Clinical Microbiology Rotations at UF Health-Jacksonville and Florida State

Overview

Microbiology is a constantly evolving branch of medical science. The challenge to the fellow is to increase their individual clinical expertise through interactions with the technical staff in each section of the laboratory and through interactions with clinical colleagues, and at the same time gain a thorough knowledge of the clinical laboratory science of Microbiology. The microbiology rotation is eight (8) weeks in length during the first year of the fellowship program. The goal of this rotation is provide microbiology laboratory exposure UF Health – Jacksonville Microbiology. The rotation provides extensive experience and the opportunity to develop clinical and interpretive expertise in the following areas of microbiology: bacteriology, mycology, mycobacteriology, parasitology, molecular microbiology, virology including rabies surveillance and bioterrorism surveillance.

I. Goals and Objectives of the Microbiology Rotation

The goal of the microbiology rotation is to enhance the fellows overall understanding of infectious diseases through a broad exposure to the clinical and technical practices of the microbiology laboratory. Upon completion of the rotations in Microbiology the fellow should be able to:

- Identify acceptable types of clinical specimens as well as proper collection and handling of such specimens to detect evidence of microbial infection by bacteria, fungi, mycobacteria, parasites, and viruses.
- Describe the basic principles, procedures, application, and interpretation of the routine and reference laboratory procedures for the isolation and identification of infectious agents (bacteria, fungi, parasites, and viruses) from clinical specimens.
- Describe the basic principles, procedures, application, and interpretation of currently recommended tests for susceptibility of microbes.
- Describe the basic principles, procedures, application, and interpretation of nucleic acid amplification procedures for agents such as HIV, HCV, HSV, Enterovirus, CMV, *Chlamydia trachomatis* and *Neisseria gonorrhoeae*.
- Demonstrate effective communication skills and the ability to consult on medical microbiology subjects with administrative, technical, and hospital professional staffs.
- Interpret microbiology data within the context of the patient's clinical condition, making recommendations for additional testing where indicated, and assess the cost effectiveness of laboratory tests for diagnosis of disease.

II. Competency Based Objectives

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A. Patient Care

- Discuss the clinically appropriate interpretation of microbiologic test results to ensure the provision of excellent patient-focused care.
- Gather essential and accurate clinical information when a microbiologic testing pattern is in question to resolve possible conflicts.
- Utilize medical knowledge with the help of information technology to make informed decisions regarding outcomes, including recommendation for appropriate test follow-up.
- Interact with other health care professionals to provide compassionate, appropriate and effective relay of microbiologic information for effective and timely patient care.

B. Medical Knowledge

- Discuss the clinical and basic sciences as applied to Clinical Microbiology, including bacteriology, mycology, mycobacteriology, parasitology, special susceptibility tests, virology and molecular microbiology.
- Describe the cost-effective and clinically relevant usage of microbiologic tests, interpretation of culture and test results, and appropriate use of test methodologies.
- Explain the technical methodologies involved in the performance of testing in all areas of microbiology

C. Practice-Based Learning and Improvement

- Describe the systematic approach to the investigation and evaluation of clinically relevant testing
- Interpret microbiologic tests to improved patient care.
- Apply systematic topical research to derive evidence based knowledge on microbiologic issues
- Demonstrate the integration of clinical knowledge with microbiologic data to affect patient care.

D. Interpersonal and Communication Skills

- Demonstrate effective communication with clinicians in obtaining pertinent clinical information to optimize patient care
- Demonstrate communication with laboratory technologists regarding processing and interpretation of patient specimens
- Explain the roles of other members of a health care team, including attending staff, other residents/fellows and laboratory technologists.
- Develop the appropriate interpersonal skills to supervise and/or interact with other laboratory personnel including supervisors and technologists.

E. Professionalism

- Maintain strict patient confidentiality with all clinical and personal information: diagnosis, prognosis, test results, etc.
- Demonstrate compassion and empathy if dealing with patients and their families.
- Discuss methods of maintaining self-control during stressful and/or emotional situations with colleagues, house staff, technical staff, and doctoral staff.
- Attend bench rotations, Microbiology Laboratory Rounds, Epidemiology Rounds and meetings with the Microbiology Director consistently and punctually.

