I. INTRODUCTION

A. An introduction to microorganisms (microbes) and their relationships to humans, the rest of the living world, and their non-living environment. Examination of the fundamental principles of microbiology, including the morphology, physiology, genetics, and classification of microbes and their relationships to soil, food, water, industry, disease, and immunology.

B. This course satisfies the Biology requirement in most curricula. Please check your degree plan to determine the status of this course in your program of study.

C. This course is occupationally related and serves as preparation for careers in science.

D. Prerequisite: CHEM 1411 and (BIOL 1406 and BIOL 1407) OR (BIOL 1411 AND BIOL 1413).

II. LEARNING OUTCOMES

Upon successfully completing this course, students will:

A. Provide examples of the impact of microorganisms on agriculture, environment, ecosystem, energy, and human health, including biofilms.

B. Identify the unique structures, capabilities, and genetic informational flow of microorganisms.

C. Compare the life cycles and structures of different types of viruses.

D. Discuss how microscopy has revealed the structure and function of microorganisms.

E. Give examples of the range of metabolic diversity exhibited by microorganisms, impact of metabolic characteristics on growth, and control of growth.

F. Describe evidence for the evolution of cells, organelles, and major metabolic pathways from early prokaryotes and how phylogenetic trees reflect evolutionary relationships.

G. Describe the causes and consequences of mutations on microbial evolution and the generation of diversity as well as human impacts on adaptation.

H. Classify interactions of microorganisms on human and non-human hosts as neutral, detrimental, or beneficial.
I. Apply scientific reasoning to investigate questions and utilize scientific tools such as microscopes and laboratory equipment to collect and analyze data.

J. Use critical thinking and scientific problem-solving to make informed decisions in the laboratory.

K. Communicate effectively the results of scientific investigations.

L. Provide examples of the impact of microorganisms on agriculture, environment, ecosystem, energy, and human health, including biofilms.

M. Identify unique structures, capabilities, and genetic information flow of microorganisms.

N. Compare the life cycles and structures of different types of viruses.

O. Discuss how microscopy has revealed the structure and function of microorganisms.

P. Give examples of the range of metabolic diversity exhibited by microorganisms, impact of metabolic characteristics on growth, and control of growth.

Q. Describe evidence for the evolution of cells, organelles, and major metabolic pathways from early prokaryotes and how phylogenetic trees reflect evolutionary relationships.

R. Describe the causes and consequences of mutations on microbial evolution and the generation of diversity as well as human impacts on adaptation.

S. Classify interactions of microorganisms on human and non-human hosts as neutral, detrimental, or beneficial.

III. INSTRUCTIONAL MATERIALS

The instructional materials identified for this course are viewable through www.ctcd.edu/books

V. COURSE REQUIREMENTS

A. **Reading Assignments:**
   You will be given a lecture schedule which details the reading requirements. **Reading should always be done before the corresponding lecture** to ensure that you have the appropriate background to understand the lecture material. Lecture tests may include any materials listed in the course outline and any additional lecture materials.

B. **Class Performance:**
   Students are expected to attend lecture and lab during their scheduled time. It is the responsibility of the student to sign-in during lecture and lab. Signing-in after class time will not be allowed. The maximum number of absences that a student that a student may accumulate is equivalent to 12.5% of the semester at which time this will be regarded as insufficient attendance which may result in an administrative withdrawal with a grade of F as stated in the college catalog. Excessive absences are usually reflected in the final grade and should be avoided.
V. EXAMINATIONS:

There will be four unit exams during the scheduled lecture time. These exams may consist of multiple choice, matching, true/false, short answer, labeling, definitions, and essay questions. There will be no exam review given during lecture time. If a student misses an exam then the comprehensive final lecture exam will count in place of the one missed exam. Other missed exams will result in a zero being recorded in the gradebook. **The final examination will be comprehensive and will be given on the date as listed in the schedule bulletin.**

VI. SEMESTER GRADE COMPUTATIONS

Microbiology 2421 course grade is based on a total of 1000 points.

