Course Review

Basic Science of Microbial Disease

*Course review committee:* Tim Lahey (chair), Virginia Lyons, Ed Usherwood, Erin D’Agostino

*Course director:* Paula Sundstrom

August 2015
• Course occurs in the Spring term of Year 1

• Course Director – Paula Sundstrom, PhD

• Course has 61 curricular hours
  – prior review it had 59 hours; 2 hours were added to pilot a PBL exercise

• Course was last reviewed in December 2012
Action Plan from Prior Review – Major Issues

• Issues related to objectives (rewriting one, placement in the syllabus, syllabus objectives to match those in Ilios) completed

• Assessment questions should correlate with objectives and major content emphasized in the course completed
  – student rating improved from 3.76 to 3.95

• Objectives relating to student skills in the lab needed to be assessed – faculty will sign off on proficiency completed; the course decided not to adopt a formal “sign off” but give verbal feedback
Action Plan from Prior Review – Major Issues

• Reduce time in traditional lecture **completed**
• Introduce more active learning exercises into lecture **completed**
• Move content from lecture into laboratory sessions **completed**
• Introduce case-based laboratory learning exercises piloted PBL for one lab; plan to incorporate a 2nd
• Incorporate fewer recall questions and more clinical vignettes in assessments; eliminate questions with negative stems **completed**
Course Objectives

1. To recognize, identify and differentiate the internal and external structures of prokaryotic and eukaryotic microbial cells.
2. To explain the function of structures of bacterial and fungal cells that are important for causing disease.
3. To describe the morphologies and growth forms of fungal pathogens in clinical specimens, in the environment and in laboratory media.
4. To explain the basic stages of microbial growth and their importance to disease.
5. To explain the basic features of microbial genomes and discuss the role of microbes in elucidating basic genetic mechanisms such as mutation, recombination and transfer of DNA between cells.
6. To describe the basic metabolic properties of microbial cells.
7. To list pathogens that grow intracellularly within host cells and explain the advantages of intracellular growth.
8. To describe the characteristics of morphology, metabolism or antigenic structure that aid in recognition of pathogens by the clinical laboratory and explain how pathogens are distinguished from normal flora and non-pathogens. Explain alternatives for staining and culturing that are used to identify the presence of or exposure to microbial pathogens.
Course Objectives

9. To recognize the essential properties of clinical specimens that are important for pathogen identification and hazards associated with handling infected clinical specimens.

10. To describe and practice methods for laboratory culture and staining for detection of microbes in clinical specimens; explain limitations of staining and culturing if applicable.

11. To describe and practice the basic principles of chemotherapy and disinfection through laboratory exercises accompanied by case studies.

12. To describe the mechanisms that lead to microbial resistance to antibiotics.

13. To describe the symptoms and clinical features of diseases caused by bacteria and fungi.

14. To describe the postulates used to establish that a disease is caused by a specific microbe as well as Koch's molecular postulates to establish the role of a specific structure of gene product in disease.

15. To describe factors important for virulence of each microbial pathogen if known.

16. To describe how pathogenic microbes are spread from person to person through the population and methods of spread in the environment.
17. To explain how specific infections are prevented and treated.
18. To describe for the most common infectious diseases whether the disease is caused primarily by toxin (e.g. Tetanus), or by microbial growth and invasion of the host (e.g. *Pneumococcal pneumonia*).
19. To list microbial toxins that cause human disease, describe the mechanism of action of each toxin and explain if antitoxins are used in treatment.
20. To specify whether a vaccine exists to prevent each disease caused by a microbe and describe the molecular basis of the vaccine function.
21. To describe properties of microbial vaccines in terms of live vs. killed, subunit or toxoid.
22. To describe underlying risk factors in mammalian hosts that increase susceptibility to microbial pathogens.
23. To apply knowledge of methods used by clinical laboratories to understand how infections are diagnosed; and to recognize the presence of normal flora and to explain beneficial roles of normal flora.
24. To behave respectfully and responsibly towards colleagues and members of the health care team at all times.
25. To solve problems effectively through collaboration with student colleagues.
26. To take responsibility for own work and gain competence in skills associated with microbiology.
27. To meet professional responsibilities fully, including being punctual, present, and engaged in laboratory activities, and being reliable in commitments to tasks.
28. To practice utilization of effective procedures for disinfection and disposal of biological hazardous waste.
29. To interact with personnel from the clinical laboratory during laboratory sessions and develop the practice of consulting clinical laboratory specialists in the future.
30. To benefit from physician input into exercises and cases for student analysis.
31. To provide opportunities to enhance communication between instructors and students.
32. To discuss the consequences of disregarding ethics related to medical human experimentation.
Course Objectives – Comments

