages of inflammation.
11. Describe the classical and alternate pathway of the complement system.
12. Distinguish between humoral immunity and cell mediated immunity.
13. Distinguish between passive immunity and active immunity.
14. Distinguish between naturally acquired immunity and artificially acquired community.
15. Distinguish between an antibody and an antigen.
16. Describe in a series of steps antibody production.
17. Explain the immunological basis of vaccination against diseases such as smallpox.

Innate Immunity

1. Differentiate innate and adaptive immunity
2. Describe the role of the skin and mucous membranes in innate immunity
3. Differentiate between physical and chemical factors and list three examples of each.
4. Describe the role of normal microbiota in innate immunity
5. Discuss the components of blood and their functions in the body's defense.
6. Explain how macrophages are named.
7. Explain the roles of interferons
8. Describe the complement system, including its three activation pathways.
9. Discuss the process and benefits of inflammation.
10. Describe the roles of vasodilation, kinins, prostaglandins, and leukotrienes in inflammation.
11. Explain the benefits of fever in fighting infection

Adaptive Immunity

1. Differentiate humoral from cellular immunity.
2. Define antigen, epitope, and hapten.
3. Explain the function of antibodies and describe their structural and chemical characteristics.
4. Name one function for each of the five classes of antibodies
5. Describe the two major classes of major histocompatibility complex (MHC) proteins with regard to their location and function.
6. Explain the roles of antigen presenting cells such as dendritic cells and macrophages.
7. Compare and contrast three types of T cells.
8. Describe a cell-mediated immune response.
9. Describe the establishment of memory T cells.
10. Describe the formation and functions of plasma cells and memory B cells.
11. Contrast primary and secondary immune responses.
12. Contrast active versus passive acquired immunity
13. Contrast naturally acquired versus artificially acquired immunity.

Antimicrobial Therapy and Resistance

1. Differentiate among disinfectants, antiseptics, chemotherapy and antibiotics.
2. Distinguish between -cidal and -static and broad vs. narrow spectrum antimicrobials.
3. Explain the 5 modes of action of antimicrobials and how they relate to selective toxicity.
4. Explain mechanisms of antibiotic resistance and strategies to prevent resistance.
5. Determine reasonable strategies to treat a particular agent of infectious disease

Microbial Diseases of the Skin and Eyes

1. Differentiate among skin infections caused by *Staphylococcus aureus* and *Streptococcus pyogenes*, and relate signs and symptoms to bacterial virulence factors.
2. Describe the progression and etiologies of burn and wound infections.
3. Analyze the progression of Hansen's disease in terms of bacterial structure and growth conditions.
4. Compare *varicella zoster*, *rubeola* and *rubella* infections in terms of etiology, disease, and at-risk groups.
5. List the common features of herpesviruses, and distinguish among different members of the *herpesviridae*.
6. Distinguish between keratitis, conjunctivitis, and trachoma, identifying the affected area, causative agent(s), and transmission.
7. Distinguish between cutaneous, subcutaneous and systemic mycoses.

Microbial Diseases of the Respiratory System

1. Describe four respiratory diseases caused by *Streptococcus*.
2. Identify virulent factors that enable *Streptococcus* to survive against the body's defenses.
3. Discuss the transmission of *Corynebacterium diphtheriae* and the effects of diphtheria toxin.
4. Describe diphtheria.
5. Describe the manifestation and characteristics of common colds.
6. Compare and contrast between Typical and Atypical pneumonia.
7. List at least five bacterial species that can cause pneumonia
8. Describe the features of mycoplasma pneumonia
9. Describe the features of Legionnaires disease
10. Describe the transmission and pathogenesis of *M. tuberculosis* and its effects on the body.
11. Describe the diagnosis, treatment, and prevention of tuberculosis.
12. Describe the characteristics of pertussis.
13. Describe the general characteristics of *Haemophilus influenzae.*
14. Describe coronavirus respiratory syndromes
15. Describe Pneumocystis pneumonia
16. Describe the general characteristics of Psittacosis (Ornithosis)

Microbial Diseases of the Cardiovascular and Lymphatic Systems

1. For each disease describe the causative agent, signs and symptoms, and treatment.
2. Distinguish between bacteremia and septicemia.
3. Distinguish between acute endocarditis and subacute endocarditis.
4. Describe the following diseases including the name of the causative agent, signs and symptoms, and treatment (if any): (a) Ebola virus (b) Hanta virus and (c) West Nile virus.
5. Distinguish between bubonic, pneumonic and septicemic plague.

Microbial Diseases of the Nervous System

1. Describe three bacterial nervous system infections including the name of the causative agent, signs and symptoms, and treatment.
2. Compare and contrast the nervous system effects of botulism vs. tetanus.
3. List three bacteria causing meningitis.
4. Describe the worldwide significance of malaria
5. Explain how toxoplasmosis can lead to congenital defects.
6. Describe the following diseases including the name of the causative agent, signs and symptoms, and treatment: (a) rabies; (b) polio; and (c) encephalitis.

Microbial Diseases of the Digestive System

1. Describe two infections of the accessory structures of the digestive system.
2. Distinguish between food intoxication and food infection.
3. Differentiate between nine causes of bacterial, viral, and parasitic food and waterborne illnesses.
4. Implement precautions to prevent foodborne illness.
5. Differentiate between different forms of viral Hepatitis (A-E) with regard to virus structure, transmission, at-risk groups, and pathogenesis.
6. Describe two diseases mediated by ingestion of mycotoxins.

