University of Kentucky
University Extension
Independent Study Program
Lexington, KY 40506-0031

BIO 208 - PRINCIPLES OF MICROBIOLOGY

(3 Credit Hours)

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Text: *Microbiology,*
Robert W. Bauman, Pearson Benjamin Cummings Publishing Co. (2004)
ISBN: 0-8053-7590-2

Biology with George Wolfe,
Thinkwell. (a set of CDs) available through www.thinkwell.com
ISBN: 096783578-X

Course Description: This is an introductory, survey course in microbiology. Emphasis is placed on structural, functional, ecological and evolutionary relationships between microorganisms.

Course Objectives:

At the completion of the course, the student should be able to:

- Demonstrate an understanding of the broad principles which unify all life.
- Apply the principles of the molecular basis of life to the study of microorganisms.
- Recognize the ubiquity of microorganisms.
- Demonstrate knowledge of the classification, metabolism, diversity and genetics of selected microorganisms.
- Describe procedures / methodology used to culture, isolate, quantify, characterize and identify microorganisms.
- Demonstrate an understanding of the basic components of the host-parasite relationship.

Grading:

Assignments 25 x 100 pts	2500 points total
Examination 1	100 points
Examination 2	100 points
Examination 2	100 points
TOTAL POINTS POSSIBLE	**2800**

NOTE: In order to receive a passing grade in the course you MUST earn a minimum of 180 points out of the possible 300 on the examinations. This represents a mean score of 60% on the three examinations. Failure to earn a mean passing grade (60%) on the examinations will result in an automatic grade of E for the course irrespective of your performance on the assignments.

Final grades will be based on total points earned and will be assigned as follows:

A = a minimum of a mean passing grade (180/300) on the examinations **AND** a total of 2520 - 2800 points for the course.

B = a minimum of a mean passing grade (180/300) on the examinations **AND** a total of 2240 -> 2519 points for the course.

C = a minimum of a mean passing grade (180/300) on the examinations **AND** a total of 1960 -> 2239 points for the course.

D = a minimum of a mean passing grade (180/300) on the examinations **AND** a total of 1680 -> 1959 points for the course.

E = Failure to receive a passing score on the comprehensive final **OR** a passing grade on the exam and a total of less than 1680 points for the course

EXAM FORMAT: **Examinations 1 and 2** will consist of both short answer and multiple-choice questions. The short answer questions will be of the type found in the assignments. The multiple choice questions will be of the type found in (a) the assignments, (b) in the textbook, (c) and on the Thinkwell website.

Examination 3 will consist of 100 multiple choice questions

Each examination will be two hours long.

You must take examination #1 after you have completed assignments # 1- 7. Assignments #8 - 25 will not be graded until after you have taken examination #1.

You must take examination #2 after you have completed assignments # 8 - 18 . Assignments #19 - 25 will not be graded until after you have taken examination #2.

About the Assignments

Each assignment consists of a series of short answer and/or multiple choice questions. Read each question carefully and answer it fully. Note: that some questions consist of several parts. Make sure you answer all parts of a question**. All submitted assignments must be typed or word-processed. Hand-written assignments will not be graded**. You do not need to re-write the questions just clearly indicate the question number. You can hand-draw diagrams and graphs. Each assignment is worth 100 points. You will lose points for bad grammar, spelling and sentence construction.

As you review each chapter, do not just memorize the facts. Instead focus on understanding the underlying concepts. Some of the questions in the assignments are direct recall questions, while others are conceptual and/or application questions. Some questions will require you to refer back to previously acquired knowledge or to conduct research either in the library or in later chapters in the textbook. Several assignments (# 11 in particular) require you to do some extensive research and writing.

As an instructor, my goals for you go beyond you just learning the facts of microbiology. I feel it is important, and crucial, that you (a) understand the concepts and theories of the subject matter; (b) develop the ability to apply this knowledge to new problems and situations; and (c) effectively communicate this knowledge to other people.

You have one year to complete all of the course requirements. Ideally, you should plan on submitting a completed assignment every 12 days. Some of these assignments require some library research and planning, so do not leave it till the last minute to work on assignments.

