



MICRO 741: Microbiology

Course Description: This course stresses the fundamental biochemical and molecular concepts for the microbial interaction with host body systems in both health and disease. Participation in lectures, laboratory exercises and small group sessions is required. **NOTE:** This course is also listed as Dental 641 and is **not** offered to microbiology graduate students

Credit Hours: 6 semester hours

Course Prerequisites: Biology, Biochemistry

Course Dates: Spring Semester

Course Times: see attached schedule

Course Location: D113 unless otherwise noted

Instructor: Michael Lundrigan, Course Director

Required Text and Other Learning Resources: Essential Microbiology for Dentistry, 3rd ed., Elsevier, 2006, by L.P. Samaranayake. **RECOMMENDED TEXT:** Oral Microbiology and Immunology, ASM Press, Washington, D.C. 2006, R.J. Lamont, M.S. Lantz, R.A. Burne and D.J. LeBlanc, editors.

Course Overview: Microbiology is a 76-hour course that provides an understanding of microbe-host interrelationships from an immunologic and microbiologic point of view. Special emphasis is placed on the importance of dental medicine not only for the health of the oral cavity but also on the health of the entire body. The students are introduced to methods of control of infectious disease and treatment of patients not only through lectures, but also through case studies, small group exercises, laboratories, and clinical presentations.

Course Objectives: Upon completion of this course, students will be able to:

A. Immunology

1. Describe the concepts relating to immunological self-recognition.
2. Describe the properties, prophylactic uses, and diagnostic uses of antigens.
3. Describe the structure, synthesis, and biological properties of the immunoglobulin classes.
4. Describe the components, activation, and biological properties of the complement system.

5. Identify the tissues and cells of the immune system and describe their roles in the primary and secondary immune response. Describe the basic characteristics of B and T lymphocytes, TH1 versus TH2 cells, neutrophils and macrophages and their respective roles in innate versus adaptive immune responses.
6. Describe the role(s) of the major histocompatibility gene products in normal immune responses.
7. Describe isotypes, allotypes and idiotypes.
8. Describe the molecular genetics of immunoglobulin, T cell receptor and the major histocompatibility genes.
9. Describe the development and potential uses of monoclonal antibodies employing hybridoma technology.
10. Identify the major cytokines and their roles in cellular interactions.
11. Describe the following *in vitro* immunological reactions:

a. precipitation tests	e. enzyme linked assays
b. agglutination tests	f. complement fixation tests
c. immunofluorescence tests	g. lymphokine assays
d. radioimmunoassay	h. lymphocyte transformation test
12. Describe the immunology of the following:

a. immune protection	f. autoimmune diseases
b. hypersensitivity reactions	g. caries
c. immunodeficiency diseases	h. periodontal diseases
d. immunosuppression	i. transplantation
e. cancer	

B. Bacterial Physiology

1. Describe the composition, structure, physiology and functions of the following:

a. bacterial chromosome	f. flagella
b. bacterial cytoplasm	g. pili
c. cytoplasmic membrane	h. endospore
d. gram negative cell outer membrane	i. lipoteichoic acids
e. capsule	j. peptidoglycans
	k. lipopolysaccharides
2. Describe, using oral bacteria whenever possible as examples, the following:

a. anabolism	g. metabolic regulatory mechanisms
b. catabolism	h. allosteric enzymes
c. fermentation	i. gram reaction
d. respiration	j. binary fission
e. sporulation	k. chemoheterotrophs
f. germination	

3. Differentiate the properties and characteristics of eucaryotic and bacterial cells.
4. Discuss the phases of a typical bacterial growth curve.
5. Classify bacteria by their oxygen requirements and compare the mechanisms involved.
6. Describe the properties of bacterial biofilms.
7. Describe the major virulence mechanisms of pathogenic bacteria.