F. Systems-Based Practice

- Discuss the Utilization of a systematic and where applicable, a multi-disciplinary approach towards solving problems, reducing errors, and improving processes is essential.
- Explain how the microbiology laboratory fits in the larger context and system of health care.
- Discuss utilization controls used in microbiology to minimize unnecessary testing.
- Consult with clinicians when appropriate to narrow diagnostic possibilities.
- Discuss the principles of quality control and procedures used in the Microbiology laboratory.

III. Knowledge to be Assessed

Knowledge and understanding of the function of the Bacteriology Laboratory including but not limited to:

- The collection, transport, direct smears, media selection and quality assurance of clinical specimens
- Use of the diverse variety of bacteriologic media
- Isolation and identification of bacterial isolates from clinical specimens
- Drawing and processing of blood culture specimens
- Methodologies of antimicrobial susceptibility testing
- Collection, processing and identification of anaerobes from clinical specimens

Knowledge and understanding of the function of the Mycology Laboratory including but not limited to:

- The collection, transport and evaluation of specimens
- Direct methods of specimen examination
- Use of fungal isolation media
- Identification of specimen contaminants
- Identification of pathogenic and opportunistic yeasts and fungi
- Methodologies of antifungal susceptibility testing

Knowledge and understanding of the function of the Mycobacteriology Laboratory including but not limited to:

- Specimen collection and initial processing
- Staining methods for initial identification of mycobacteria and streptomycetes
- Selection of appropriate media for isolation and identification of organisms
- Identification schema and methodology for mycobacteria and streptomycetes

Knowledge and understanding of the function of the Parasitology Laboratory including but not limited to:

- Availability and use of transport/fixative media for enteric pathogens
- Recognition of stool pathogenic and non-pathogenic protozoa and helminthes
- Recognition of *Plasmodium* species in blood smears
- Methodology for identification of *Pneumocystis* in respiratory specimens

Knowledge and understanding of the function of the Virology Laboratory including but not limited to:

- Collection, transport, evaluation of virology specimens
- Cell lines and reagents for the isolation and identification of suspected viruses from clinical specimens
- Commercially available methodology for molecular determinations of
- HIV viral load, HCV viral load, HCV genotyping, HSV, enterovirus and CMV viral load
- Methodology for nucleic acid amplification testing for *Neisseria* and *Chlamydia* from appropriate clinical specimens

IV. Methods of Achieving Objectives

- Laboratory rotation: Fellows are required to complete an 8-week rotation in Microbiology. A rotation schedule is prepared by the Microbiology Director for the fellow prior to the beginning of each rotation.
- Microbiology Laboratory Rounds: Fellows are required to attend daily Microbiology Laboratory Rounds, as instructed, during their rotation.
- Literature and case study review: Fellows will be given assigned reading and case studies during their rotation. Fellows are expected to prepare for weekly discussions regarding the material. Fellows are expected to review and discuss current Microbiology literature.
- Epidemiology Rounds: Fellows will actively participate in Epidemiology rounds with microbiology and infection control practitioners during their rotation.
- Microbiology self-study: Fellows are given a series of CD-ROMs. Fellows are expected to complete the study sets and be prepared to discuss them.
- Microbiology unknowns: Fellows are given a series of unknowns and their ability to accurately complete the unknowns will be assessed.
- Laboratory management: Fellows are expected to review the CAP checklist for one area in microbiology at some time during their rotation.
- Microbiology Texts: Fellows are provided with texts specifically covering Microbiology, Parasitology and Mycology for use during their rotation.
- The Microbiology Laboratory Directors directly supervises the activities of the fellows during the course of their training and will ensure that the general competencies (as defined above) are covered and evaluated during the training period.