<table>
<thead>
<tr>
<th>Component</th>
<th>Points</th>
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<tbody>
<tr>
<td>LECTURE EXAMS - Four @ 100 points</td>
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<tr>
<td>FINAL EXAM - One @ 150 points</td>
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<td>PRESENTATIONS - ONE @ 100 points</td>
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<td>COURSE TOTAL</td>
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COURSE GRADE:

- **A-** 900-1000 points
- **B-** 800-899
- **C-** 700-799
- **D-** 600-699
- **F-** 0-599

VII. NOTES AND ADDITIONAL INSTRUCTIONS FROM THE INSTRUCTOR

A. **Course Withdrawal:** It is the student’s responsibility to officially drop a class if circumstances prevent attendance. An instructor cannot initiate a withdrawal based on the student’s request. GoArmyEd students should contact their ACES counselor before withdrawing and withdraw through the GoArmyEd portal. All other students who desire to or must officially withdraw from a course on or after the first scheduled class meeting must file an Application for Withdrawal with the local CTC representative by the last date to withdraw. Students enrolled in distance learning courses and who do not have access to a local CTC representative should submit a withdrawal form to EaglesOnCall@ctcd.edu or the CTC Records Office in Killeen, Texas.

*Applications for Withdrawal will be accepted at any time before the completion of the 12th week of classes for 16-week courses, the sixth week of classes for eight-week courses, or the fourth week of classes for six-week courses.
*For non-GoArmyEd active military students, the effective date of withdrawal is the filing date with the Education Center. For all other students, the effective date
of withdrawal is the date that the withdrawal application is received by the Central Texas College representative.
*Students who used financial aid, military tuition assistance, VA benefits, or other non-personal funds may be required to repay tuition and fees to the funding agency. For specific repayment requirements, contact the Office of Student Financial Aid or Veterans Services Office before withdrawing. Military tuition assistance students should visit their military Education Center or Navy College Office.
*Students may not withdraw from a class for which the instructor has previously issued a grade of “F,” “FI,” “FN,” “IP,” or “XN.”

B. **Administrative Withdrawal:** A student may be administratively withdrawn by a designated member of the administrative staff of the College under the following conditions:
- The student has been placed on Academic Suspension or Disciplinary Suspension;
- The student has an outstanding financial obligation owed to the college; or
- The student registered for a course without the required prerequisite or departmental permission.

The college is under no obligation to refund tuition and fees, or other costs associated with a student who is administratively withdrawn.

C. **Incomplete Grade:** Incomplete, Course in Progress (for non-developmental courses): An “IP” grade may be assigned by an instructor if a student has made satisfactory progress in a course with the exception of a major quiz, final exam, or other project. The “IP” grade may also be assigned for extenuating circumstances beyond a student’s control such as personal illness, death in the immediate family, military orders, or in the case of distance learning courses, institutional technology failures and mail delays. Notice of absences with supporting documentation may be required by the instructor. The instructor makes the final decision concerning the granting of the incomplete grade. The instructor may set a deadline for completing the remaining course requirements. In no case will the deadline exceed 110 days after the scheduled end of the course. An “IP” grade cannot be replaced by the grade of “W.” If a student elects to repeat the course, the student must register, pay full tuition and fees and repeat the entire course.

At the end of the 110 calendar days if the student has not completed the remaining coursework as required by the instructor, the “IP” will be converted to an “FI” and appear as an “F” on the student’s official transcript. A student who merely fails to show for the final examination will receive a zero for the final and a “F” for the course.

D. **Cellular Phones:** Cellular phones will be turned off while the student is in the classroom or laboratory. Use of a cell phone during an exam will result in a zero for that exam. If a student in any way makes a copy of exam questions then that student will be dropped from the course with an “F”. The number for your
family members to call in an emergency is 254-526-1200. Appropriate personnel will immediately communicate the message to you.
E. **Americans With Disabilities Act (ADA):** Disability Support Services provide services to students who have appropriate documentation of a disability. Students requiring accommodations for class are responsible for contacting the Office of Disability Support Services (DSS) located on the central campus. This service is available to all students, regardless of location. Explore the website at [www.ctcd.edu/disability-support](http://www.ctcd.edu/disability-support) for further information. Reasonable accommodations will be given in accordance with the federal and state laws through the DSS office.