• The objectives give an excellent description of course content
• They are clear and generally address one topic
• Course objectives are numerous and detailed, and in some cases read more like session objectives
  • Ex: To list microbial toxins that cause human disease, describe the mechanism of action of each toxin and explain if antitoxins are used in treatment.
• Objectives 11 and 28 partially overlap
• Professionalism-related objectives 24-32 are assessed in labs
Some objectives address detailed topics that may not be necessary to learn as a Y1 medical student:

8. To describe the characteristics of morphology, metabolism or antigenic structure that aid in recognition of pathogens by the clinical laboratory...

10. To describe and practice methods for laboratory culture and staining for detection of microbes in clinical specimens; explain limitations of staining and culturing if applicable.

15. To describe factors important for virulence of each microbial pathogen if known.

19. To list microbial toxins that cause human disease, describe the mechanism of action of each toxin and explain if antitoxins are used in treatment.
USMLE Alignment is very good

Microbial biology
- Microbial identification and classification, including principles, microorganism identification, and non-immunologic laboratory diagnosis
- Bacteria: structure (e.g., cell walls, composition, appendages, virulence factors, extracellular products, toxins, mechanism of action of toxins), processes, replication, and genetics (e.g., metabolism, growth, and regulation), oncogenesis, antibacterial agents (e.g., mechanisms of action on organism, toxicity to humans, and mechanisms of resistance)
- Viruses: structure (e.g., physical and chemical properties, virulence factors), processes, replication, and genetics (e.g., life cycles, location of virus in latent infection), oncogenesis, antiviral agents (e.g., mechanisms of action on virus, toxicity to humans, and mechanisms of resistance)
- Fungi: structure (e.g., cell wall, composition, appendages, virulence factors, extracellular products, toxins, mechanisms of action of toxins), processes, replication, and genetics (e.g., asexual vs. sexual, metabolism, growth), antifungal agents (e.g., mechanisms of action on fungus, toxicity to humans, and mechanisms of resistance)
- Parasites: structure (e.g., appendages, macroscopic features, and virulence factors), processes, replication, and genetics (e.g., life cycles, metabolism, and growth), oncogenesis, antiparasitic agents (e.g., mechanisms of action on parasite, toxicity to humans, and mechanisms of resistance)
- Prions

Infectious and immunologic infectious disorders
- Bacteria: hemorrhagic fever (Ebola virus, Marburg virus), chikungunya, dengue fever
- Viral: malaria (Plasmodium spp.), babesiosis (Babesia species)
- Parasitic: primary infections of lymphoid tissue, lymphadenitis (viral, bacterial, fungal, parasitic), lymphangitis, buboes, bubonic plague (Yersinia pestis), cat scratch disease (Bartonella henselae)
Course objectives are provided in the syllabus and are written in the correct format.

There are inconsistencies with the distribution and content of session objectives. The course provides a compiled set of notes for all sessions, and objectives are present for all sessions in this packet. Some (but not all) session objectives are also listed on Canvas (the preferred method for Y1 courses). In many cases the session objectives in the notes do not match the session objectives on Canvas.

Session objectives for the 14 laboratories are in the lab manual.
• Session objectives are not provided on Canvas for the following sessions:
  – Antibiotics I and II; Antibiotics IV (there is one set of session objectives for all 4 Antibiotic sessions and they are listed on Canvas under Antibiotics III)
  – Small group on Enterics
  – Clostridia II
  – Anaerobes
  – Normal Flora
  – Staphylococci I, Staphylococci II
  – Streptococci
  – Pneumococci, Listeria, Anthrax
  – Plague, Tularemia, Brucellosis
Session objectives in the notes do not match the session objectives on Canvas for the following sessions:

- Introduction to Pathogens
- Salmonella and Shigella
- Legionella, Mycoplasma, Diphtheria
- Neisseria
- Clostridia I and II (combined in notes)
- Mycoses: intro & cutaneous/mucosal infections
- Systemic Mycoses
- Opportunistic Fungal Pathogens
Format of Course & Session Objectives

• Session objectives that are not written in the correct format (they do not have a measurable verb):

  – objectives #2 and #5 in the Bacterial Metabolism session objective #4 in the Introduction to Specific Pathogens session
  – objective #5 in the Salmonella/Shigella session
  – objective #2 in the Escherichia coli session
  – objective #3 in the Clostridia I
  – objective #3 in the Streptococcus pneumoniae session
  – objective #3 in the tuberculosis session
  – objectives #1-2 in the nontuberculous mycobacteria session
  – objective #5 in the spirochetes session
  – objective #4 in mycoses (Canvas version)
  – objectives #2-5 in Systemic Mycoses (Canvas version)
Session Objectives – Comments

• Course covers a large amount of factual information, potentially at the expense of conceptual understanding. Many of these facts were not known by an ID specialist on the review team.

• Some information covered is beyond the level of detail that Y1 students – or actually physicians in general – should know.
Sample class notes demonstrate focus on facts

3. Virulence Determinants and Pathogenicity:
   a) Pili-mediated attachment (relatively weak)
      a. E. coli common pilus
   b) Type III secretion system (T3SS) that induces formation of attaching-effacing lesions [see Salmonella lecture for description of the T3SS]
   c) Genes for the T3SS are encoded on a pathogenicity island called the LEE pathogenicity island. The LEE encodes intimin, and tir. LEE stands for the locus for enterocyte effacement.
   d) Tir: a T3SS-secreted bacterial protein that is delivered to surface of epithelial cells to allow for E. coli attachment
   e) Intimin: Tir binding protein on surface of E. coli
   f) Other E. coli proteins can recruit host cell actin, causing altered morphology, and impact signal transduction pathways in the host cell to form A/E lesions
   g) Lesions leads to effacement (destruction of host cell microvilli)
   h) Shiga-like toxin
      a. Similar to Shiga toxin (produced by Shigella)
      b. Gene found on phage
      c. Shiga-like toxin disrupts eukaryotic protein synthesis and is cytotoxic.
      d. Interferes with protein synthesis via its RNA cleavage activity (subunit A) and may impact cytoskeleton (subunit B)
      e. HUS (Hemolytic uremic syndrome) is due to the activity of Shiga-like toxin.
         1. Why is the cow not susceptible to EHEC? Shiga toxin binds to Gb3/CD77 host glycolipid likely by the B subunit unit and this host receptor is not present in cattle.
   i) Hemolysin
      a. Pore forming protein that inserts into host cell membranes
      b. Common in E. coli strains that cause meningitis (next lecture)
      c. Present in other Gram-negative pathogens
      d. Encoded by a plasmid
   j) Capsule (K-antigen), LPS, and nutrient acquisitions pathways
Not all UPEC strains are equivalent. Different *E. coli* strains have different types can elaborate different types of surface adhesions. The type of adhesin elaborated by a particular *E. coli* strain can influence the locations that it is capable of colonizing and thus the type of infection caused.

<table>
<thead>
<tr>
<th>Uropathogenic <em>E. coli</em> adhesins</th>
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<th>Disease</th>
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<tr>
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<td></td>
<td>Dr adhesin</td>
<td>Cystitis</td>
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</tbody>
</table>
Issues of Redundancy

The keywords used to search for redundancy were:

- bacteria
- antibiotics
- Salmonella
- Escherichia coli
- Cholera
- Staphylococcus
- Chlamydia
- Streptococcus
- Pneumococci
- Tuberculosis
- fungi
Issues of Redundancy

• For the broad terms “bacteria”, “antibiotics” and “fungi”, there was overlap with two courses: SBM Infectious Diseases and Organ Based Pharmacology. While this is to be expected, there may be unplanned redundancy in some introductory sessions. Coordination has occurred between micro and pharmacology and in most cases this is planned redundancy but we identified points where unplanned redundancy could be removed.

• Many of the specific bacteria did not reveal significant overlap with other courses
Issues of Redundancy

• Staphylococcus, Streptococcus, Pneumococcus and Tuberculosis are discussed in the Infectious Disease unit of Y1 Pathology and there appears to be some redundancy, however we determined it was not disadvantageous.