Disabilities/ Medical Conditions: If you have a disability or medical condition that requires special accommodations, please contact me immediately so that we can discuss these accommodations.

Thinkwell's Biology (CDs)

This supplement consists of a series of lectures and notes that are designed to supplement your own lecture notes and reading of the textbook. At the beginning of most assignments you will be directed to view certain lectures. In order to view the lectures you will first have to download a plug-in onto your computer. The directions for this can be found on the card in your box of CDs. On this card you will also find an authorization code that will allow you to register on the Thinkwell website. This will give you access to hundreds of practice exam questions.

*****A Note Concerning Academic Offenses (READ THIS INFORMATION CAREFULLY)**

PLAGIARISM and CHEATING are serious academic offenses.

The following is an excerpt taken from the "Students Rights and Responsibilities Handbook, University of Kentucky" regarding cheating.

"Cheating is defined by its general usage. It includes, but is not limited to, the wrongful giving, taking, or presenting any information or material by a student with the intent of aiding himself/herself or another on any academic work which is considered in any way in the determination of the final grade."

The following is an excerpt taken from the "Students Rights and Responsibilities Handbook, University of Kentucky" regarding plagiarism.

"All academic work, written or otherwise, submitted by students to their instructors or other academic supervisors, is expected to be the result of their own thought, research, or self-expression.

When students submit work purporting to be their own, but which in any way borrows ideas, organization, wording or anything else from another source without appropriate acknowledgment of the fact, the students are guilty of plagiarism.

Plagiarism includes reproducing someone else's work..... If the words of someone else are used, the student MUST put quotation marks around the passage in question and add an appropriate indication of its origin. Making simple changes while leaving the organization, content and phraseology intact is plagiaristic."

Charges of an academic offense will be made against any student that cheats or commits plagiarism. The **MINIMUM** penalty for such an offense is the assignment of a grade of E for the course in which the offense occurred. More severe penalties include suspension or dismissal from the University. **I have a zero-tolerance policy regarding academic offenses.**

About the Instructor

Ruth E. Beattie is an Assistant Professor of Biology at the University of Kentucky. She received a B.A. and a M.Sc. in Biochemistry from Trinity College Dublin, Ireland, and a Ph.D. in Biochemistry from Queen's University Belfast, N. Ireland. She completed two postdoctoral fellowships at The Hipple Cancer Research Center and at Wright State University in Dayton, Ohio. She then taught for four years at Ball State University, Muncie, Indiana. In the Fall of 1995 Dr. Beattie joined the faculty at the University of Kentucky as an instructional specialist, where her primary responsibility is teaching large enrollment freshman level biology classes. Dr. Beattie has developed a variety of innovative classroom activities, which have been successfully implemented in these large classes. In 2000, Dr Beattie was the recipient of a University of Kentucky's Chancellor's Award for Outstanding Teaching. In 2000, 2002 and 2003 she was named a Top Ten Teacher in the College of Arts and Sciences.

COURSE INSTRUCTIONAL OBJECTIVES

CHAPTER 1 –A Brief History of Microbiology

Instructional Objectives:

By the end of this chapter you should be able to:

- Discuss the role of microorganisms in your life.
- Identify some of the important events (and players) in the history of microbiology and discuss their significance.
- Discuss the role of the following, Redi, Needham, Spallanzani, and Pasteur in the spontaneous generation debate.
- Discuss the importance of Koch's postulates as they relate to medicine.
- Discuss the classification of microorganisms into five groups and give the criteria used to assign members to each group.
- Demonstrate how scientific names are written.

CHAPTER 2 – The Chemistry of Microbiology

Instructional Objectives:

By the end of this chapter you should be able to:

- Describe the structure of an atom.
- Relate electronic configuration of an atom to its chemical properties.
- List three bond types, and describe the conditions under which each can form.
- Draw the structure of water, indicate its polarity and illustrate how it forms hydrogen bonds with other water molecules.
- Identify the following functional groups: hydroxyl, carbonyl, carboxyl, amino, sulfhydryl, methyl. Relate their structure to their function.
- List the four groups of biomolecules. Describe their structure and relate it to their function in cells.
- Define acid, base, buffer and pH.
- Relate pH scale to hydrogen ion concentration.
- Demonstrate how macromolecules are formed and how they are broken down.