V. Assessment Tools

- The microbiology technologists will evaluate the fellow during their individual bench rotations.
- The microbiology director will oversee the fellow's review of appropriate procedure manuals and rotations on the bench and active participation with technologists in performing laboratory procedures.
- Microbiology Directors will observation the fellow's participation in Laboratory and Epidemiology Rounds.
- Fellows are given a written **post-rotation test** at the end of the microbiology laboratory rotation at Shands Jacksonville.
- The fellows review and preparation of daily case studies, including performing literature reviews as needed, will be assessed.
- The laboratory director will observe the fellow's consultation with clinical staff regarding the appropriate workup of patient cultures.
- The microbiology director will evaluate the fellow for accuracy and completion of Microbiology specimen unknowns.
- The fellow will be assessed for demonstrated proficiency in obtaining library and Internet resources.

VI. Evaluation Process

- Goals and Objectives will be reviewed with the fellow at the beginning of each rotation.
- The fellow will sign the attestation statement verifying receipt of goals and objectives.
- The attending Microbiology Director will provide verbal feedback to the subspecialty resident throughout the rotation period.
- The attending Microbiology Director will provide verbal feedback to the subspecialty resident at the completion of the rotation.
- The attending Microbiology Director will complete the fellow's evaluation form and review the form with the fellow at the conclusion of the rotation.
- The fellow will sign the attestation statement verifying review of the evaluation form.

▪ Addendum A: Resident Curriculum Outline

I. Review of Laboratory Procedures

A. Bacteriology
1. Collection, transport, direct smears, isolation and identification, quality assurance
2. Media
3. Blood culture
4. Antimicrobial susceptibility testing
5. Anaerobes
   a. Control of specimens, evaluation
   b. Identification, biochemicals, antimicrobials
   c. Antimicrobial susceptibility testing

B. Mycology
1. Collection, transport, evaluation of specimens
2. Direct methods of examination
3. Media
4. Identification of contaminants
5. Identification of pathogens and opportunists
   a. Yeast
   b. Dimorphic fungi
   c. Molds
6. Antifungal agents
   a. Susceptibility testing

C. Mycobacteriology
1. Collection, initial processing
2. Staining
3. Media
4. Primary isolation, inspection of media
5. Identification

D. Parasitology
1. Protozoa, malaria, *Toxoplasma, Pneumocystis*
2. Helminths

E. Virology
1. Collection, transport, evaluation of specimens
2. Isolation and identification

F. Chlamydia

G. Molecular Testing
1. HIV viral load
2. HCV viral load
3. HCV genotyping
4. Nucleic acid amplification testing for *Neisseria* and *Chlamydia*
5. CMV viral load
6. HSV PCR
7. Enterovirus PCR

II. General Education

A. Review of current literature

B. Daily bench rounds with technologists

C. Daily case study and weekly review sessions

III. Laboratory Consultation

A. Physician inquiries

B. Technologist and Supervisor inquiries

Addendum B: Teaching Content and References – UF/Shands Laboratory

I. Bacteriology Rotation
Processing/Antimicrobial Susceptibility Testing (1 day)
Bacteriology (4 days)

A. The fellow will be expected to accomplish the following objectives:

1. Processing
   a. Review the function of commonly used primary plating media.
   b. Handle specimens from receipt through processing. This includes the proper selection of media, streaking for isolation of microorganisms, and appropriate incubation.
   c. Prepare, stain and interpret Gram stains.
   d. Review the approach used to subculture positive blood cultures.
   e. Identify the specimen quality and bacterial morphologies in ten (10) unknown specimen Gram stains.

2. Antimicrobial Susceptibility Testing
   a. Review the use of the Phoenix automated ID/AST system and review daily susceptibility results.
   b. Observe and then assist in the inoculation and reading of any susceptibility tests required on patient isolates.
   c. Perform, read and interpret Kirby-Bauer disk diffusion, gradient diffusion and broth dilution susceptibility tests.
   d. Review the Antimicrobial Susceptibility Testing self-study course (CD-ROM).
   e. Review the results of "unknown" antimicrobial susceptibility reports to determine the appropriateness of the antimicrobials reported.