• The term “Tuberculosis” revealed the most redundancy as it is discussed in three Y1 courses (Microbiology, Pathology, Immunology/Virology) and two Y2 courses (SBM Neurology, SBM Infectious Diseases). We evaluated in our course review conversation whether this represented complementary coverage. We asked Elizabeth Talbot who teaches in both courses to clarify if approaches are complementary.
VIG: Ethics/Humanities

• One course objective relates to ethics:
  – To discuss the consequences of disregarding ethics related to medical human experimentation.

• One session objective relates to ethics:
  – To discuss the Tuskegee experiment as an unethical example of neglecting ethics related to medical human experimentation
  – (See student comments about social determinants of health)
• Course evaluation indicates there is discussion of the prevalence of various diseases in particular groups, however the subject is not fully explored and students would like to hear more about it

[see student comments about SDOH later]
Summary regarding Objectives

• Clear course objectives describe the course well
• Numerous detailed objectives may contribute to course focus on lots of detailed information
• Addressing minor unplanned redundancy issues might free up a little more time for conceptual learning
• Frame SDOH-related topical coverage with mention that discussion about drivers will occur elsewhere in the curriculum
Course Learning Opportunities

- Lecture 35 hrs. (57.4%)
  - prior review the percentage was 66%
- PBL Small Groups 2 hrs. (3.3%)
- Laboratory 24 hrs. (39.3%)
  - prior review the percentage was 34%

Optional Review Sessions are offered prior to each quiz
Course Learning Opportunities

• The course has made good progress in reducing the number of traditional lectures from 39 hours (AY 11-12) to 35 hours (AY 14-15) and continues to make substantial efforts in this direction.

• Clicker questions are used in nearly all lectures to increase faculty-student interactions.

• The course piloted a PBL activity this year that was very successful (data was collected after the activity via surveys); this has resulted in plans to incorporate six PBL sessions in Y1 during AY 15-16 including a second PBL in the microbiology course.
Summary regarding Pedagogy

• The course is working towards reducing the number of traditional lectures to below the recommended percentage of 40-50% per course on average and is encouraged to continue in this direction.

• Faculty are incorporating tools to make lectures more interactive.

• The course director is to be commended for her initiative in piloting a PBL session, and leading the way in incorporating PBL into Year 1.
Assessment

- Written Quizzes (33% of course grade)
- Final Exam (42% of course grade)
- Laboratory Reports (20% of course grade)
- Class Participation (5% of course grade) – determined by clicker responses to questions during lectures [determined by the MEC this past spring to conflict with the official attendance policy]
Assessment Questions

• As promised in the prior action plan, questions with negative stems were removed and more clinical vignettes were incorporated; most quiz questions used clinical stems, however only ~35% of final exam questions used vignettes

• Commensurate with the high level of detail in course objectives, many exam questions assessed the students’ ability to memorize facts
  – Examples: which bugs are catalase positive, which clostridia have spores, which organism can be cultured on which medium, what alcohols do in biofilms, etc.

• Laboratory sessions used laboratory specimens and case histories to assess evaluative and analytical skills; this was done very well
Assessment of Course Objectives

• All exam and quiz questions map to course objectives.
• Some course objectives (4, 15) are not represented on the final exam; as edits occur correspondence between assessment and objectives should remain strong.
• Course objectives 24-31 are not represented on the exam, but are assessed in lab exercises. The exception is objective 30 (To benefit from physician input into exercises and cases for student analysis.) which the team thought might be difficult to assess.
Summary regarding Assessment

• All quiz and exam questions map to at least one course objective
• The subcommittee feels that some assessment questions focus on recalling details that are not necessary for physicians to know
• Most quiz questions had clinical stems, however many final exam questions did not; quizzes may not prepare students well for the final exam format
  [Note: the committee does not expect all questions to use clinical vignettes, however consistency between exams is ideal]
• Laboratory sessions do a good job of testing evaluative and analytical skills
“Indicate how well you think that instruction in microbiology prepared you for clinical clerkships and electives.” [1=poor; 2=fair; 3=good; 4=excellent]