F. **Instructor Discretion:** The instructor reserves the right of final decision in course requirements.

G. **Civility:** Individuals are expected to be cognizant of what a constructive educational experience is and respectful of those participating in a learning environment. Failure to do so can result in disciplinary action up to and including expulsion.

H. Absolutely no food or drinks in the lecture classroom or the laboratory room.

I. Courtesy dictates that you discuss any problem with your instructor first. If the issue cannot be resolved, then contact the Chair of the Science and Agricultural Department.

VIII. **COURSE OUTLINE**

1: A Brief History of Microbiology

1. List several ways in which microbes affect our lives.
2. Recognize the system of scientific nomenclature that uses two names: a genus and specific epithet.
3. Differentiate among the major characteristics of each group of microorganisms.
4. List the three domains.
5. Explain the importance of observations made by Hooke and van Leeuwenhoek.
6. Compare spontaneous generation and biogenesis.
7. Identify the contributions to microbiology made by Needham, Spallanzani, Virchow, and Pasteur.
8. Identify the importance of Koch’s postulates.
9. Explain how Pasteur’s work influenced Lister and Koch.
10. Identify the importance of Jenner’s work.
11. Identify the contributions to microbiology made by Ehrlich and Fleming.
12. Define bacteriology, mycology, parasitology, immunology, and virology.
13. Explain the importance of recombinant DNA technology.
14. List at least four beneficial activities of microorganisms.
15. List two examples of biotechnology that use recombinant DNA technology and two examples that do not.
17. Define and describe several infectious diseases.
18. Define emerging infectious disease.

January 11, 2017
2: The Chemistry of Microbiology

1. Describe the structure of an atom and its relation to the chemical properties of elements.
3. Diagram three basic types of chemical reactions.
4. List several properties of water that are important to living systems.
5. Define acid, base, salt, and pH.
6. Distinguish between organic and inorganic compounds.
8. Identify the building blocks of carbohydrates.
9. Differentiate between simple lipids, complex lipids, and steroids.
10. Identify the building blocks and structure of proteins.
11. Identify the building blocks of nucleic acids.
12. Describe the role of ATP in cellular activities.

3: Cell Structure and Function

1. Compare and contrast the overall cell structure of prokaryotes and eukaryotes.
2. Identify the three basic shapes of bacteria.
3. Describe the structure and function of the glycocalyx, flagella, axial filaments, fimbriae, and pili.
4. Compare and contrast the cell walls of gram-positive bacteria, gram-negative bacteria, acid-fast bacteria, archaea, and mycoplasmas.
5. Differentiate between protoplast, spheroplast, and L form.
6. Describe the structure, chemistry, and functions of the prokaryotic plasma membrane.
7. Define simple diffusion, facilitated diffusion, osmosis, active transport, and group translocation.
8. Identify the functions of the nuclear area, ribosomes, and inclusions.
9. Describe the functions of endospores, sporulation, and endospore germination.
10. Differentiate between prokaryotic and eukaryotic flagella.
11. Compare and contrast prokaryotic and eukaryotic cell walls and glycocalyces.
12. Compare and contrast prokaryotic and eukaryotic plasma membranes.
13. Compare and contrast prokaryotic and eukaryotic cytoplasms.
15. Describe the functions of the nucleus, endoplasmic reticulum, ribosomes, Golgi complex, lysosomes, vacuoles, mitochondria, chloroplasts, peroxisomes, and centrosomes.
16. Discuss evidence that supports the endosymbiotic theory of eukaryotic evolution.

4: Microscopy, Staining, and Classification

1. List the metric units of measurement, including their metric equivalents that are used for microorganisms.
2. Diagram the path of light through a compound microscope.
3. Define total magnification and resolution.
4. Identify a use for darkfield, phase-contrast, differential interference contrast, fluorescence, confocal, and scanning acoustic microscopy, and compare each with brightfield illumination.
5. Explain how electron microscopy differs from light microscopy.
6. Identify one use for the TEM, SÉM, and scanned-probe microscopes.
7. Differentiate between an acidic dye and a basic dye.
8. Compare simple, differential, and special stains.
9. List the steps in preparing a Gram stain, and describe the appearance of gram-positive and gram-negative cells after each step.
10. Compare and contrast the Gram stain and the acid-fast stain.
11. Explain why each of the following is used: capsule stain, endospore stain, flagella stain.
5: Microbial Metabolism