3. Bacteriology
   Observe the technologist reading all the new and old bacteriology cultures.
   a. The technologist will provide the following instructions:
      - Organization of the bench
      - The format for recording results
      - Quantitation of organisms
      - Reporting of final results
   b. The technologist will discuss the normal flora found in urines, stools, respiratory, wound and genital specimens in addition to the protocol for working up these specimen types.
   c. The technologist will discuss the biochemical reactions of the different organisms, and the fellow should be able to interpret and explain the basis for the different biochemical reactions (i.e. TSI, NaCl, bile esculin, citrate, indole, PYR, etc.).
   d. Differentiate between α, β, and γ hemolysis on blood agar plates and lactose and non-lactose fermenters on MacConkey plates.
   e. Review the instrumentation for blood cultures.
   f. Review appropriate case studies and discuss the cases as well as accompanying questions with the Director.
   g. The fellow will receive 1 pure and 1 mixed unknown bacterial culture for identification. The fellow will be expected to work independently to arrive at an identification using standard laboratory protocol.

B. By the end of this rotation the fellow should be able to do the following:

1. Processing
   a. Discuss the criteria for proper collection and submission of commonly received specimens (i.e. sterile body fluids, respiratory specimens, urine, wounds, tissues, genital specimens).
   b. Recognize specimens that are not routinely cultured for anaerobes and indicate why they are unacceptable for anaerobic culture (i.e. vagina, cervix, feces, sputum, perirectal discharge, and decubitus).
   c. Discuss examples and use of the following types of primary plating media:
      - Enriched

- Selective
- Differential
- Enrichment

d. Discuss the proper technique for processing, battery of media used, and incubation conditions for the following specimens:
   - Body fluids
   - Feces
   - Lower respiratory
   - Throat
   - Cervix
   - Wounds/Tissues
   - Urine

e. Describe the special techniques required for the cultivation of the following organisms:
   - *Legionella pneumophila*
   - *Yersinia enterocolitica*
   - *Campylobacter* spp.
   - *Escherichia coli* O157:H7

f. Discuss the basic principles of gram stain interpretation.

g. Gram stain and interpret positive blood culture smears

2. Antimicrobial Susceptibility Testing
   a. Discuss the methods used to detect resistance to commonly used antimicrobials
   b. Review and interpret daily susceptibility results.
   c. Discuss antimicrobial mechanisms of action and resistance.

3. Bacteriology
   a. Distinguish between α, β, and γ hemolysis on blood agar plates.
   b. Distinguish lactose from non-lactose fermenters on MacConkey and normal flora from potential pathogens on Hektoen.
   c. Recognize typical colonial and microscopic morphology of the following:
      - *E. coli*
      - *Klebsiella/Enterobacter* species
      - *Proteus* spp.
      - *Ps. aeruginosa*
      - *S. aureus*/coagulase negative staphylococci
      - *Corynebacterium* spp.
   d. Explain basic principles and interpretation of the following tests:
      - Latex agglutination for group A/B strep
      - Catalase
      - Oxidase
      - Coagulase and latex agglutination for *S. aureus*
      - TSI
      - Phoenix identification and susceptibility testing system
      - Motility
      - Urea
      - Spot indole
      - Bile solubility test
   e. List the biochemical tests required for identification and expected results for the following organisms:
      - *E. coli*
      - Non-lactose fermenting gram-negative rods
      - *Pseudomonas aeruginosa*
      - Group A and B streptococci and *Enterococcus*
      - *Staph aureus* and staphylococci other than *S. aureus*
      - *H. influenzae*
      - Pathogenic *Neisseria*
      - *S. pneumoniae*

f. Discuss the basic work-up of urine, stool, respiratory wound/tissue, body fluid and genital cultures including normal flora and the workup of potential pathogens.
g. Correlate culture results with the direct specimen Gram stain results.