CHAPTER 3 – Cell Structure and Function

Instructional Objectives:

By the end of this chapter you should be able to:

- Compare and contrast the structure of procaryotic and eucaryotic cells.
- Describe cellular morphology.
- Relate the structure of procaryotic cell structures (glycocalyx, flagella, axial filaments, fimbriae, pili, cell wall, plasma membrane, nuclear area, cytoplasm, ribosomes, inclusion bodies, and endospores) to their function.
- Relate the structure of eucaryotic cell structures (flagella, cilia, cell wall, plasma membrane, endoplasmic reticulum, Golgi complex, mitochondrion, chloroplasts, lysosomes, centrioles, ribosomes) to their function.
- Compare and contrast gram-positive cell wall structure with gram-negative cell wall structure.
- Relate membrane structure to membrane function.

- Describe simple diffusion, facilitated diffusion, osmosis, active transport, and group translocation and cite examples of each process.
- Predict the effect of exposing cells to solutions of differing solute concentration and describe the solute in terms of hypertonic, isotonic and hypotonic.
- Compare and contrast passive transport processes with active transport processes.

CHAPTER 4 – Microscopy, Staining and Classification

Instructional Objectives:

By the end of this chapter you should be able to:

- Convert metric units of length into their equivalents.
- Identify the parts of a microscope.
- Determine magnification given the magnification of the objective and ocular lenses.
- Differentiate between magnification and resolution.
- Discuss the factors involved in determining resolution.
- Compare and contrast the following microscopes; compound, darkfield, phase-contrast, fluorescence, confocal, transmission electron, scanning electron, in terms of resolution, principle use, distinguishing features and image.
- Define morphology.
- Discuss the role of simple, differential and structural staining procedures in microbiology.
- Discuss the importance of the Gram stain in bacterial identification.
- Identify the reagents of the Gram staining procedure.
- Discuss the differential nature of the following staining procedures; acid-fast stain, endospore stain, Gram stain,

CHAPTER 5 - Microbial Metabolism

Instructional Objectives:

By the end of this chapter you should be able to:

- Define metabolism.
- Define oxidation and reduction and relate these reactions to energy loss or gain.
- Identify given reactions as catabolic or anabolic.
- Describe how an enzyme catalyzes a reaction.
- Discuss the relationship between enzyme structure and its specificity of action.
- Describe how environmental changes can influence enzyme activity.
- Describe the control of a metabolic pathway by feedback inhibition.
- Discuss the role of ATP as the energy currency of the cell.
- Compare and contrast substrate-level phosphorylation with oxidative phosphorylation.
- Describe the role of key compounds in aerobic respiration.
- Describe chemiosmosis
- Compare and contrast aerobic respiration, anaerobic respiration and fermentation in terms of ATP yield, final electron acceptor and type of phosphorylation involved.
- Discuss the classification of organisms based on nutritional patterns.

CHAPTER 6 – Microbial Nutrition and Growth

Instructional Objectives:

By the end of this chapter you should be able to:

- Discuss the classification of bacteria into groups based on their chemical and physical requirements for growth (temperature, pH, osmotic pressure, oxygen, carbon source, etc).
- Describe the methodologies used to culture, isolate, and quantify microorganisms.
- Compare and contrast a chemically defined medium with a complex medium.
- Discuss, giving examples, how selective and differential media can be used to identify microorganisms.
- Distinguish between exponential and linear population growth.
- Successfully complete population growth problems.
- Draw a graph from a set of population data. Use the graph to identify linear and exponential population growth.
- Solve sample problems involving dilution factors.
- Describe accepted procedures for enumerating bacteria found in water. Use and interpret a Most Probable Number chart.

