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STAPHYLOCOCCI

Th e staphylococci are gram-positive spherical cells, usually arranged in grapelike irregular clusters. Th ey grow readily on many types of media and are active metabolically, fermenting carbohydrates and producing pigments that varyfrom white to deep yellow. Some are members of the normal microbiota of the skin and mucous membranes of humans; others cause suppuration, abscess formation, a variety of pyogenic infections, and even fatal septicemia. Th e pathogenicstaphylococci oft en hemolyze blood, coagulate plasma, and produce a variety of extracellular enzymes and toxins.

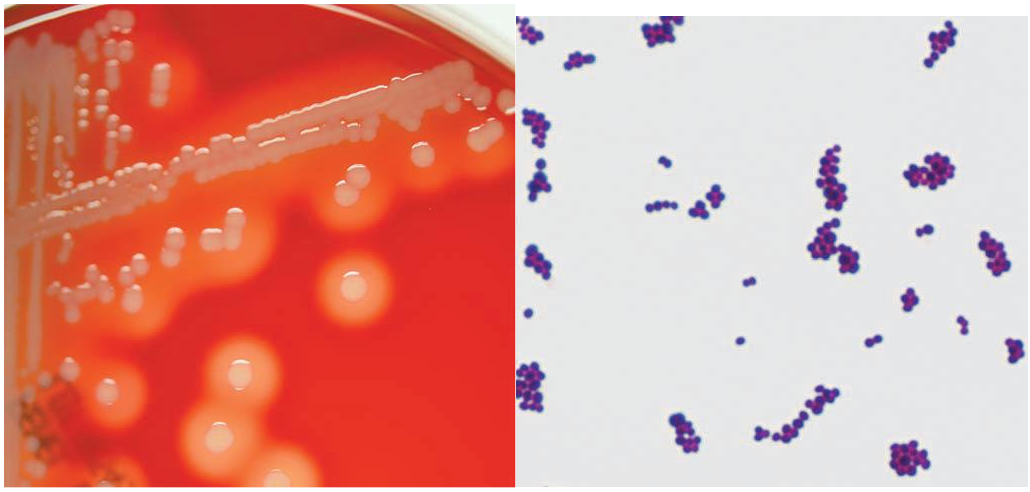
Th e most common type of food poisoning is caused by a heatstable staphylococcal enterotoxin. Staphylococci rapidly develop resistance to many antimicrobial agents, which consequently presents diffi cult therapeutic problems.

Th e genus *Staphylococcus* has at least 40 species. Th e four most frequently encountered species of clinical importanceare *Staphylococcus aureus, Staphylococcus epidermidis, Staphylococcus lugdunensis* , and *Staphylococcus saprophyticus.*

S aureus is **coagulase positive** , which diff erentiates it from the other species. *S aureus* is a major pathogen for humans. Almost every person will have some type of *S aureus* infection

Th e coagulase-negative staphylococci are normal human microbiota and sometimes cause infection, oft en associated with implanted devices, such as joint prostheses, shunts, and intravascular catheters, especially in very young, old, and immunocompromised patients. Approximately 75% of these infections caused by **coagulase-negative** staphylococci are caused by *S epidermidis;* . *S saprophyticus* is a

relatively common cause of urinary tract infections in young women, although it rarely causes infections in hospitalized
patients.



Pathogenesis

Staphylococci, particularly *S epidermidis*, are members of the normal microbiota of the human skin and respiratory and gastrointestinal tracts.

Nasal carriage of *S aureus* occurs in 20–50% of humans. Staphylococci are also found regularly on clothing, bed linens, and other fomites in human Environments The pathogenic capacity of a given strain of *S aureus* is the combined effect of extracellular factors and toxins together with the invasive properties of the strain.

At one end of the disease spectrum is staphylococcal food poisoning, attributablesolely to the ingestion of preformed enterotoxin; at the other end are staphylococcal bacteremia and disseminated abscesses in all organs.

Pathogenic, invasive *S aureus* produces coagulase and tends to produce a yellow pigment and to be hemolytic.