C. References

Processing/Bacteriology

a. Bartlett, RC. 1982. Making optimum use of the microbiology laboratory, Part I. JAMA 247: 857-859.
b. Bartlett, RC. 1982. Making optimum use of the microbiology laboratory, Part II. JAMA 247: 1336-1338.
c. Bartlett, RC. 1982. Making optimum use of the microbiology laboratory, Part III. JAMA 247: 1868-1871.
d. Barenfanger, J. 2000. Quality in, quality out: rejection criteria and guidelines for commonly (mis)used tests. Clin Microbiol Newsletter 22: 65-72.
e. Barenfanger, J. 2005. Quality assurances: Decreasing clinically irrelevant testing from clinical microbiology laboratories. Clin Microbiol Newsletter 28: 17-24.
f. McCarter, YS, et al. 2008. Cumitech 2C, Urinary Tract Infections. Coordinating ed., SE Sharp. ASM Press, Washington, D.C.
g. Sharp, SE, et al. 2004. Cumitech 7B, Lower Respiratory Tract Infections. Coordinating ed., SE Sharp. ASM Press, Washington, D.C.
h. Baron, EJ, et al. 2005. Cumitech 1C, Blood Cultures IV. Coordinating ed., EJ Baron. ASM Press, Washington, D.C.

2. Antimicrobial Susceptibility Testing

a. Kuper KM, et al. 2009. Antimicrobial susceptibility testing: A primer for clinicians. Pharmacotherapy 29:1326-1343.

D. By the end of this rotation the fellow should be able to discuss the following topics:

1. Processing/Bacteriology
   a. Appropriate collection and processing of microbiologic specimens.
   b. Cost-effective approaches from the standpoint of the laboratory.
   c. The clinical value of the Gram stain in Microbiology.
   d. Establishing the clinical relevance of results by the clinical microbiology laboratory.
   e. Laboratory diagnosis of urinary tract infections.
   f. Laboratory diagnosis of lower respiratory tract infections.
   g. Laboratory diagnosis of bacteremia and the variables affecting the recovery of organisms from blood.
   h. Rapid identification and susceptibility testing of positive blood cultures.
   i. The clinical significance of the resident's unknown culture results.

2. Antimicrobial Susceptibility Testing
   a. Clinical relevance of antimicrobial susceptibility tests and antibiograms for commonly isolated organisms.
   b. Performance and interpretation of susceptibility testing including the significance of antimicrobial resistance.

II. Virology/Mycobacteriology/Mycology/Parasitology/Molecular Microbiology Rotation

Mycology (1 day – combined with Virology)
Parasitology (1 day – combined with Mycobacteriology)
Virology (1 day)
Mycobacteriology (2 days)
Molecular Microbiology (2 days)

A. The fellow will be expected to accomplish the following objectives:

1. Mycology
   a. Discuss principles of Mycology processing and media used.
   b. Observe the technologist reading all new and old mycology cultures.
   c. Discuss principles of KOH, lactophenol cotton blue and calcofluor white procedures.
   d. Discuss the principles of yeast identification.
   e. Discuss basis of mold identification and the principle of the lactophenol cotton blue

procedure.
f. Discuss the clinical relevance and performance of antifungal susceptibility testing of yeast.
g. Review the Mycology self study course (CD-ROM).
h. Complete Mycology case study unknowns.
i. Complete antifungal sheet.
j. Review appropriate case studies and discuss the cases as well as accompanying questions with the Director.