1. Define metabolism, and describe the fundamental differences between anabolism and catabolism.
2. Identify the role of ATP as an intermediate between catabolism and anabolism.
3. Identify the components of an enzyme.
4. Describe the mechanism of enzymatic action.
5. List the factors that influence enzymatic activity.
6. Define ribozyme.
7. Explain what is meant by oxidation–reduction.
8. List and provide examples of three types of phosphorylation reactions that generate ATP.
9. Explain the overall function of biochemical pathways.
10. Describe the chemical reactions of glycolysis.
11. Explain the products of the Krebs cycle.
12. Describe the chemiosmotic model for ATP generation.
13. Compare and contrast aerobic and anaerobic respiration.
14. Describe the chemical reactions of, and list some products of, fermentation.
15. Describe how lipids and proteins undergo catabolism.
16. Provide two examples of the use of biochemical tests to identify bacteria.
17. Compare and contrast cyclic and noncyclic photophosphorylation.
18. Compare and contrast the light-dependent and light-independent reactions of photosynthesis.
19. Compare and contrast oxidative phosphorylation and photophosphorylation.
20. Write a sentence to summarize energy production in cells.
21. Categorize the various nutritional patterns among organisms according to carbon source and mechanisms of carbohydrate catabolism and ATP generation.
22. Describe the major types of anabolism and their relationship to catabolism.
23. Define amphibolic pathways.

6: Microbial Nutrition and Growth

1. Classify microbes into five groups on the basis of preferred temperature range.
2. Identify how and why the pH of culture media is controlled.
3. Explain the importance of osmotic pressure to microbial growth.
4. Provide a use for each of the four elements (carbon, nitrogen, sulfur, and phosphorus) needed in large amounts for microbial growth.
5. Explain how microbes are classified on the basis of oxygen requirements.
6. Identify ways in which aerobes avoid damage by toxic forms of oxygen.
7. Distinguish between chemically defined and complex media.
8. Justify the use of each of the following: anaerobic techniques, living host cells, candle jars, selective and differential media, enrichment media.
10. Describe how pure cultures can be isolated by using streak plates.
11. Explain how microbes are preserved by deep-freezing and lyophilization (freeze-drying).
12. Define bacterial growth, including binary fission.
13. Compare the phases of microbial growth and describe their relation to generation time.
14. Explain four direct methods of measuring cell growth.
15. Differentiate between direct and indirect methods of measuring cell growth.
16. Explain three indirect methods of measuring cell growth.

7: Microbial Genetics

1. Define genetics, genome, chromosome, gene, genetic code, genotype, phenotype, and genomics.
2. Describe how DNA serves as genetic information.
3. Describe the process of DNA replication.
4. Describe protein synthesis, including transcription, RNA processing, and translation.
5. Explain the regulation of gene expression in bacteria by induction, repression, and catabolite repression.
6. Classify mutations by type, and describe how mutations are prevented and repaired.
7. Define mutagen.
8. Describe two ways mutations can be repaired.
9. Describe the effect of mutagens on the mutation rate.
10. Outline methods of direct and indirect selection of mutants.
11. Identify the purpose and outline the procedure for the Ames test.
12. Compare the mechanisms of genetic recombination in bacteria.
13. Differentiate between horizontal and vertical gene transfer.
14. Describe the functions of plasmids and transposons.
15. Discuss how genetic mutation and recombination provide material for natural selection to act on.

8: Recombinant DNA Technology

1. Compare and contrast biotechnology, genetic modification, and recombinant DNA.
2. Identify the roles of a clone and a vector in making recombinant DNA.
3. Compare selection and mutation.
4. Define restriction enzymes, and outline how they are used to make recombinant DNA.
5. List the four properties of vectors.
6. Describe the use of plasmid and viral vectors.
7. Outline the steps in PCR and provide an example of its use.
8. Describe five ways of getting DNA into a cell.
9. Describe how a gene library is made.
10. Differentiate cDNA from synthetic DNA.
11. Explain how each of the following are used to locate a clone: antibiotic-resistance genes, DNA probes, gene products.
12. List one advantage of engineering the following: *E. coli*, *Saccharomyces cerevisiae*, mammalian cells, plant cells.
13. List at least five applications of rDNA Technology.
14. Define RNAi.
15. Discuss the value of the Human Genome Project.
16. Define the following terms: random shotgun sequencing, bioinformatics, proteomics.
17. Diagram the Southern blot procedure and provide an example of its use.
18. Diagram DNA fingerprinting and provide an example of its use.
19. Outline genetic engineering with *Agrobacterium*.
20. List the advantages of, and problems associated with, the use of genetic modification techniques.