C. Microbial Genetics and Gene Transfer

1. Describe the structure and function of genes and chromosomes.
2. Describe the components and metabolism of an operon.
3. Describe how the following apply to microbial genetics:

a. transcription	g. transformation
b. translation	h. transduction
c. mutation	i. conjugation
d. transition	j. genetic recombination
e. transversion	k. plasmids
f. genetic recombination	l. genetic engineering
4. Describe how a bacteriophage genome can affect a host cell.
5. Describe the steps involved in conjugation between bacteria.
6. Name types of donor cells.
7. Compare and contrast gram-negative and gram-positive bacterial conjugation.
8. Describe the essential features of the F factor.
9. Compare and contrast F factors and resistance transfer factors.
10. Describe how the different types of donor cells are generated.
11. Define plasmid types.
12. Describe plasmid functions.
13. Explain transfer mechanism of mobilizable plasmids.
14. Describe conjugative transposons.
15. Relate conjugal transfer of genetic material to bacterial pathogenesis.
16. Outline Griffith's original discovery of transformation.
17. Compare and contrast natural and artificial transformation.
18. Define bacterial competence.
19. Describe the steps involved in the development of competence and transformation in *Streptococcus pneumoniae*.
20. Explain the relevance of bacterial transformation to pathogenesis.
21. Define bacterial transduction by bacteriophages.
22. Describe lytic and lysogenic responses in bacteriophages.
23. Compare and contrast generalized and specialized transduction.
24. List examples of phage encoded virulence factors.

D. Disinfection and Sterilization

1. Define the following:
 - a. sepsis
 - b. asepsis
 - c. antiseptic
 - d. germicide
 - e. disinfectant
 - f. disinfection
 - g. bacteriostatic/bactericidal
 - h. sterilization
 - i. cold sterilization
 - j. microbial death
2. Describe the influence on sterilization of the following:
 - a. kinds of microbes
 - b. numbers of microbes
 - c. duration of exposure
 - d. concentration of agent
 - e. temperature
 - f. medium
 - g. debris
3. Describe the mechanisms of microbial destruction.
4. Describe properties of an "ideal" germicide.
5. Describe the actions, conditions for use, and efficacy, of the following physical agents:
 - a. pasteurization
 - b. boiling
 - c. steam
 - d. dry heat
 - e. radiant energy
 - f. filtration
 - g. ultrasonic energy
 - h. mechanical cleansing
6. Describe the actions, uses, advantages, and disadvantages of the following antimicrobial agents:
 - a. alcohol
 - b. phenols
 - c. peroxide
 - d. sodium hypochlorite
 - e. iodine
 - f. chlorine dioxide
 - g. quaternary ammonium compounds
 - h. heavy metals
 - i. aldehydes
 - j. ethylene oxide
 - k. chlorhexidine
7. Describe the tests used to evaluate the efficacy of antimicrobial agents.
8. Describe the uses and effectiveness of chemical and biological indicators to monitor gas, steam, and dry heat sterilization.
9. List the infections most transmissible during dental treatments and describe their routes of transmission.
10. List the immunizations, diagnostic tests, and methods of protection for the eyes, airways, hands, and clothing of dental personnel.
11. Describe available cleansers and the effectiveness of handwashing techniques.
12. List the kinds of operatory surfaces that must be disinfected or protected with covers.

13. Distinguish categories of dental surgical and non-surgical instruments and discuss their safe handling, cleaning, packaging, sterilization, and storage.

E. Antibiotics and Chemotherapeutics

1. Define antibiosis, antibiotic, chemotherapeutic agent spectrum, and semisynthetic antimicrobial agents.
2. Differentiate and contrast the properties of antibiotics and disinfectants.
3. Describe the properties of an "ideal" antibiotic.
4. Describe the factors involved in the efficacy of antibiotic use.
5. Identify and describe the dangers in indiscriminate use of antibiotics.
6. Define synergism, antagonism and describe the use of antibiotic combinations.
7. Describe the theories and mechanisms of antibiotic resistance.
8. Describe the methods used for antibiotic sensitivity testing and explain the clinical significance of the test results.
9. Describe ways to minimize development of antibiotic resistance.
10. Describe the spectrum, targets, mode of action and mechanisms of microbial resistance of:
 - a. penicillins
 - b. cephalosporins
 - c. sulfa compounds
 - d. nitrofurans
 - e. azithromycin
 - f. trimethoprim
 - g. erythromycin
 - h. tetracycline
 - i. clindamycin
 - j. rifampin
 - k. quinolones
 - l. cycloserine
 - m. lincomycin
 - n. chloramphenicol
 - o. streptomycin
 - p. quinupristin/dalfopristin
 - q. linezolid
 - r. vancomycin
 - s. griseofulvin
 - t. amphotericin B
 - u. 5-fluorocytosine
 - v. imidazoles
 - w. nystatin