2. Parasitology
   a. Review the life cycles of the protozoa, cestodes, trematodes, and nematodes.
   b. Become familiar with the concentration and processing techniques used to prepare wet mounts, Trichrome smears and *Cryptosporidium* smears from clinical specimens.
   c. Gain expertise in the identification of the diagnostic stage(s) of parasites in wet mounts and smears.
   d. Become familiar with the examination of blood smears for parasites.
   e. Review the Parasitology self study course (CD-ROM).
   f. Review appropriate case studies and discuss the cases as well as accompanying questions with the Director.
3. Virology
   a. Observe and perform specimen processing for viruses and *Chlamydia.*
   b. Review conventional and rapid cell culture techniques including the pros and cons of various cell lines and potential problems associated with tissue culture.
   c. Review the identification of viral CPE associated with herpes simplex virus, varicella zoster virus, cytomegalovirus, RSV, enteroviruses, adenovirus, influenza viruses and parainfluenza viruses.
   d. Review the application of immunofluorescence to viral diagnosis.
   e. Review the microbiology and diagnostic techniques used in the identification of the *Chlamydia.*
   f. Review and discuss the principles of other staining procedures performed by the Virology technologist including calcofluor white for fungus, DFA for PCP, and DFA for *Cryptosporidium/Giardia.*
   g. Review appropriate case studies and discuss the cases as well as accompanying questions with the Director.
4. Molecular Microbiology
   a. Observe technologists performing molecular testing.
   b. Discuss principles of polymerase chain reaction and strand displacement amplification.
   c. Discuss principles of unidirectional workflow.
   d. Discuss appropriate sample collection and processing to avoid contamination.
   e. Determine the significance of viral load determinations.
   f. Review molecular instrumentation including AmpliPrep/TaqMan, ProbeTec, Smart Cycler and GeneXpert.
5. Mycobacteriology
   a. Observe the technologist reading all new and old AFB cultures.
   b. Discuss the principles of conventional acid fast and fluorochrome staining.
   c. Discuss principles of AFB processing.
   d. Discuss principles of media used for AFB processing.
   e. Discuss AFB identification.
   f. Discuss principles and methods of AFB susceptibility testing.
   g. Review appropriate case studies and discuss the cases as well as accompanying questions with the Director.

B. By the end of this rotation the fellow should be able to:
1. Mycology
   a. Discuss and perform the processing of fungal cultures.
   b. Examine calcofluor white smears.
   c. Discuss the utility of lactophenol cotton blue preparations.
   d. Discuss work-up for both yeast and mold identification.

e. Discuss the performance of a slide culture.
f. Explain the basic principles and interpretation of the following tests:
    - API 20C identifications system
    - *C. albicans* Screen test
    - Cornmeal agar
    - Lactophenol cotton blue
    - Slide culture
g. Recognize typical colony morphology of the following:
    - Yeast
    - Mold
h. Read and interpret fungal susceptibility testing results.

2. Parasitology
    a. Discuss the processing of parasitology specimens.
    b. Examine and interpret iodine mount preparations and Trichrome stained smears from patient specimens for protozoa and ova.
    c. Examine *Pneumocystis* and *Cryptosporidium* smears and smears for blood parasites.
    d. Recognize the typical morphology of the following organisms:
        - *G. lamblia*
        - *E. histolytica*
        - Common nonpathogenic protozoans
        - *A. lumbricoides*
        - *S. stercoralis*
        - *T. trichiura*
        - Hookworm
        - *Cryptosporidium*
        - *Cyclospora*
        - *Plasmodium* spp.
3. Virology
    a. Discuss the processing of specimens for viral culture.
    b. Evaluate shell vial HSV cultures for the presence of HSV CPE.
    c. Discuss the processing, staining and interpretation of rapid viral cultures.
    d. Discuss available fluorescent staining methods.
    e. Interpret stains for virus identification.
    f. Describe the typical CPE of the following viruses:
        - HSV
        - VZV
        - CMV
        - Enterovirus
        - Adenovirus
        - RSV
        - Influenza/parainfluenza viruses
    g. Discuss the processing, staining and interpretation of specimens submitted for *Chlamydia trachomatis* culture.
4. Molecular Microbiology
    a. Describe the principles of polymerase chain reaction and strand displacement amplification.
    b. Interpret viral loads and their significance.
    c. Discuss the significance of HSV, enterovirus and respiratory virus PCR results.
    d. Discuss PCR testing for *C. difficile*.
    e. Interpret GeneXpert results for MRSA surveillance and differentiation of MRSA and *S. aureus* in positive blood cultures.
5. Mycobacteriology
    a. Discuss the processing of AFB cultures.
    b. Discuss principle and interpretation of stains used.
    c. Appropriately interpret ASB stains.
    d. Discuss the media used for AFB culture processing.
    e. Discuss principle and advantages of the instrumentation for AFB cultures.