9: Controlling Microbial Growth in the Environment

1. Define the following key terms related to microbial control: sterilization, disinfection, antisepsis, degerming, sanitization, biocide, germicide, bacteriostasis, and asepsis.
2. Describe the patterns of microbial death caused by treatments with microbial control agents.
3. Describe the effects of microbial control agents on cellular structures.
4. Compare the effectiveness of moist heat (boiling, autoclaving, pasteurization) and dry heat.
5. Describe how filtration, low temperature, high pressure, desiccation, and osmotic pressure suppress microbial growth.
6. Explain how radiation kills cells.
7. List the factors related to effective disinfection.
8. Interpret results of use-dilution tests and the disk-diffusion method.
9. Identify the methods of action and preferred uses of chemical disinfectants.
10. Differentiate between halogens used as antiseptics and as disinfectants.
11. Identify the appropriate uses for surface-active agents.
12. List the advantages of glutaraldehyde over other chemical disinfectants.
13. Identify the method of sterilizing plastic labware.
14. Explain how microbial control is affected by the type of microbe.
10: Controlling Microbial Growth in the Body: Antimicrobial Drugs

1. Identify the contributions of Paul Ehrlich and Alexander Fleming to chemotherapy.
2. Name the microbes that produce most antibiotics.
3. Describe the problems of chemotherapy for viral, fungal, protozoan, and helminthic infections.
4. Define the following terms: spectrum of activity, broad-spectrum drugs, superinfection.
5. Identify five modes of action of antimicrobial drugs.
6. Explain why the drugs described in this section are specific for bacteria.
7. List the advantages of each of the following over penicillin: semisynthetic penicillins, cephalosporins, and vancomycin.
8. Explain why INH and ethambutol are antimycobacterial agents.
9. Describe how each of the following inhibits protein synthesis: aminoglycosides, tetracyclines, chloramphenicol, macrolides.
11. Describe how rifamycins and quinolones kill bacteria.
12. Describe how sulfa drugs inhibit microbial growth.
13. Explain the modes of action of currently used antifungal drugs.
14. Explain the modes of action of currently used antiviral drugs.
15. Explain the modes of action of currently used antiprotozoan and antihelminthic drugs.
16. Describe two tests for microbial susceptibility to chemotherapeutic agents.
17. Describe the mechanisms of drug resistance.
18. Compare and contrast synergism and antagonism.
19. Identify three areas of research on new chemotherapeutic agents.

12: Characterizing and Classifying Eukaryotes

1. List the defining characteristics of fungi.
2. Differentiate between sexual and asexual reproduction, and describe each of these processes in fungi.
3. List the defining characteristics of the three phyla of fungi described in this chapter.
4. Identify two beneficial and two harmful effects of fungi.
5. List the distinguishing characteristics of lichens, and describe their nutritional needs.
6. Describe the roles of the fungus and the alga in a lichen.
7. List the defining characteristics of algae.
8. List the outstanding characteristics of the five phyla of algae discussed in this chapter.
9. List the defining characteristics of protozoa.
10. Describe the outstanding characteristics of the seven phyla of protozoa discussed in this chapter, and give an example of each.
11. Differentiate an intermediate host from a definitive host.
12. Compare and contrast cellular slime molds and plasmodial slime molds.
13. List the distinguishing characteristics of parasitic helminths.
15. List the characteristics of the two classes of parasitic helminths, and give an example of each.
16. List the characteristics of parasitic nematodes, and give an example of infective eggs and infective larvae.
17. Compare and contrast platyhelminthes and nematodes.
18. Define arthropod vector.
19. Differentiate between a tick and a mosquito, and name a disease transmitted by each.