Nonpathogenic, noninvasive staphylococci such as *S epidermidis* are coagulase negative and tend to be nonhemolytic.

. ***S saprophyticus* is typically nonpigmented, novobiocin resistant, and nonhemolytic; it causes urinary tract infections in young women**.

Enzymes and Toxins

Catalase

Staphylococci produce catalase, which converts hydrogen peroxide into water and oxygen. The catalase test differentiates the staphylococci, which are positive, from the streptococci, which are negative.

Coagulase and Clumping Factor

S aureus produces coagulase, an enzyme-like protein that clots oxalated or citrated plasma. Coagulase binds to prothrombin; together they become enzymatically active and initiate fibrin polymerization.

Clumping factor that is responsible for adherence of the organismsto fibrinogen and fibrin. When mixed with plasma, *S aureus* forms clumps. Clumping factor is distinct from coagulase. Because clumping factor induces a strong immunogenic response in the host, it has been the focus of vaccine efforts. However, no human vaccines against this factor are available

Hemolysins

α-Hemolysin is a heterogeneous protein that acts on a broad spectrum of eukaryotic cell membranes. The β-toxin degrades sphingomyelin and therefore is toxic for many kinds of cells, including human red blood cells. The δ-toxin is heterogeneous and dissociates into subunits in non-ionic detergents. It disrupts biologic membranes and may have a role in *S aureus* diarrheal diseases. toxins are capable of efficiently lysing white blood cells by causing pore formation

Panton-Valentine Leukocidin

This toxin of *S aureus* has two components, and unlike the chromosomally encoded hemolysins above, PVL is encoded on a mobile phage. It can kill white blood cells of humans and rabbits. The two components designated as S and F act synergistically on the white blood cell membrane as described for γ toxin. This toxin is an important virulence factor in CA-MRSA infections.

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Toxic Shock Syndrome Toxin

Most *S aureus* strains isolated from patients with toxic shock syndrome produce a toxin called **toxic shock syndrome toxin-1** (TSST-1), which is the same as enterotoxin F. TSST-1 is the prototypical **superantigen**

The toxin is associated with fever, shock, and multisysteminvolvement, including a desquamative skin rash. The gene for TSST-1 is found in about 20% of *S aureus* isolates, including MRSA.

Enterotoxins

There are multiple (A–E, G–J, K–R and U, V) enterotoxins that, similar to TSST-1, are superantigens. Approximately 50% of *S aureus* strains can produce one or more of them. The enterotoxins are heat stable and resistant to the action of gut enzymes. Important causes of food poisoning, enterotoxins are produced when *S aureus* grows in carbohydrate and protein foods. Ingestion of 25 μg of enterotoxin B results in vomiting and diarrhea. The emetic effect of enterotoxin is probably the result of central nervous system stimulation (vomiting center) after the toxin acts on neural receptors in
the gut.

Exfoliative Toxins

These epidermolytic toxins of *S aureus* are two distinct proteins of the same molecular weight. Exfoliative toxin A is encoded by *eta* located on a phage and is heat stable (resists boiling for 20 minutes). Exfoliative toxin B is plasmid mediated and heat labile. These epidermolytic toxins yield the generalized desquamation of the staphylococcal scalded skin syndrome by dissolving the mucopolysaccharide matrix of the epidermis. The toxins are superantigens

Treatment and Prevention

There are no approved antistaphylococcal vaccines. Health care workers identified as intranasal carriers of an epidemic strain of *S. aureus* are treated with topical mupirocin and, in some cases, with rifampin.

Some physicians advocate the use of antibacterial substances such as gentian violet, acriflavine, chlorhexidine, or bacitracin to the umbilical cord
stump to prevent staphylococcal disease in hospital nurseries.

The Centers for Disease Control and Prevention recommend a concerted effort to battle multiple drug-resistant organisms identified in health care settings. Current recommended strategies for the control of spread and prevention of infection within health care settings include the screening of patients for MRSA before admission along with a variety of contact isolation procedures.

Guidelines for the prevention and control of such organisms are included in the Campaign to Reduce Antimicrobial Resistance in Healthcare Settings