<table>
<thead>
<tr>
<th>Course</th>
<th>Geisel mean 2010</th>
<th>Geisel mean 2011</th>
<th>Geisel mean 2012</th>
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# Measures of Quality – Step I

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*values reported for core disciplines are SD above the US/Can mean for Geisel mean scores
# Measures of Quality – Course Evaluation

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<th>Year 1 courses</th>
<th>Overall Satisfaction AY 2014-2015</th>
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<tr>
<td>Human Anatomy and Embryology II</td>
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*scale [1=poor; 2=fair; 3=good; 4=very good; 5=excellent]*
# Measures of Quality – Course Evaluation

*Scale [1=poor; 2=fair; 3=good; 4=very good; 5=excellent]*

<table>
<thead>
<tr>
<th>Measure</th>
<th>BSoMD 2012 (93%)*</th>
<th>BSoMD 2013 (68%)*</th>
<th>BSoMD 2014 (86%)*</th>
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*student participation rate on course evaluation
Measures of Quality – Student Comments

Strengths:

• Many students felt the class was well organized and the material was up-to-date and relevant: “Very organized. Material presented clearly and consistently.”

• Students enjoyed the labs: “Lab was low-stress and applicable.”

• Students appreciated that the notes were provided all at once in one packet: “Micro course book with all the relevant information - this should be replicated in all our other courses.”

• The PBL session was a great addition to the course: “The PBL was really great in my opinion.”
Measures of Quality – Student Comments

Suggestions for Improvement:

• Many students felt that there was too much clinically irrelevant information – that the course needed to emphasize the important information and not focus so much on memorizing details

• Additionally, they felt the exams focused on these details: “Exam questions DID NOT align with the important information - instead, it would sometimes specifically look for some factoid in a lecture that wasn't in the course notes and use that as one question in a 20 question exam aka 5% was about a factoid not relevant to practicing clinician. Sometimes, there were multiple of these factoid questions...”
Measures of Quality – Student Comments

• Some students were concerned about how patient groups were discussed with various diseases, i.e. social determinants of health: “The microbiology course more or less promoted stereotyping in medicine to come to diagnoses.”

• There were various minor suggestions about improving the course materials. Additionally the students prefer being “paperless” (currently class materials are printed and students are charged for them without their permission)

• As already discussed at the MEC, the students were not happy with a portion of the grade being determined by class participation: “5% participation requirement was inconsistent with Geisel's mentality of supporting students varying learning styles.”
Measures of Quality – Student Comments

Other Suggestions:

• A significant number of students used the “Sketchy Medical” app, and felt it was instrumental to their success. Some students thought it would be nice if the instructors incorporated videos from the app in their teaching; others hoped a site license could be purchased for the class.

• It was mentioned that a flipped classroom approach might be advantageous in the course: “I think the material for this course could benefit from flipped sessions- the content is relatively straightforward and could really benefit from a higher degree of student engagement. Right now there is little difference between going to class and reading notes independently.”
Summary regarding Measures of Quality

• Very good preparation in microbiology, and for the boards
• PBL and other interactive sessions well received
• Faculty investment valued by students
• Heavy emphasis on fact transfer and memorization
• Students would like access to lab manual (course director aware but needs to work through IP and biosafety details)
• Could stop printing course notes so students are not obligated to have it printed or to pay a fee
• Summary tables in notes could be presented in a consistent format across pathogens rather than with a different organizational scheme for each
• 5% attendance credit approach has already been abolished
• Is there a way for Geisel to support student access to study aids like Sketchy Medical?
• Instead of current parallel between lectures and syllabus could use lectures to emphasize key concepts & difficult-to-learn facts in an interactive fashion
Recommendations

• Revise course objectives to cover bigger picture topics; most courses have about 8-15 course objectives [see samples in the appendix]

• Revise course materials and session content to focus on concepts not facts. This could be through redactions or by indicating which information will be tested and which not.

  [some samples are provided here in dropbox:]
  https://www.dropbox.com/s/ygwga1mvsuq019b/Basic%20Science%20of%20Microbial%20Disease%20TL.pdf?dl=0

• Address small amount of unplanned content redundancy e.g. re antibiotic mechanisms of action via coordination with relevant other courses
**Recommendations**

- Continue to reduce hours in lecture & emphasize successful active learning approaches like PBL and flipped sessions
- Reduce emphasis on fact-based questions in assessment; increase proportion of final exam questions that begin with a clinical stem
- Notify students that social determinants of risk of various infectious diseases will be covered in other parts of the curriculum
- Discontinue the printing of the course materials
Action Plan

Course Objectives
✓ Reduce the number of objectives and decrease the amount of detail.
✓ Eliminate overlap.
✓ Remove objectives that cannot be assessed.
✓ Use the example objectives during revision.