f. Interpret the presence of growth in AFB cultures slants.
g. Discuss the work-up of positive AFB cultures.
h. Interpret positive acid-fast smears from positive broth cultures including how results are recorded and disseminated to patient care areas

C. References

1. Mycology
   a. Nye, MB et al. 2006. Diagnostic Mycology: Controversies and Consensus. Clin Microbiol Newsletter 28: 121-127.
   b. Connolly, P et al. 2007. Rapid diagnosis of systemic and invasive mycoses. Clin Microbiol Newsletter 29: 1-6.
2. Parasitology
   a. Garcia, LS et al. 2003. Cumitech 30A, Selection and use of laboratory procedures for diagnosis of parasitic infections of the gastrointestinal tract. Coordinating ed., LS Garcia. ASM Press, Washington, DC.
   b. Garcia, LS et al. 2008. Cumitech 46, Laboratory Procedures for Diagnosis of Blood-Borne Parasitic Diseases. Coordinating ed., L. S. Garcia. ASM Press, Washington, DC.
3. Virology
   a. Leland DS and CC Ginocchio. 2007. Role of Cell Culture for Virus Detection in the Age of Technology. . Clin Microbiol Rev 20:49-78.
4. Molecular Microbiology
   a. Paillard, F and CS Hill. 2004. Direct nucleic acid diagnostic tests for bacterial infectious diseases. MLO Jan:10-17.
   b. Ginocchio, CC. 2004. Life beyond PCR: Alternative target amplification technologies for the diagnosis of infectious diseases, Part I. Clin Microbiol Newsletter 26: 121-128.
   c. Ginocchio, CC. 2004. Life beyond PCR: Alternative target amplification technologies for the diagnosis of infectious diseases, Part II. Clin Microbiol Newsletter 26: 129-136.
5. Mycobacteriology
   a. Kawamura LM and E Desmond. 2005. Tuberculosis and the expanding role of the laboratory. MLO Aug:12-18.
   b. Woods, GL. 1999. Molecular methods in the detection and identification of mycobacterial infections. Arch Pathol Lab Med 123: 1002-1006.
   c. Woods, GL. 2000. Susceptibility testing for mycobacteria. Clin Infect Dis 31: 1209-1215.

D. By the end of this rotation the resident should be able to discuss the following topics:

1. Mycology
   a. General approach to identification of yeasts and molds.
   b. The group characterization, clinical significance, transport, culture, identification, and characteristics of the following groups: medically important yeast, agents of systemic mycoses, and *Aspergillus* species.
   c. The appropriate use of antifungal agents.
2. Parasitology
   a. Preservation, storage and handling of specimens for examination for intestinal and urogenital protozoa.
   b. Concentration methods, wet mounts and stained preparations used for the diagnosis of parasites.
   c. Laboratory diagnosis of blood and reticuloendothelial protozoa, *Toxoplasma gondii*, *Pneumocystis,* nematodes, cestodes and trematodes.
3. Virology
   a. Transport and processing of specimens for viruses and Chlamydiae.
   b. Tissue culture methods and the use of the various cell lines in a clinical virology laboratory.
   c. The identification of viruses and Chlamydiae.
4. Molecular Microbiology
   a. Collection and processing of specimens for amplified testing to minimize contamination.
   b. Principles of polymerase chain reaction and strand displacement amplification.

c. The use of viral load determinations in monitoring HIV and HCV infection.
d. The usefulness of molecular testing in the Microbiology laboratory.

5. Mycobacteriology
   a. Laboratory techniques for AFB specimen processing.
   b. The clinical significance, transport, processing, culture, staining procedures, and identification of *M. tuberculosis* and non-tuberculosis mycobacteria.
   c. The epidemiology, pathology, clinical manifestations and chemotherapy of tuberculosis.