**Staphylococcus aureus**

**Microscopic Morphology:** Gram-positive cocci in pairs or clusters.

**Clinical Significance:** *Staphylococcus aureus* causes a wide range of diseases affecting multiple body systems. It contains numerous virulence factors and mechanisms for development of antibiotic resistance. Resultant infections range from superficial to deep/systemic and may be suppurative or toxin mediated. *S aureus* is a common colonizer of skin and mucous membranes. *S aureus* is one of the most common causes of bacteremia.

**Comment:** *Staphylococcus aureus* colonies on SBA are 1–3 mm in diameter, cream-yellow to golden, smooth, and slightly raised. Colonies are surrounded by a distinct zone of beta hemolysis.

Isolated colonies may be characterized by tests for agglutination of *S aureus* protein A or monoclonal antibodies directed toward other capsular polysaccharides. *S aureus* is catalase positive. The characteristic staphylococcal coagulase, which converts plasma fibrinogen to fibrin, may be detected using slide or tube test formats; both are widely used for confirmatory identification.
**Enterococcus faecium**

**Microscopic Morphology:** Gram-positive cocci in pairs or short chains; 1–2 µm in diameter.

**Clinical Significance:** *Enterococcus faecium* causes a wide variety of pathogenesis, ranging from wound infections and intraabdominal infections to bacteremia and endocarditis. They are noted in 5–10% of enterococcal species isolated from human clinical specimens. Nosocomial transmission may occur, resulting in urinary tract and implanted medical device infections. Mortality rates in bacteremia may be high, with seeding of metastatic abscesses in multiple organs. *E faecium* may also cause sepsis in neonates.

*E faecium* is a commensal organism of the GI tract, skin, and oral cavity. The organisms have intrinsic antimicrobial resistance to β-lactam agents and aminoglycosides. MICs to penicillin may range from 16–64 µg/mL. Inducible resistance to vancomycin is noted in strains expressing the vanA or vanB genes. Vancomycin-resistant enterococci (VRE) pose challenges in therapy and infection control. *E faecium* are most likely to express vanA and subsequent high levels of vancomycin resistance (>128 µg/mL).

**Comment:** Organisms serologically type as Lancefield group D streptococci. They are environmentally hardy and can survive in NaCl concentrations up to 6.5%. Selective media containing bile salts and antibiotics may be helpful for isolation of enterococci from nonsterile sites.
Microscopic Morphology: Gram-positive bacilli; 4-6 µm by 1 µm. May be arranged in pairs or short chains. Organisms are obligate anaerobes.

Clinical Significance: Clostridium perfringens infection may result in gas gangrene or necrotizing myositis. Sporulation in tissue is uncommon, and inflammatory infiltrate may be minimal. Gas gangrene due to C. perfringens is a fulminant, rapidly progressing infection due to the expression of multiple exotoxins, which produce tissue destruction. Mortality may exceed 50%. C. perfringens is also a significant cause of anaerobic bacteremia.

C. perfringens is one of the most common causes of foodborne illness in the US. Pathogenicity is due to the presence of an enterotoxin, which forms pores in host cells. Alpha and beta toxins in certain strains of C. perfringens can cause ischemic necrosis of the jejunum (enteritis necroticans) in infants and children. Adults who are neutropenic or have other underlying chronic conditions are at enhanced risk of disease.

Clostridium species are commonly found in soils, sewage, and feces, and are also part of the normal human gastrointestinal microbiome. These organisms are environmentally hardy due to the ability to form spores when conditions for growth are poor.

Comment: Gram stain of tissue is critical for diagnosis of gas gangrene or necrotizing myositis, as plate cultures may not be positive for several days.
**Streptococcus pyogenes** (group A strep [GAS])

**Microscopic Morphology:** Gram-positive cocci in pairs or chains. Infection is pyogenic, typically showing many PMNs. However, *S pyogenes* may produce leukocytic toxins that destroy white cells, as seen in the image.

**Clinical Significance:** *Streptococcus pyogenes* is a colonizer of the GI tract, skin, and upper respiratory tract. It is the most common cause of impetigo and bacterial pharyngitis. Invasive infections, such as bacteremia, pneumonia, necrotizing fasciitis, septic arthritis, meningitis, and endocarditis, may also occur. Other sequelae of GAS infections include glomerulonephritis and rheumatic fever. An erythrogenic exotoxin produced by some GAS can result in a confluent, erythematous rash of the trunk and extremities, characteristic of scarlet fever. Streptococcal toxic shock syndrome (STSS) is a result of pyogenic exotoxins produced by GAS and mediated by various cytokines produced by the host.

**Comment:** *S pyogenes* colonies on SBA are 1–2 mm in diameter, grey-white, transparent to translucent, circular, convex, matte or glossy, and surrounded by a wide (>0.5 mm) zone of beta hemolysis. Isolated colonies may be further identified by a catalase test. Large-colony, beta-hemolytic, catalase-negative, gram-positive cocci in pairs or chains may be confirmed as GAS by detection of the Lancefield group A antigen by immunoassay (latex agglutination) or by a DNA probe test.
**Listeria monocytogenes**

**Microscopic Morphology:** Gram-positive bacilli; 0.5–2.0 µm by 0.4–0.5 µm. May occur in short chains. Non-spore forming.

**Clinical Significance:** Development of disease from *Listeria monocytogenes* is dependent upon the immune competency of the host, with most infections occurring at the extremes of age (<1 month or >60 years). Systemic infections in adults include septicemia, encephalitis, and meningitis, with up to 50% mortality. Focal infections, such as endocarditis, osteomyelitis, and abscesses, occur rarely. In pregnant women, *L monocytogenes* can infect the fetus, resulting in abortion, stillbirth, or preterm labor. Disseminated CNS infection may also occur in the neonate. The human intestinal tract may normally be colonized with both pathogenic and nonpathogenic *Listeria* species.

*Listeria monocytogenes* is found in the environment and as a contaminant of processed poultry, meat, fish, vegetables, raw milk, and cheese. Outbreaks of gastroenteritis due to *L monocytogenes* may occur after ingestion of a contaminated food item. High organism loads can occur in foods because of the ability of this organism to multiply at 4°C.

**Comment:** Organisms pictured within the WBC in this photo appear gram negative due to prior antimicrobial therapy.