Course materials and session objectives
✓ Review materials and session objectives to decrease the amount of detail.
✓ Revise course materials to clarify testable content.
✓ Modify session objectives that are in the incorrect format.
✓ Establish a single location for session objectives (Canvas).
✓ Discontinue printing course materials.
Redundancy – antibiotics

✓ Coordination has occurred between micro and pharmacology and it was determined that the presentations of antibiotics in the two courses are complementary and that any redundancy is useful to students.

✓ Redundancy with Infectious Diseases will be addressed in a meeting with faculty representatives from both courses.
Action Plan

Course Learning Opportunities

✓ Reduce number of formal lectures by increasing PBL sessions and trimming lecture hours.

✓ Make lectures interactive through use of polling exercises for extra credit and explore flipping the classroom.

✓ Optional Review Sessions will not be offered in the coming year per communication with Dr. Lyons on 5/28/15. In lieu of these sessions, faculty will write answers to student questions about the material and will make all the answers available to all students. This was pioneered in 2015 and worked well. Peer-led tutoring groups have recently been introduced in Y1 and are very effective. (communication with Dr. Lyons)
Action Plan

Assessment

✓ Increase the proportion of clinical vignettes in the final exam to be consistent with quizzes.
✓ Decrease the focus on facts.
✓ Map exam questions to revised session and course objectives.
Social Determinants of Health and Culturally Competent Care
✓ For topics that include SDOH-related coverage, faculty will inform students that discussion about the drivers of SDOH will occur elsewhere in the curriculum.

Sketchy Medical
• Medical Education Dept will check about a copy for the library.

Lab Manual
• Place the lab manual on-line after registering with the US copyright office if the Medical Education Dept. will process the application.
Appendix: Example course objectives

University of Virginia

Upon completion of this course, students are expected to have acquired the following competencies:
1) To describe the role of microbial pathogens in immune responses.
2) To identify the action and regulation of organs, cells, genetics and molecules of the immune system.
3) To understand the mechanisms of allergy, inflammation, autoimmune disease, tolerance, and transplant immunology.
4) To categorize the mechanisms by which individuals mount immunity to tumors, bacteria, viruses and fungi.
5) To know the structure, physiology, growth, genetic exchange and drug resistance of microorganisms.
6) To correlate properties of viruses, bacteria and fungi with the diseases they cause.
7) To identify most likely causative agents of disease and to appreciate differential diagnoses of infectious diseases based on symptoms, epidemiology and laboratory tests.
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Appendix: Example course objectives

Tulane

Upon completion of this course the student will be able to:
1. Explain relationships and apply appropriate terminology relating to the structure, metabolism, genetics, and ecology of prokaryotic microorganisms, eukaryotic microorganisms, and viruses.
2. Explain interactions between opportunistic and pathogenic microorganisms and susceptible hosts in contacts that result in infection and/or disease and apply these interactions to disease symptoms.
3. Explain innate and adaptive immune responses and apply this understanding to the infectious disease process as well as the prevention and control of infectious diseases.
4. Explain principles of physical and chemical methods used in the control of microorganisms and apply this understanding to the prevention and control of infectious diseases.
5. Demonstrate an appreciation and understanding of clinical laboratory skills and techniques related to the isolation, staining, identification, assessment of metabolism, and control of microorganisms.
6. Interpret and draw appropriate conclusions from laboratory results.
7. Analyze and distinguish therapeutic treatments for microbial infections, and distinguish when a vaccine, antibiotic, or other therapy is likely to be the most appropriate response.
8. Specify the role of ecology and evolution in the spread of infectious diseases, comparing the role of transmission, population size and susceptibility, and virulence in endemic disease, epidemic disease, emerging diseases, and bioterrorism.
9. Develop the ability to work both independently and with others in teams and study groups.
10. Develop an information base for making personal health decisions in regard to infectious diseases.