F. Host-Parasite Relationship

1. List Koch's postulates and describe the problems associated with their application in light of modern concepts of infectious diseases, especially oral diseases.
2. Define the following:
 - a. pathogenicity
 - b. virulence
 - c. infection
 - d. disease
3. Discuss, using examples, different methods by which an organism may exert its pathogenicity.
4. Describe the specific and nonspecific mechanisms of host defense.
5. Differentiate between the properties of exotoxins and endotoxins and give examples of microorganisms that produce them.

6. Define the following epidemiological terms:

- | | |
|--------------------|-------------|
| a. morbidity | e. endemic |
| b. mortality | f. epidemic |
| c. prevalence | g. pandemic |
| d. incidence rates | |

G. Infectious Diseases (Bacterial and Mycological)

- List the sources, genera, and species detected in mixed aerobic and anaerobic pyogenic infections of oral tissues.
- Describe the morphologic features unique to fungi.
- Describe the etiology, pathogenesis, clinical manifestations, epidemiology, diagnosis, and treatments of the following fungal diseases:
 - candidiasis
 - histoplasmosis
 - blastomycosis
 - cryptococcosis
 - coccidioidomycosis
 - dermatophytic infections
- Describe the morphology, physiology, pathogenesis, clinical manifestations, epidemiology, prevention, and control of the diseases caused by the following bacteria:

a. <i>Staphylococcus aureus</i>	q. <i>Hemophilus influenzae</i>
b. <i>Staphylococcus epidermidis</i>	r. <i>Brucella</i> species
c. <i>Streptococcus pyogenes</i>	s. <i>Yersinia pestis</i>
d. <i>Streptococcus pneumoniae</i>	t. <i>Neisseria gonorrhoeae</i>
e. <i>Mycobacterium tuberculosis</i>	u. <i>Treponema pallidum</i>
f. <i>Corynebacterium diphtheriae</i>	v. <i>Mycoplasma</i> species
g. <i>Bacteroides</i> species	w. <i>Rickettsiae</i>
h. <i>Actinomyces</i> species	x. <i>Chlamydiae</i>
i. <i>Nocardia</i> species	y. <i>Mycobacterium</i> species
j. <i>Clostridium botulinum</i>	z. <i>Legionella pneumophila</i>
k. <i>Clostridium tetani</i>	aa. <i>Francisella tularensis</i>
l. Gas gangrene clostridia	bb. <i>Pasteurella multocida</i>
m. Opportunistic Enterobacteriaceae	cc. <i>Bartonella henselae</i>
n. <i>Salmonella typhi</i>	dd. <i>Borrelia burgdorferi</i>
o. <i>Vibrio cholerae</i>	ee. <i>Prevotella</i> species
p. <i>Bordetella pertussis</i>	ff. <i>Porphyromonas</i> species
	gg. <i>Campylobacter</i> species

H. Normal Oral Flora

- Describe major groups of bacteria that are part of the normal oral flora.
- Describe the problems associated with studying oral flora including:
 - sampling

- b. microbial cultivation
 - c. microbial identification
3. Describe the physiological interrelationships associated with colonization of the oral cavity and subsequent microbial growth including adherence and retention mechanisms as well as bacterial antagonism.
 4. Discuss parameters (chemicals, physical, host factors, hygiene, medications) that can influence oral flora.
 5. Describe the changes in oral flora from birth through aging.
 6. List the predominant oral flora associated with:
 - a. saliva
 - b. tongue dorsum
 - c. coronal plaque
 - d. buccal mucosa
 - e. gingival crevice
 7. List the oral flora that may cause chronic or recurrent infections.