13: Characterizing and Classifying Viruses, Viroids, and Prions

1. Differentiate a virus from a bacterium.
2. Describe the chemical composition and physical structure of an enveloped and a nonenveloped virus.
3. Define viral species.
4. Give an example of a family, genus, and common name for a virus.
5. Describe how bacteriophages are cultured.
6. Describe how animal viruses are cultured.
7. List three techniques that are used to identify viruses.
8. Describe the lytic cycle of T-even bacteriophages.
9. Describe the lysogenic cycle of bacteriophage lambda.
10. Compare and contrast the multiplication cycle of DNA- and RNA-containing animal viruses.
11. Define oncogene and transformed cell.
12. Discuss the relationship between DNA- and RNA-containing viruses and cancer.
13. Provide an example of a latent viral infection.
14. Differentiate between persistent viral infections and latent viral infections.
15. Discuss how a protein can be infectious.
16. Differentiate virus, viroid, and prion.
17. Name a virus that causes a plant disease.

14: Infection, Infectious Diseases, and Epidemiology

1. Define pathology, etiology, infection, and disease.
2. Define normal and transient microbiota.
3. Compare commensalism, mutualism, and parasitism, and give an example of each.
4. Contrast normal and transient with opportunistic microbes.
5. List Koch’s postulates.
6. Differentiate a communicable from a noncommunicable disease.
7. Categorize diseases according to frequency of occurrence.
8. Categorize diseases according to severity.
9. Define herd immunity.
10. Identify four predisposing factors for disease.
11. Put the following terms in proper sequence in terms of the pattern of disease: period of decline, period of convalescence, period of illness, prodromal period, incubation period.
12. Define reservoir of infection.
13. Contrast human, animal, and nonliving reservoirs, and give one example of each.
15. Define nosocomial infections and explain their importance.
16. Define compromised host.
17. List several methods of disease transmission in hospitals.
18. Explain how nosocomial infections can be prevented.
19. List several probable reasons for emerging infectious diseases, and name one example for each reason.
20. Define epidemiology and describe three types of epidemiologic investigation.
21. Identify the function of the CDC.
22. Define the following terms: morbidity, mortality, and notifiable disease.
23. Identify the principal portals of entry.
24. Define LD$_{50}$ and ID$_{50}$.
25. Using examples, explain how microbes adhere to host cells.
26. Explain how capsules and cell wall components contribute to pathogenicity.
27. Compare the effects of coagulases, kinases, hyaluronidase, and collagenase.
28. Define and give an example of antigenic variation.
29. Describe how bacteria use the host cell’s cytoplasm to enter the cell.
30. Describe the function of siderophores.
31. Provide an example of direct damage, and compare this to toxin production.
32. Contrast the nature and effects of exotoxins and endotoxins.
34. Identify the importance of the LAL assay.
35. Using examples, describe the role of plasmids and lysogeny in pathogenicity.
36. List nine cytopathic effects of viral infections.
37. Discuss the causes of symptoms in fungal, protozoan, helminthic, and algal diseases.
38. Compare and contrast portal of entry and portal of exit.
15: Innate Immunity:

1. Differentiate between innate and adaptive immunity.
2. Define toll-like receptors.
3. Describe the role of the skin and mucous membranes in innate immunity.
4. Differentiate physical from chemical factors, and list five examples of each.
5. Describe the role of normal microbiota in innate resistance.
6. Classify phagocytic cells, and describe the roles of granulocytes and monocytes.
7. Define differential white blood cell count.
8. Define phagocyte and phagocytosis.
9. Describe the process of phagocytosis, and include the stages of adherence and ingestion.
10. Identify six methods of avoiding destruction by phagocytes.
11. List the stages of inflammation.
12. Describe the roles of vasodilation, kinins, prostaglandins, and leukotrienes in inflammation.
13. Describe phagocyte migration.
14. Describe the cause and effects of fever.
15. List the components of the complement system.
17. Describe three consequences of complement activation.
18. Define interferons.
19. Compare and contrast the actions of α-IFN and β-IFN with γ-IFN.
20. Describe the role of transferrins in innate immunity.
21. Describe the role of antimicrobial peptides in innate immunity.