CHAPTER 9 – Controlling Microbial Growth in the Environment
&
CHAPTER 10 – Controlling Microbial growth in the Body

Instructional Objectives:

By the end of these chapters you should be able to:

- Describe the basic environmental and physiological parameters, which affect the growth of microorganisms.
- Distinguish between bactericide and bacteriostasis.
- Cite the factors that influence the effectiveness of anti-microbial treatments.
- Identify procaryotic cell structures that are potential targets for anti-microbial control agents.
- List physical methods of microbial control. Give an example of each. Describe the effectiveness of each method, mechanism of action, and preferred use.
- Differentiate between disinfectant and antiseptic. Give an example of each.
- Describe the effects of antiseptics and disinfectants on bacterial growth.
- Demonstrate an understanding of the use of the Filter Paper Method and the Use-Dilution Test for determining the effectiveness of an antiseptic or disinfectant.
- Cite an example of each of the following chemical disinfectants (phenols, halogens, biguanides, alcohols, heavy metals, surface-active agents, quats, aldehydes, organic acids, and gaseous chemosterilizers). Describe the effectiveness of each chemical, the mechanism of action, and preferred use.
- Describe the effects of antibiotics on bacterial growth.
- Describe the mode of action of selected antibiotics (penicillins, streptomycin, tetracyclines, sulfanilamide, rifampin, bacitracin, neomycin, trimethoprim and Polymyxin B).
- Demonstrate an understanding of the use of the disk-diffusion method for determining antibiotic effectiveness.
- Interpret the results of broth dilution tests (determine MIC and MBC values).
- List the ideal properties for an antibiotic and describe the significance of each property.

CHAPTER 7 – Microbial Genetics

Instructional Objectives:

By the end of this chapter you should be able to:

- Describe the structure and chemical composition of DNA.
- Describe the role of hydrogen bonding in DNA structure.
- Distinguish between phenotype and genotype.
- Describe DNA replication.
- Describe protein synthesis.
- Given a DNA sequence be able to transcribe and translate it into the designated protein.
- List the different kinds of mutations and consequences on gene expression and factors that cause those mutations.
- Describe how gene expression is controlled in procaryotic cells.
- Define genetic recombination.
- List and describe four mechanisms of genetic recombination in bacteria (transformation, conjugation, transduction, and transposons).
- Describe how the Ames test is used to screen for potential carcinogens.

CHAPTER 8 – Recombinant DNA Technology

Instructional Objectives

By the end of this chapter you should be able to:

- Describe the role of restriction enzymes and probes as tools of biotechnology.
- Describe the structure of a plasmid.
- List applications of genetic engineering.
- Demonstrate the use of DNA fingerprinting to identify unknowns.
- Describe the PCR method.
- Describe some of the methodologies of biotechnology (making gene libraries, screening, restriction digests, etc.).

CHAPTER 11 – Characterizing and Classifying Prokaryotes

Instructional Objectives;

By the end of this chapter you should be able to:

- Discuss the five-kingdom system of classification of organisms, and give the criteria used to assign members to each kingdom.
- Compare and contrast Archaea and Eubacteria.
- Discuss why viruses are not included in the five-kingdom classification system.
- Demonstrate how scientific names are written.
- Arrange in order the following categories of classification: kingdom, phylum, class, order, family, genus and species.
- Describe the use of laboratory tests and scientific methodologies in the identification of unknown microorganisms.
- Describe immunological and DNA technological methodologies used in the identification of unknown microorganisms.
- Use a flow chart to identify bacteria.
- Construct a flow chart.
- List characteristics that are used to assign bacteria to groups for the purpose of classification.
- List representative bacteria from the main bacterial groupings discussed in chapter 11.

CHAPTER 12 – Characterizing and Classifying Eukaryotes

Instructional Objectives:

By the end of this chapter you should be able to:

- Describe the distinguishing features of selected fungi, algae, protozoa and multicellular parasites.
- Discuss the role of sexual and asexual reproduction in the life cycle of a fungus.
- Cite examples of fungal diseases.
- Cite examples of the economic importance of fungi.
- Discuss the classification of algae.
- Describe the structure of cellular and plasmodial slime molds.
- Cite examples of medically important protozoa.
- Describe the life cycle of a parasitic worm (example: liver fluke).
- Discuss the problems associated with treating diseases caused by eucaryotic pathogens compared to those caused by procaryotic pathogens.