I. Dental Plaque

1. Define acquired enamel pellicle, dental plaque and calculus.
2. Describe the formation of the acquired pellicle.
3. Describe the structure and chemical composition of the acquired pellicle.
4. Describe the structure of and the microbial and physiological changes in developing dental plaque and mature plaque at various oral sites.
5. Describe mechanisms that have been proposed to explain the formation of dental plaque including bacterial adherence and growth factors and interactions with host-derived factors.
6. Describe the influence on dental plaque formation and/or removal of chewing, salivary flow, flossing and brushing, oral rinses, antibiotics and antimicrobial agents, and diet.
7. Describe the composition and structure of dental calculus.
8. Describe the formation of calculus and the role it might play in dental diseases.

J. Microbiology of Dental Caries

1. Define dental caries.
2. Describe the relationships among host, diet, and microorganisms in the causation and progression of dental caries.
3. Describe host factors that can influence susceptibility to caries.
4. Describe theories that explain caries formation.
5. Discuss etiology of dental caries and evidence linking the following as agents in dental caries:
 - a. *Streptococcus mutans*
 - b. Other *Streptococcus* species
 - c. *Lactobacillus* species
 - d. *Actinomyces* species

- e. Other microorganisms
- 6. Discuss the rationale for and current methodologies of caries control.
- 7. Describe the status of caries vaccines and the immunological mechanisms that may be used to help provide caries immunity.

K. Microbiology of Periodontal Diseases

- 1. Define gingivitis and periodontitis.
- 2. Describe evidence supporting a microbial etiology for inflammatory periodontal diseases.
- 3. Describe the characteristics of dental plaque that contribute to the pathogenesis of periodontal disease.
- 4. Discuss concepts of specific and nonspecific etiology of periodontal diseases.
- 5. Describe evidence implicating the following microorganisms in periodontal diseases:
 - a. *Actinomyces* species
 - b. *Bacteroides* species
 - c. *Porphyromonas* species
 - d. *Prevotella* species
 - e. *Campylobacter* species
 - f. *Capnocytophaga* species
 - g. *Fusobacterium* species
 - h. *Streptococcus* species
 - i. Spirochetes (*Treponema* species)
 - j. *Eubacterium* species
 - k. *Actinobacillus actinomycetemcomitans*
 - l. *Eikenella corrodens*
- 6. Discuss the microbiology of
 - a. periodontal health
 - b. gingivitis - nonspecific and acute necrotizing ulcerative
 - c. periodontitis - adult, refractory, and rapidly progressive; juvenile, prepubertal, generalized, and localized
 - d. gingival disease as manifestations of systemic and hormonal disturbances
 - e. periodontal disease of compromised patients
- 7. Know the major microbial factors of oral bacteria associated with virulence and describe how they can produce tissue destruction.
- 8. Discuss the role of host resistance factors and immunity in periodontal diseases.
- 9. Know about the microbiological tests that have potential usefulness for diagnosis of periodontal disease.

10. Describe microbiological aspects for control and therapy of periodontal disease.

L. Dentoalveolar Infections

1. Be familiar with the bacteria that are found in dentoalveolar infections and know their source.
2. Describe the microbial virulence factors that are involved in dentoalveolar infections.
3. Know the clinical presentations of dentoalveolar infections and the etiologies involved.
5. Describe host defense mechanisms in dentoalveolar infections.
4. Describe the microbiological aspects of therapy for dentoalveolar infections.

