18 INFECTIOUS DISEASES

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OBJECTIVES

After completing this chapter, the reader should be able to

- List the common tests utilized by the microbiology laboratory for the identification of bacteria
- Describe the types of clinical specimens that may be submitted for Gram stain and culture
- Discuss the processes involved in staining and culturing a clinical specimen for bacteria, including the time required to obtain a result from either method; describe the clinical utility of the information obtained from a Gram stain or a culture
- Identify bacteria according to Gram stain results (gram-positive versus gram-negative), morphology (cocci versus bacilli), and growth characteristics (aerobic versus anaerobic)
- Define normal flora; identify anatomic sites of the human body where normal flora are commonly present and those that are usually sterile; identify bacteria that are considered normal flora in each of these sites
- Describe the most common causative pathogens based on infection type or anatomic site of infection
- Describe the common methods used for antimicrobial susceptibility testing including technique, type of result, clinical implications, and limitations of each method; demonstrate the

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The assessment, diagnosis, and treatment of a patient with an infection may appear to be an overwhelming task to some clinicians. This may be partly due to the nonspecific presentation of many infectious processes; the continuously changing taxonomy, diagnostic procedures, and antimicrobial susceptibility patterns of infecting organisms; and the continuous, albeit diminishing, introduction of new antimicrobials to the existing large collection of anti-infective agents. This chapter focuses on the laboratory tests utilized for the diagnosis of infectious diseases. It is important to note that diagnostic tests for many infectious diseases, particularly the diagnosis of human immunodeficiency virus (HIV) infection, are continuously being modified to reflect technological advances in laboratory procedures.

This chapter describes some of the laboratory tests utilized in the diagnosis of the most common infections due to bacteria, fungi, mycobacteria, viruses, and other organisms. Information regarding white blood cells (WBCs) and their role in infection is discussed in Chapter 17. Laboratory tests utilized in the diagnosis of viral hepatitis, *Helicobacter pylori* gastrointestinal (GI) infection, and *Clostridium difficile* pseudomembranous colitis are addressed in Chapter 15. Lastly, information regarding the clinical utility of the erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) as they relate to inflammatory diseases are addressed in Chapter 19; however, this chapter will provide a brief discussion regarding their clinical utility in the diagnosis and management of infectious diseases.

BACTERIA

Bacteria are small, unicellular, prokaryotic organisms that contain a cell wall but lack a well-defined nucleus. They are a diverse group of microorganisms that exist in different shapes and morphologies with varying rates of pathogenicity. Bacteria are a common cause of infection in both the community and hospital setting and can cause infection in patients with normal or suppressed immune systems. Bacteria must be considered potential causative pathogens in any patient presenting with signs and symptoms of infection.

The Identification of Bacteria

Several factors should be considered when choosing an appropriate antimicrobial regimen for the treatment of infection, including patient characteristics (e.g., immune status, age, end-organ function, drug allergies, and severity of illness), drug characteristics (e.g., spectrum of activity, pharmacokinetics, penetration to the site of infection, and proven clinical efficacy), and infection characteristics such as the site/type of infection (suspected or known) and potential causative organism(s). Therefore, appropriate diagnosis is a key factor in selecting appropriate empiric and directed antibiotic therapy for the treatment of an infection. In the case of a suspected infection, appropriate culture specimens should be obtained for laboratory testing from the suspected site of infection *before* antibiotics are initiated, if possible, in an attempt to isolate and identify the causative pathogen. Special attention should be placed on specimen collection and timely transport to the laboratory because the accuracy of the results will be limited by the quality and integrity of

OBJECTIVES

ability to appropriately use susceptibility information when choosing an antimicrobial regimen for a patient

