

Prepared by the Department of Natural Sciences & Applied Technology

Date of Department Approval: February 6, 2012

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Effective: Fall 2012

1. Course Number: BIO201 and BIO 201L

Course Title: Microbiology and Microbiology Laboratory

2. Description: An introduction to microorganisms and their activities, for health-related majors. The topics cover cell structure, classification, metabolism, methods of control, antimicrobial drugs, genetics, microbial and host defenses, immunology and applications, representative infectious diseases, and food and industrial microbiology. Independent study is encouraged. The laboratory component introduces basic procedures of handling, growing, and identifying microorganisms. (3 class hours/ 2 laboratory hours per week)

3. Student Learning Outcomes (instructional objectives; intellectual skills):

Upon successful completion of the course, students are able to do the following:

- Describe the properties and types of sugars and polysaccharides, amino acids and proteins, DNA, and various classes of RNA
- Identify the basic components of a bright field microscope, and the types of microscopes and staining techniques
- Explain the structure and function of cellular components in eukaryotes and prokaryotes
- Identify the species concept, and how DNA sequences are used in classification of organisms
- Describe the properties of the Archaea, and various groups and species of the Bacteria, especially with respect to pathogenesis, symptoms, spread, and control
- Describe the properties of the Fungi with emphasis on pathogenic Fungi
- Describe the properties of the pathogenic Protozoa
- Describe the properties of the Algae, their use in food additives, and how they affect human and animal health
- Describe the structural components of viruses, their mechanisms of propagation, their effects on cells
- Describe the symptoms, transmission, prevention, and sequelae of animal viral infections
- Describe the properties of viroids
- Describe the properties of prions, with respect to transmission and pathogenesis, and the symptoms of prion diseases
- List the general properties of enzymes, including allosteric enzymes, and how their activity can be modulated by inhibitors
- Describe the major pathways of sugar metabolism and energy generation, and the energetics of respiration and fermentation
- Describe the processes of microbial growth, requirements, and how to estimate cell number
- Define the basic processes of sterilization, disinfection, and antisepsis, with examples from physical and chemical methods of control
- Describe the properties, function, and regulation of prokaryotic and eukaryotic genes, and how genes are involved in protein synthesis
- Describe mutations, their effects, and how mutations are the basis of cancer development
- Describe the basic principles of gene cloning, and the diagnostic applications of the polymerase chain reaction
- Describe the various mechanisms of microbial pathogenicity
- Describe the components of the innate and induced immune system in humans, disorders of the immune system, and diagnostic and therapeutic applications
- Explain the different classes of antimicrobial drugs, how they cure disease, and the health problems of drug resistance
- Relate the impact of microbiology on public health and control of disease in the population

4. Credits: Four credits

5. Satisfies General Education Requirement: No.

6. Prerequisites: A grade of C or higher in (CHM101 or CHM109) and in (BIO101 or BIO107)

7. Semesters Offered: Fall, Spring, Summer

8. Suggested General Guidelines for Evaluation: Course grading procedures and make-up policies are detailed in a handout. In summary:

- Four 60 min tests, covering lecture material and required reading material. Test format includes multiple choice, fill ins, definitions, and problem solving.
- One required term paper on a topical subject.
- Second optional paper on a topic in the recent news, will substitute the lowest test score. Multimedia projects are also acceptable in place of a research paper.
- The cumulative 2 hour final exam.
- The lab exam consists of an extended series of experiments performed individually. An unknown (to the student) enteric organism is characterized by Gram staining, streaking and colony characteristics, and biochemical identification. The results are summarized in a formal report.
- The lecture tests, paper, and final exam are 75% of the grade; the lab test and report are 25%.

9. General Topical Outline (Optional): See Attached.

COURSE OUTLINE

Chapter 1 - Basic biochemistry (self study)

- 1 Essential properties of: sugars, polysaccharides, lipids, fatty acids, phospholipids
- 2 Structure and properties of amino acids, proteins
- 3 Structure of RNA and DNA, nucleotide, strand, and complementarity
- 4 Named examples of sugars, polysaccharides, fatty acids, amino acids, proteins

Chapter 2 - Microscopy

- 1 Know the terms - Limit of resolution, and the function of major microscope components: condenser, objective, ocular, stage.
- 2 Advantages of the phase contrast, fluorescence, electron, and atomic force microscopes.
- 3 Difference between simple and differential stains. Prokaryotic cell components that can be stained.

Chapter 3A, 3B - Cell structure of eukaryotes and prokaryotes

- 1 Major cellular differences between eukaryotes and prokaryotes.
- 2 In eukaryotes, function of: membrane, nucleus, chromosome, mitochondria, endoplasmic reticulum, ribosomes, Golgi complex, flagella and cilia.
- 3 In prokaryotes, function of: membrane, cell wall, differences between the Gram-positive and Gram-negative cell wall, nucleoid, plasmids, ribosomes, inclusions (metachromatic, PHB, magnetosomes), flagella and axial filaments, fimbriae, F and R pili.
Different cell shapes and arrangements. Properties of endospores.