M. Virology

1. Describe the composition, synthesis, and function of the components of the virion.
2. Describe the replication of viruses.
3. Describe the methods of replication of typical RNA and DNA animal viruses.
4. Define the following:
 - a. cytolytic infection
 - b. slow infection
 - c. latent viral infection
 - d. acute viral infection
 - fe chronic viral infection
 - f. congenital infection
5. Describe the immunological mechanisms that function in viral infections.
6. Describe the induction, biological activities, and therapeutic potential of interferon.
7. Describe the spectrum, action, advantages, and disadvantages of antiviral chemotherapeutic agents.
8. Describe the possible role of viruses in the etiology of cancer.
9. Describe the pathogenesis, clinical manifestations, epidemiology, diagnosis, treatment and prevention of the diseases caused by the following hepatitis viruses:
 - a. Hepatitis virus Type A
 - b. Hepatitis virus Type B
 - c. Hepatitis virus Type C
 - d. Hepatitis virus Type D
10. Describe the pathogenesis, clinical manifestations, epidemiology, diagnosis and treatment of the diseases caused by the following DNA viruses:
 - a. Variola (smallpox)
 - b. Molluscum contagiosum
 - c. Herpes simplex, types 1 and 2
 - d. Papillomavirus
 - e. Varicella-Zoster virus
 - f. Epstein-Barr virus
 - g. Herpesvirus simae
 - h. Cytomegalovirus
 - i. Adenovirus
11. Describe the diseases caused by the following RNA viruses:
 - a. Retroviridae
 - c. Coronaviridae

Dental Microbiology 641, Winter-Spring 2009, Lecture Room D113 or as otherwise noted

Lecture slides, notes and other documents are available on Blackboard

<u>Period</u>	<u>Day</u>	<u>Date</u>	<u>Time</u>	<u>Title/Activity</u>	<u>Instructor</u>
1	Mon	5-Jan	1:00 PM	Introduction to Course	Lundrigan
			1:10 PM	Innate Immunity	Miller
2			2:00 PM	Innate Immunity; Lymphoid Tissues	Miller
3	Tue	6-Jan	1:00 PM	Acquired Immunity: Antigens, Antibodies and Diversity	Bengten
4			2:00 PM	Immunoglobulins: Structure and Function	Wilson
5	Wed	7-Jan	1:00 PM	B Cell Activation; Immunoassays	Bengten
6			2:00 PM	Hypersensitivity	Lobb
7	Thur	8-Jan	1:00 PM	Patient Oriented Problem and Anaphylaxis Simulation (Classrooms CW212, 213, 214)	Faculty
8			2:00 PM	POP continued	
9	Fri	9-Jan	1:00 PM	Immunoglobulin Class Switching; B Cell Markers	Wilson
10			2:00 PM	Complement	Lobb
11	Tue	13-Jan	1:00 PM	T Cell Receptors & MHC Molecules	Wilson
12			2:00 PM	Role of MHC in Immunity, T Cell Activation	Miller
13	Thur	15-Jan	1:00 PM	T Cell Effector Functions and Immune Regulation	Bengten
14			2:00 PM	Immunodeficiencies, Vaccine Development	Wilson
15	Tue	20-Jan	1:00 PM	Tolerance, Autoimmunity, Transplantation,	Bengten
16			2:00 PM	Clinical Presentation: Immunology	Serio
17	Thur	22-Jan	1:00 PM	Bacterial Anatomy	Lundrigan
18			2:00 PM	Bacterial Growth, Nutrition and Regulation	Lundrigan
19 & 20	Tue	27-Jan	1:00 & 2:00 PM	EXAM 1 Includes Periods 1-16	
21	Thur	29-Jan	1:00 PM	Gene Transfer	Lundrigan
22			2:00 PM	Microbial Genetics	Lobb
23	Tue	3-Feb	1:00 PM	Antimicrobial Agents	O'Callaghan
24			2:00 PM	Antimicrobial Agents (cont'd)	O'Callaghan
25	Thur	5-Feb	1:00 PM	Sterilization/Disinfection	Lundrigan
26			2:00 PM	Bacterial Virulence	Marquart
Community Health Project: February 9 to February 13					
27	Mon	16-Feb	10:00 AM	Mechanisms of Pathogenesis	Marquart
28			11:00 AM	Pyogenic Cocci: Staphylococci	Lobb
29	Tue	17-Feb	1:00 PM	Streptococci	Lobb
30			2:00 PM	Oral Streptococci	Lobb
31	Thur	19-Feb	1:00 PM	<i>Neisseria</i> and other Gram Negative Cocci	McDaniel
32			2:00 PM	Principles of Biosafety (Must Attend)	Lundrigan
33	Mon	23-Feb	10:00 AM	Video: Gram Stain and Isolation Techniques (Path. Lab, 2nd Floor)	Lundrigan