- Define minimum inhibitory concentration (MIC), MIC_{50}, MIC_{90}, MIC susceptibility breakpoints, and minimum bactericidal concentration
- Describe the information that is utilized to construct a cumulative antibiogram; discuss the clinical utility of the cumulative antibiogram when choosing empiric antibiotic therapy for the treatment of a patient's infection
- Understand the basic methods that may be utilized in the diagnosis of systemic fungal infections
- Discuss the laboratory tests that are commonly utilized in the diagnosis of infections due to *Mycobacterium tuberculosis* and nontuberculous mycobacteria
- Discuss the laboratory tests that are commonly utilized in the diagnosis of common viral infections such as influenza, herpes simplex virus, cytomegalovirus, and respiratory syncytial virus
- Discuss the laboratory tests that are commonly utilized in the diagnosis of human immunodeficiency virus; describe the laboratory tests that are commonly utilized in the assessment and monitoring of patients with human immunodeficiency virus infection
- Understand the laboratory tests that may be performed for the diagnosis of infections due to miscellaneous or uncommon organisms such as *Borrelia burgdorferi*, *Treponema pallidum*, *Legionella pneumophila*, and *Pneumocystis (carinii) jirovecii*
- Understand the clinical utility of laboratory tests routinely performed for the diagnosis of infection in the following:
  a. Cerebrospinal fluid when meningitis is suspected
  b. Respiratory secretions when upper or lower respiratory tract infections are suspected
  c. Urine, prostatic secretions, or genital secretions when a genitourinary tract infection is suspected
  d. Otherwise sterile fluid when infection is suspected (e.g., synovial fluid, peritoneal fluid)

TABLE 18-1. Common Biologic Specimens Submitted for Culture[1-4]

Abscess, lesion, wound, pustule—swab or aspirate

Blood

Bone marrow

Body fluids—amniotic, abdominal, bile, pericardial, peritoneal, pleural, or synovial by needle aspiration

Bone—biopsy of infected area

CSF—by lumbar puncture or directly from shunt

Cutaneous—hair and nail clippings, skin scrapings, aspiration of leading edge of skin infection; biopsy

Ear—middle ear fluid specimen by myringotomy; outer ear specimen by swab or biopsy

Eye—swab of conjunctiva, corneal scrapings, vitreal or anterior chamber fluid

Foreign bodies—intravenous catheter tip by roll plate method; prosthetic heart valve, prosthetic joint material, intrauterine device, etc.

Gastrointestinal—gastric aspirate for AFB, gastric biopsy for *H. pylori*, rectal swab for VRE, stool cultures, stool specimen for *Clostridium difficile* toxin

Genital tract—cervical, endometrial, urethral, vaginal, or prostatic secretions; ulcer biopsy

Respiratory tract—sputum, tracheal aspirate, BAL, pharyngeal or nasopharyngeal swab, sinus aspirate

Tissue—biopsy specimen

Urine—clean catch midstream, catheterized, suprapubic aspirate

AFB = acid-fast bacilli; BAL = bronchoalveolar lavage; CSF = cerebrospinal fluid; VRE = vancomycin-resistant enterococci.

the submitted specimen.[1-4] **Table 18-1** lists common biologic specimens that may be submitted to the microbiology laboratory for bacteriologic analysis.[1-4]

When a specimen from the suspected site of infection is submitted to the microbiology laboratory, a number of microbiologic tests are performed to aid in identification of the infecting bacteria. The most common laboratory tests used for the identification of bacteria include direct microscopic examination using specialized stains (e.g., the Gram stain, fluorescent stains such as acridine orange or auramine-rhodamine stains) and bacterial culture techniques to foster growth of the microorganism. When bacteria grow in culture, additional tests are then performed to identify the infecting organism and to determine the susceptibility of the bacteria to various antimicrobial agents.

The Gram Stain

The *Gram stain* is the most common staining method utilized for the microscopic examination of bacteria and is most appropriate for evaluation of fluids (cerebrospinal fluid [CSF], pleural, synovial, etc.), respiratory tract secretions, and wound/abscess swabs or aspirates.[4] The Gram stain classifies bacteria into one of two groups, gram-positive or gram-negative, based on their reaction to an established series of dyes and decolorizers. The difference in stain uptake between gram-positive and gram-negative bacteria is primarily due to differences in their