CHAPTER 13 – Characterizing and Classifying Viruses, Viroids and Prions

Instructional Objectives:

By the end of this chapter you should be able to:

- Describe the structure of a virus.
- Discuss why viruses are not included in the five kingdom classification system.
- Describe procedures for the isolation, culture and identification of viruses.
- Describe the life cycles (lytic and lysogenic) of T-even bacteriophages.
- Distinguish between the biosynthesis of animal RNA viruses and animal DNA viruses.
- List examples of viral diseases.
- Discuss the role of viruses in cancer.
- Describe the mechanism of action of antiviral drugs.

CHAPTER 14 – Infection, Infectious Diseases and Epidemiology

Instructional Objectives:

By the end of this chapter you should be able to:

- Cite Koch's Postulates.
- Discuss the criteria used to classify infectious diseases.
- Define content-appropriate terms.
- Cite examples of reservoirs of infection.
- Describe methods by which disease is transmitted.
- Describe the factors that contribute to a nosocomial infection.
- Describe the stages of a disease.
- Discuss the role of epidemiology in controlling the spread of disease.
- Describe how microorganisms can enter the human body.
- Describe how microorganism can evade the host defense mechanisms.
- Discuss the significance of the LD_{50} and ID_{50} values.
- Describe how mircoorganisms can damage host cells.

CHAPTER 15 – Nonspecific Lines of Defense

Instructional Objectives:

By the end of this unit you should be able to:
- Describe chemical and mechanical nonspecific defense mechanisms.
- Describe the criterion used to classify blood cells.
- Cite the role of the different blood cells found in human blood.
- Describe the stages of phagocytosis.
- Describe the events of the inflammation response.
- Describe complement activation pathways.
- Describe the antiviral action of interferons.

CHAPTER 16 – Specific Defense: The Immune System

Instructional Objectives:

By the end of this chapter you should be able to:
- Compare and contrast humoral and cell-mediated immunity.
- Describe the four types of acquired immunity.
- Describe the basic structure of an antibody.
- Define antigen.
- Distinguish between the five classes of antibodies.
- Compare and contrast B cells and T cells.
- Define apoptosis.
- Describe the events of B cell activation.
- Discuss the consequences of antibody-antigen binding.
- Describe primary and secondary immune responses to an antigen.
- Cite four different types of T cells and describe their function.
- Describe the mechanism of the cell-mediated immune response.

CHAPTER 17 – Immunization and Immune Testing

Instructional Objectives:

By the end of this chapter you should be able to:
- Describe how vaccination works.
- Describe the characteristics of five types of vaccines.
- Discuss the hazards associated with some types of vaccines.
- Discuss the role of immunology in the diagnosis of disease.
- Describe commonly used immunological tests.

CHAPTER 18 – Hypersensitivities, Autoimmune Diseases, and Immune Deficiencies

Instructional Objectives:

By the end of this chapter you should be able to:
- Describe the events of anaphylaxis.
- Describe the symptoms associated with systemic and localized anaphylaxis.
- Describe the conditions under which hemolytic disease of the newborn can occur.

- Describe the ABO blood grouping system.
- Describe the development of an allergy to a chemical.
- Cite examples of autoimmune diseases.
- Discuss the importance of tissue matching in transplants.
- Describe the structure of the HIV virus.
- Describe the stages of a HIV infection.

CHAPTERS 19-25: Microbial Diseases

Instructional Objectives

By the end of this unit you should be able to:

- Cite the cause, mode of transmission, progression of disease, symptoms and treatment (including structure and mode of action of drugs) of the following diseases:

  Staphylococcal and Streptococcal Skin Infections
  Anthrax
  Conjunctivitis
  Meningitis
  Tetanus and Botulism
  Diphtheria and plague
  Rabies
  Rheumatic Fever
  Lyme Disease
  Leprosy and Polio
  Malaria
  Measles
  Tuberculosis
  Pneumonia
  Cholera
  Hepatitis A, B, C
  Gonorrhea, Syphilis
  Genital Herpes and other sexually transmitted diseases
  Influenza
  Amoebic Dysentery
  Toxoplasmosis
  Candidiasis
  Tinea pedis
  Systemic mycoses
  AIDS
  Warts
  Food Poisoning/Infection
  Chickenpox and shingles

- Classify the organisms or infective particles that cause the above diseases, into groups, based on the classification criteria discussed in chapters 11, 12 and 13.