Chapter 4 - Classification

- 1 General understanding of the species concept.
- 2 Why and how DNA sequences are used for classifying organisms.
- 3 Understand the evolutionary relationship between bacteria, archaea, and eukaryotes.
- 4 Conventions in naming organisms.
- 5 Terms describing the physiology of organisms.

Chapter 5 - Archaea

- 1 Physiological properties of the three archaeal groups, and where they are found.

Chapter 6A, B, C - The Bacteria

- 1 For the different bacterial species: associate name, cell shape and arrangement, Gram stain, virulence and disease symptoms (if any), method of disease transmission, and prevention. For non-pathogens, unusual characteristics.

Chapter 7 - Fungi

- 1 Know the terms: mycelium, yeast, pseudohyphae, dimorphism, spores, saprophyte.
- 2 Commercial uses of fungi.
- 3 Whether individual species are mycelial, yeast, or dimorphic. If they are human/animal pathogens - symptoms, prevention, transmission, etc.
- 4 Know the different types of mycoses (fungal infections).

Chapter 8 - Protozoa

- 1 General characteristics and nutrition, excluding reproduction details.
- 2 Name of the organism, disease, symptoms, prevention (like for bacteria). Do not need to know what the organism looks like microscopically.

Chapter 9 - Algae

- 1 Terms: photosynthetic pigment, unicellular, macroscopic.
- 2 Commercial uses of red and brown algae.
- 3 For the dinoflagellates, harmful algal blooms, and their health consequences with general symptoms.
- 4 Lichens as algal/fungal symbiosis.

Chapters 10A, B - Viruses

- 1 Terms: virion, capsid, nucleic acid, envelope, spikes, host range, bacteriophage, lytic cycle, lysogenic cycle, retrovirus, reverse transcriptase, cytopathic effect.
- 2 Why viruses are not considered "living".
- 3 Summary of how viruses are propagated. Lytic and lysogenic life cycle of bacteriophages. Propagation of animal viruses. Cytopathic effects. Representative life cycle of animal viruses. Properties of retroviruses.
- 4 For each virus: transmission, symptoms, prevention. Do not need to know what they look like.

Chapter 11 - Viroids, and Prions

- 1 General properties of viroids.
- 2 What prions are, and how they "replicate".
- 3 Characteristics of prion disorders, transmission, prevention.

Chapter 12 - Enzymes (Self-study)

- 1 Terms: catalysis, activation energy, enzyme, substrate, product.
- 2 How enzymes catalyze chemical reactions.
- 3 Enzyme characteristics. Coenzymes and metal ion activators.
- 4 Factors affecting enzyme activity - pH, temperature.
- 5 Examples of enzymes, and the reactions they catalyze.
- 6 Inhibitors of enzyme activity - competitive inhibitors. Drugs as enzyme inhibitors - sulfa drugs.
- 7 Allosteric enzymes and regulation of enzyme activity. Metabolic networks.

Chapter 13 - Metabolism

- 1 Definition of metabolism, catabolism, anabolism - why the cell needs energy and metabolites.
- 2 ATP as the energy-trapping system in the cell. Oxidation-reduction reactions and NAD/NADH.
- 3 Summary of glycolysis, intermediate steps, Krebs cycle, and the electron transport chain. How ATP is generated in the electron transport chain.
- 4 Outline of lipid and protein metabolism.
- 5 Comparison between fermentation and oxidative metabolism - the regeneration of NAD. End-products of fermentation in prokaryotes and eukaryotes. Energy efficiency of fermentation and oxidative metabolism.
- 6 Origin of cellular components from various pathways, for biosynthesis.

Chapter 14 - Microbial growth

- 1 Chemical requirements for growth of cells - different nutrients. Growing anaerobic cultures.
- 2 Types of specialized culture media - reducing, selective, differential, enriched, with named examples.
- 3 Physical requirements for growth - temperature, pH, osmotic pressure. Food preservation.
- 4 Cell division in bacteria. Concept of growth rate and generation time.
- 5 Phases of bacterial growth.
- 6 Estimation of bacterial number by cell count.

Chapter 15 - Sterilization and disinfection

- 1 Definitions of static and cidal activity, sterilization, disinfection, antisepsis, sanitization.
- 2 Factors affecting the death rate of organisms.
- 3 Physical methods - Boiling, autoclaving, pasteurization; x-rays, g-rays, electron irradiation, ultraviolet light; filtration.
- 4 Food preservation methods - refrigeration and freezing, desiccation, osmotic pressure.
- 5 Chemical disinfectants, antiseptics, and sterilants. Chemical food preservatives.
- 6 Evaluation of chemical agents - the MIC and its interpretation.