16: Adaptive Immunity:

1. Differentiate between innate and adaptive immunity.
2. Differentiate between humoral and cellular immunity.
3. Define antigen, epitope, and hapten.
4. Explain the function of antibodies and describe their structural and chemical characteristics.
5. Name one function for each of the five classes of antibodies.
6. Compare and contrast T-dependent antigens and T-independent antigens.
7. Differentiate between plasma cell and memory cell.
8. Describe clonal selection.
9. Describe how a human can produce different antibodies.
10. Describe four outcomes of an antigen-antibody reaction.
11. Describe at least one function of each of the following: M cells, TH₁ cells, TH₂ cells, TC cells, Tg cells, CTL, NK cell.
12. Differentiate between helper T, cytotoxic T, and regulatory T cells.
13. Differentiate between TH₁ and TH₂ cells.
15. Define antigen-presenting cell.
16. Describe the function of natural killer cells.
17. Describe the role of antibodies and natural killer cells in antibody-dependent cell-mediated cytotoxicity.
18. Identify at least one function of each of the following: cytokines, interleukins, interferons.
19. Distinguish a primary from a secondary immune response.
20. Contrast the four types of adaptive immunity.

19: Microbial Diseases of the Skin and Wounds

1. Describe the structure of the skin and mucous membranes and the ways pathogens can invade the skin.
2. Provide examples of normal skin microbiota, and state their locations and ecological roles of its members.
3. Differentiate staphylococci from streptococci, and name several skin infections caused by each.
5. List the causative agent, method of transmission, and clinical symptoms of these skin infections: warts, smallpox, chickenpox, shingles, cold sores, measles, rubella, fifth disease, roseola.
6. Differentiate cutaneous from subcutaneous mycoses, and provide an example of each.
7. List the causative agent of and predisposing factors for candidiasis.
8. List the causative agent, method of transmission, clinical symptoms, and treatment for scabies and pediculosis.

18: AIDS and Other Immune Disorders

1. Compare and contrast the four types of hypersensitivity.
2. Discuss the mechanisms underlying transfusion reactions.
3. Describe the mechanisms and treatment of hemolytic disease of the newborn.
4. Discuss the cause and signs of systemic Lupus erythematosus.
5. Describe the significance of the tuberculin test.
6. Compare four types of drugs commonly used to prevent graft rejection.
7. Discuss the causes of autoimmunity and autoimmune diseases.
8. Describe HIV, including its structure, possible origin, replication cycle, and transmission.
9. Describe the relationship of helper T cell population to the course of AIDS.
10. Describe the diagnosis, treatment, and prevention of AIDS, and list four behaviors that increase the risk of infection with HIV.

20: Microbial Diseases of the Nervous System and Eyes

1. Define central nervous system and blood-brain barrier.
2. Differentiate meningitis from encephalitis.
3. Discuss the epidemiology of meningitis caused by \textit{H. influenzae}, \textit{S. pneumoniae}, \textit{N. meningitidis}, and \textit{L. monocytogenes}.
4. Explain how bacterial meningitis is diagnosed and treated.
5. Discuss the epidemiology of tetanus, including mode of transmission, etiology, disease symptoms, and preventive measures.
6. State the causative agent, symptoms, suspect foods, and treatment for botulism.
7. Discuss the epidemiology of leprosy, including mode of transmission, etiology, disease symptoms, and preventive measures.
8. Discuss the epidemiology of poliomyelitis, rabies, and arboviral encephalitis, including mode of transmission, etiology, and disease symptoms.
9. Compare the Salk and Sabin vaccines.
10. Compare preexposure and postexposure treatments for rabies.
11. Explain how arboviral encephalitis can be prevented.
12. Identify the causative agent, reservoir, symptoms, and treatment for cryptococcosis.
13. Identify the causative agent, vector, symptoms, and treatment for African trypanosomiasis and amebic meningoencephalitis.
14. List the characteristics of diseases caused by prions.
15. List some possible causes of chronic fatigue syndrome.
16. List the causative agent, method of transmission, and clinical symptoms of these eye infections: neonatal gonorrheal ophthalmia, inclusion conjunctivitis, trachoma.
17. List the causative agent, method of transmission, and clinical symptoms of these eye infections: herpetic keratitis, \textit{Acanthamoeba} keratitis.