34			11:00 AM	Laboratory: Gram Stain and Isolation of Pure Cultures; Oral Flora (Path. Lab, 2nd Floor, N215)	Faculty
35	Tue	24-Feb	1:00 PM	Laboratory (cont'd)	Faculty
36			2:00 PM	Laboratory (cont'd)	Faculty
37	Thur	26-Feb	3:00 PM	Laboratory (cont'd)	Faculty
38			4:00 PM	Laboratory (cont'd)	Faculty
39 & 40	Mon	3-Mar	10:00 & 11:00 AM	EXAM II Includes Periods 17-38	
41	Wed	4-Mar	10:00 AM	Gram Negative Bacilli	McDaniel
42			11:00 AM	Oral Fastidious Gram Negative Bacilli	McDaniel
43	Thur	5-Mar	1:00 PM	<i>Corynebacterium</i>	Marquart
44			2:00 PM	Oral Gram Positive Bacilli	Marquart
45	Tue	10-Mar	1:00 PM	<i>Bacillus</i> and <i>Clostridium</i>	Marquart
46			2:00 PM	Gram Negative Anaerobes	McDaniel
47	Thur	12-Mar	3:00 PM	Gram Negative Zoonotic Organisms	McDaniel
48			4:00 PM	Spirochetes	Miller
Spring Break: March 13, 5:00 PM to March 23, 8:00 AM					
49	Tue	24-Mar	1:00 PM	Mycobacteria	Lundrigan
50			2:00 PM	Introduction to Mycology	Sullivan
51	Thur	26-Mar	3:00 PM	Mycoplasma; Chlamydia	Lushbaugh
52			4:00 PM	Rickettsiae	Lushbaugh
53	Tue	31-Mar	1:00 PM	Mycology	McDaniel
54			2:00 PM	Case Studies	Faculty
55	Thur	2-Apr	3:00 PM	Microbiology of Oral Health	Lundrigan
56			4:00 PM	Microbiology of Dental Disease	Lundrigan
57	Tue	7-Apr	1:00 PM	Clinical Presentation: Antimicrobial Treatment	Serio
58			2:00 PM	Introduction to Virology	Chinchar
59	Thur	9-Apr	3:00 PM	Introduction to Virology (cont'd)	Chinchar
60			4:00 PM	RNA Virus Overview	Chinchar
61 & 62	Tue	14-Apr	1:00 & 2:00 PM	EXAM III Includes Periods 41-57	
63	Thur	16-Apr	3:00 PM	HIV and Other Retroviruses	Chinchar
64			4:00 PM	Influenza, Paramyxoviruses, and Rubella	Chinchar
65	Tue	21-Apr	1:00 PM	Papovaviruses and Cancer	Chong
66			2:00 PM	Arboviruses and Viral Zoonoses, Enteric Viral Infections	Sullivan
67	Thur	23-Apr	1:00 PM	Herpesviruses I	Marquart
68			2:00 PM	Herpesviruses II	Marquart
69	Tue	28-Apr	3:00 PM	Picornaviruses, GI Tract Viruses, SARS	Chinchar
70			4:00 PM	Pox-, Adeno-, and Parvo-viruses	Chinchar
71	Thur	30-Apr	1:00 PM	Hepatitis I	Stray
72			2:00 PM	Hepatitis II	Stray

73 & 74	Fri	1-May	1:00 & 2:00 PM	EXAM IV Includes Periods 58-72
75 & 76	Mon	4-May	1:00 & 2:00 PM	FINAL (Comprehensive)