Microbial Diseases of the Of the Urinary/Reproductive Systems

1. Compare the anatomy, function, and normal microbiota associated with the male and female urogenital systems
2. Explain how microorganisms, in general, overcome the defenses of the urogenital system to cause infection
3. Name, describe, and differentiate between general signs and symptoms associated with infections of the urogenital tract.
4. Describe the progression of syphilis (primary, secondary, and tertiary)
5. Describe the effects of 2 sexually transmitted diseases on a fetus.

BIOLOGY 5100 LABORATORY

Recommendations to the student:

- Observe all safety precautions in the laboratory. They are for your protection.
- Each student is responsible for the proper safety and maintenance of their work area.
  Bench tops and microscopes must be properly cleaned before and after use.
  Microquat disinfectant is used on bench tops.
- Wear your laboratory coat at all times while in the microbiology laboratory.
- Read the laboratory exercises before class and the textbook pages corresponding to the laboratory activities.

- If you are unsure of any of the work you are required to perform during the lab, ask your instructor.
- If you spill any bacterial cultures or make a mistake you think might be a potential health hazard, inform your instructor.
- Wash your hands with betadine before, during and after lab work.

LABORATORY OUTLINE

NOTE: Due to the live cultures and complicated media preparation required for each lab, labs cannot be made up if missed.
A knee length lab coat & safety goggles must be brought to each week's lab session. Lab coats and safety goggles cannot be left in the lab. It is recommended that you wash your lab coat after each lab.

Session	Activities	Exercise # and Page (Brancaccio-Taras)
1	Introduction, Safety Guidelines, Check-in Culture Transfer Instruments Techniques & Isolation & Maintenance of Pure Cultures (Aseptic Technique only) **MICROBIAL MORPHOLOGY** Smear Preparation and Simple Staining Gram Stain Bright Field Light Microscope	v-vii 10 (p. 61) 2 (p. 12) 4 (p. 25) 1 (p. 3)
2	**BACTERIAL ANATOMY** Acid-fast Staining Endospore Staining Capsule Staining (Graham & Evans procedure) The Effectiveness of Handwashing	 5 (p. 32) 7 (p. 43) 6 (p. 38) 22 (p. 131)
3	Gram Stain Practical **MICROBIAL GROWTH** Environmental Factors Affecting Growth of Microorganisms: Temperature, pH, & Osmotic Pressure Cultivation of Anaerobic Bacteria (Broth & Plate cultures- demonstration)	 15-17 (p. 97) 18 (p. 110)
4	**ISOLATION AND ENUMERATION OF MICROORGANISMS** Spread Plate Technique Streak Plate Technique Determination of Bacterial Numbers Bacterial Count of a Food Product	 11 (p. 72) 11 (p. 70) 12 (p. 75) 42 (p. 327)

Week	Activities	Exercise # and Page (Brancaccio-Taras)
5	**CONTROL OF MICROBIAL GROWTH**	
	Radiation (Ultraviolet Light)	21 (p. 126)
	The Effects of Chemical Agents on Bacteria I: Disinfectants and Antiseptics	19 (p. 115)
	The Effects of Chemical Agents on Bacteria II: Antimicrobial Agents (Kirby-Bauer method)	20 (p. 120)
6	**NORMAL FLORA, HOST DEFENSES, AND THROAT UNKNOWN IDENTIFICATION**	
	Nonspecific Host Defenses: Lysozyme (demonstration)	44 (p. 344)
	Isolation of Normal Microbiota from the Human Body (Nose, Throat, or Skin)	37 (p. 289)
	Throat Culture Unknown Activity - Control and unknown specimens inoculated	
	Proteins, Amino Acid & Enzymes V: catalase activity	25 (p. 170)
	Proteins, Amino Acid & Enzymes VI: coagulase & DNase activity	25 (p. 169, 167)
	Selective and Differential Media (blood & mannitol salt agar only)	14 (p. 87)
7	**TECHNIQUES TO ISOLATE AND IDENTIFY BACTERIA**	25 (p. 169, 167)
	Throat Culture Unknown Activity- Observe & Record results	14 (p. 87)
8	**GASTROINTESTINAL TRACT UNKNOWN IDENTIFICATION**	
	Gastrointestinal (GI) Unknown Activity- Control & Unknown specimens inoculated	
	Carbohydrate Fermentation	23 (p. 139)
	The IMViC Tests	23,24 (p. 144-148; 152-153)
	Hydrogen Sulfide Production	24 (p. 159)
	Motility	
9	**GASTROINTESTINAL TRACT UNKNOWN IDENTIFICATION**	23 (p. 139-142; 144-148)
	GI Unknown Activity- Observe & Record results	24 (p. 152-153; 159-160)
10	**URINARY TRACT UNKNOWN IDENTIFICATION**	
	Urinary Tract (UT) Unknown Activity- Control and Unknown specimens inoculated	
	Selective & Differential Media (EMB & MacConkey only)	14 (p. 87)
	Tryptophan Hydrolysis	24 (p. 152)
	Oxidase Test	25 (p. 171)
	Urease Activity	24 (p. 156)
	Phenylalanine Deamination	24 (p. 153)
	Nitrate Reduction	25 (p. 172)

Week	Activities	Exercise # and Page
11	**URINARY TRACT UNKNOWN IDENTIFICATION** UT Unknown Activity- Observe & Record results	14 (p. 87) 24 p. 152; 153; 156 25 (p. 171, 172)
12	Final Laboratory Practical* Laboratory Check-Out**	

*The final laboratory practical cannot be made up if missed. The point value for this practical (5%) will be deducted from your final grade.

**For check out, empty your drawer of all slides and media and place them in the discard bin. Clean empty drawer with Microquat. Once the drawer has been cleaned, reusable materials can be returned to the drawer. Material in the slide discard bowls is placed in the discard bin. All paper trash is placed in the proper receptacle. Lastly, wash the laboratory bench top with Microquat.