Chapter 16A - Introduction to genetics and genomics

- 1 Definition and function of a gene. Genetic properties of chromosomes and plasmids.
- 2 General processes of transcription - promoter, terminator, RNA polymerase, mRNA. Transcription in eukaryotes.
- 3 Translation - rRNA, tRNAs, codon, initiator codon, stop codon. Steps in protein synthesis.
- 4 Gene regulation and regulatory genes, with examples.
- 5 Spontaneous and induced mutations. Physical and chemical mutagens, transposons. Difference between genotype and phenotype.
- 6 Biotech applications of microbes.
- 7 Cancer as a mutation. Oncogene, tumor suppressor genes, metastasis. Oncogenic viruses.

Chapter 16B - Recombinant DNA

- 1 Principle of cloning, with terms - restriction enzyme, ligase, transformation, clones.
- 2 Examples of genes cloned for commercial/medical use. Transgenic animals and plants.
- 3 The polymerase chain reaction and its diagnostic applications.

Chapter 17 - Principles of disease and epidemiology (self study 1-2)

- 1 Development of the normal flora, and their function. Named examples with locations. Opportunistic pathogens.
- 2 Definitions of various epidemiology terms. Terms relating diseases and organs.
- 3 Koch's postulates and their limitations, Molecular Koch's postulates.
- 4 Nosocomial infections - causes, prevention, control. Named examples. Tracking nosocomial infections.

Chapter 18 - Microbial pathogenicity

- 1 Portals of entry.
- 2 Predisposing factors to infection - immune compromised conditions, diabetes, age.
- 3 Virulence factors: fimbriae, capsules, extracellular enzymes, exotoxins, endotoxins, virulence plasmids and lysogenic viruses.
- 4 Additional virulence mechanisms - intracellular growth, antigenic variation, formation of biofilms. Physiological properties of biofilm bacteria. Applications in dentistry and nursing, biofilm control.

Chapter 19 - Non-specific host defenses (self-study)

- 1 Predisposing factors of resistance - environmental, species, genetic.
- 2 Physical defenses - skin and mucous membranes, urine flow and secretions, normal flora.
- 3 Chemical defenses: Tears, nasal, vaginal secretions, skin oils, earwax; transferrin and lactoferrin; phagocytosis, inflammation and phagocyte migration, complement.

Chapter 20 - The immune system

- 1 Types of immunity - natural, acquired, active, passive. The HLA.
- 2 Cell-mediated immunity and T-cells.
- 3 Humoral immunity and B-cells. Antigens, immunogens, haptens, epitopes. Antibody structure. Ig classes, functions, locations. the antigen-antibody reaction.
- 4 Development of primary and secondary immune responses,. Generation of antibody diversity.

Chapter 21A, B - Immunology applications and disorders

- 1 Detection and quantitation of antigens: Direct agglutination, fluorescent antibody tests, ELISA, vaccine types and characteristics with examples.
- 2 Monoclonal antibodies. Human monoclonals.
- 3 Antibodies as enzymes.
- 4 Hypersensitivity types. Autoimmunity, infections as triggers.
- 5 Immune deficiencies.
- 6 Acquired Immune Deficiency Syndrome.

Chapter 22 - Antimicrobial drugs

- 1 Synthetic drugs, antibiotics, biologicals. Desired properties of antimicrobial drugs.
- 2 Some common drugs and where they act. Drugs are enzyme inhibitors.
- 3 Antibiotic sensitivity testing - Kirby Bauer method and MIC.
- 4 Drug resistance and the use of drug combinations. Transfer of resistance between bacteria.
- 5 Antimicrobial drug development.

Chapter 23 - Representative microbial diseases

- 1 Steps in diagnosis and treatment of infections. Notifiable and quarantinable diseases, with named examples.
- 2 For the diseases below, you should know the causative agent, transmission, essential symptoms, prevention.
- 3 Diseases of the throat and respiratory system: Streptococcal pharyngitis, otitis media, tuberculosis, various pneumonias, influenza.
- 4 Diseases of the mouth and digestive system: Streptococcus mutans, Porphyromonas gingivalis and Actinomyces, Helicobacter pylori gastritis, gastroenteritis due to E. coli, Salmonella, Staphylococcus, Clostridium difficile colitis, Hepatitis A.
- 5 Diseases of the urinary and reproductive tracts E. coli cystitis, gonorrhea, syphilis, Chlamydia trachomatis urethritis, genital herpes.
- 6 Diseases of the nervous system: Meningitis. Listeria monocytogenes. tetanus.
- 7 Diseases of the skin and eyes: Staphylococcus aureus, Pseudomonas aeruginosa, Trachoma.
- 8 Diseases of the cardiovascular system: Septicemia and septic shock, endocarditis, Lyme disease, malaria.