21: Microbial Cardiovascular and Systemic Diseases

1. Identify the role of the cardiovascular and lymphatic systems in spreading and eliminating infections.
2. List the signs and symptoms of septicemia, and explain the importance of infections that develop into septicemia.
3. Differentiate gram-negative sepsis, gram-positive sepsis, and puerperal sepsis.
4. Describe the epidemiologies of bacterial endocarditis and rheumatic fever.
5. Discuss the epidemiology of tularemia.
6. Discuss the epidemiology of brucellosis.
7. Discuss the epidemiology of anthrax.
8. Discuss the epidemiology of gas gangrene.
9. List three pathogens that are transmitted by animal bites and scratches.
10. Compare and contrast the causative agents, vectors, reservoirs, symptoms, treatments, and preventive measures for plague, Lyme disease, and Rocky Mountain Spotted Fever.
11. Identify the vector, etiology, and symptoms of five diseases transmitted by ticks.
12. Describe the epidemiologies of epidemic typhus, endemic murine typhus, and spotted fevers.
13. Describe the epidemiologies of CMV inclusion disease, Burkitt’s lymphoma, and infectious mononucleosis.
14. Compare and contrast the causative agents, vectors, reservoirs, and symptoms for yellow fever, dengue, and dengue hemorrhagic fever.
15. Compare and contrast the causative agents, modes of transmission, reservoirs, and symptoms for Ebola hemorrhagic fever and Hantavirus pulmonary syndrome.
16. Compare and contrast the causative agents, modes of transmission, reservoirs, symptoms, and treatments for Chagas’ disease, toxoplasmosis, malaria, leishmaniasis, and babesiosis.
17. Discuss the worldwide effects of these diseases on human health.
18. Diagram the life cycle of Schistosoma, and show where the cycle can be interrupted to prevent human disease.

22: Microbial Diseases of the Respiratory System

1. Describe how microorganisms are prevented from entering the respiratory system.
2. Characterize the normal microbiota of the upper and lower respiratory systems.
3. Differentiate among pharyngitis, laryngitis, tonsillitis, sinusitis, and epiglottitis.
4. List the causative agent, symptoms, prevention, preferred treatment, and laboratory identification tests for streptococcal pharyngitis, scarlet fever, diphtheria, cutaneous diphtheria, and otitis media.
5. List the causative agents and treatments for the common cold.
6. List the causative agent, symptoms, prevention, preferred treatment, and laboratory identification tests for pertussis and tuberculosis.
7. Compare and contrast the seven bacterial pneumonias discussed in this chapter.
8. List the etiology, method of transmission, and symptoms of melioidosis.
9. List the causative agent, symptoms, prevention, and preferred treatment for viral pneumonia, RSV, and influenza.
10. List the causative agent, mode of transmission, preferred treatment, and laboratory identification tests for four fungal diseases of the respiratory system.

23: Microbial Diseases of the Digestive System

1. Describe how normal microbiota are confined to the mouth and large intestines.
2. List the causative agents, suspect foods, signs and symptoms and treatments for staphylococcal food poisoning, shigellosis, salmonellosis, typhoid fever, cholera, gastroenteritis, and peptic ulcer disease.

24: Microbial Diseases of the Urinary and Reproductive Systems

1. Describe the modes of transmission for urinary and reproductive system infections.
2. List the microorganisms that cystitis, pyelonephritis, and leptospirosis and the predisposing factors for these disease.
3. List the causative agents, symptoms, methods of diagnosis, and treatments for gonorrhea, nongonococcal urethritis, PID, syphilis, LVG, cancroid, and bacterial vaginosis.
25: Environmental, Applied, and Industrial Microbiology

1. Outline the sulfur cycle and explain the roles of microorganisms in this cycle.
2. Explain the process of nitrogen fixation.
3. List the stages in a typical sewage treatment.
4. Define industrial fermentation and bioreactor.
5. Describe how microbes provide fuels for cars and electricity.
6. Discuss the Hazard Analysis and Critical Control Point System.