

The GRAM POSITIVE COCCI

GENUS: STAPHYLOCOCCI

Staphylococci and streptococci constitute the main groups of medically important gram-positive cocci. Staphylococcal infections range from the trivial to the rapidly fatal. They can be very difficult to treat, especially those contracted in hospitals, because of the remarkable ability of staphylococci to become resistant to antibiotics. Staphylococci are ubiquitous in nature, with about a dozen species occurring as part of human flora. The most virulent of the genus, *Staphylococcus aureus*, is one of the most common causes of bacterial infections, and is also an important cause of food poisoning and toxic shock syndrome. Among less virulent staphylococcal species, *Staphylococcus epidermidis* is an important cause of prosthetic implant infections, whereas *Staphylococcus saprophyticus* causes urinary tract infections.

Characteristics:

- Gram positive non spore-forming non-motile, spherical cells, usually arranged in grape-like clusters (They are arranged in grape-like irregular clusters due to cell divisions occur in three planes).
- Single cocci , pairs, tetrads and chains are seen in liquid cultures
- Young cocci stain strongly gram-positive, on aging many cells become gram-negative
- The three main species of clinical importance :

Staphylococcus aureus

Staphylococcus epidermidis (albus)

Staphylococcus saprophyticus (citrus)

Medical Bacteriology

Second Class L/ Env. Health

3 rd. lec. / Dr. mayada Ahmed

Differences between Staphylococcal species

Character	Spp.	<i>S. aureus</i>	<i>S. epidermidis</i>	<i>S. saprophyticus</i>
1-colony colour		golden yellow	white	lemon yellow
2- coagulase		+	-	-
3- fermentation of mannitol		+	-	-
4-Beta haemolysis		+	-	-



Morphology and Culture characters:

Colonies on solid media are round, smooth, raised, and glistening. *S. aureus* (coagulase positive) usually forms gray to deep golden yellow colonies. Coagulase negative Staphylococcus like *S. epidermidis* colonies usually are gray to white, though some may be slightly pigmented, usually cream or yellow like *S. saprophyticus* colonies on primary isolation. Also *Staphylococcus aureus* grows with NaCl in concentration 7.5-10% that inhibit most types of other bacteria.

They produce pigments that vary from white to deep yellow. Catalase positive, oxidase negative, it is aerobic and facultative anaerobic. Some

staphylococci are part of the normal flora, they are present on skin and in the mucous membranes, but others can cause suppuration, abscess formation, pneumonia and meningitis. The most common type of food poisoning is caused by staphylococcal enterotoxin. Staphylococci rapidly develop resistance to many antimicrobial agents and cause difficult therapeutic problems.

Classification of Staphylococci :

A- Based on pigment production: as above.

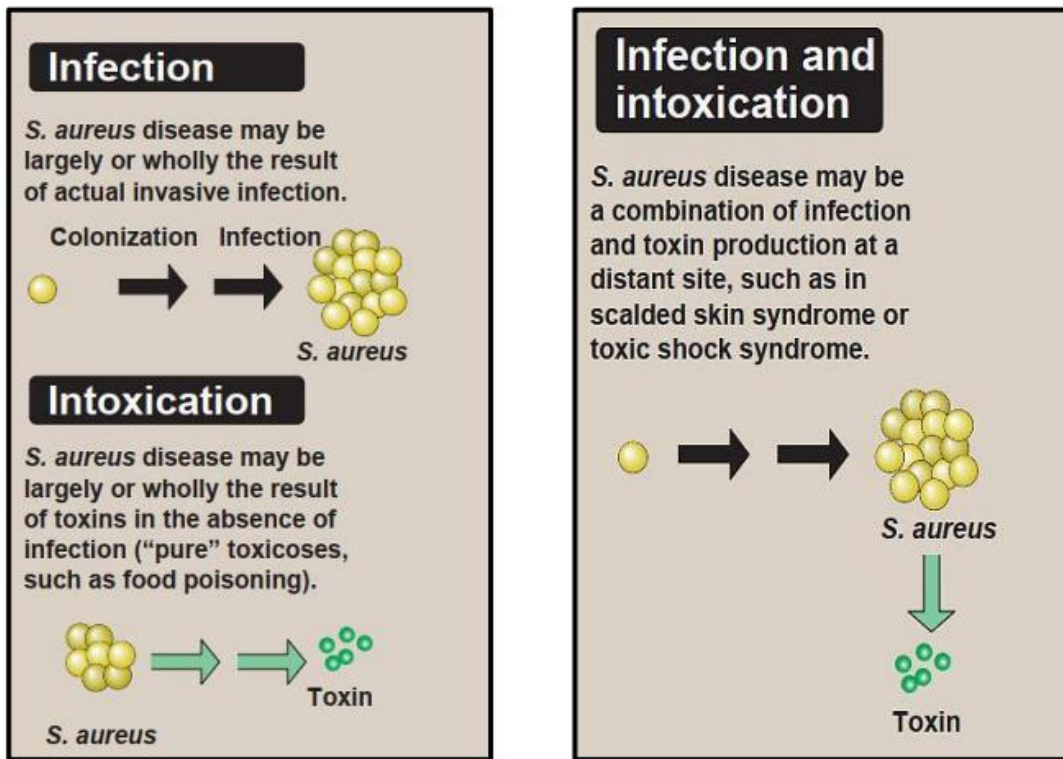
B- Based on coagulase production:

Coagulase is an enzyme that causes the formation of clots. Specifically, coagulase catalyzes the conversion of a plasma protein called fibrinogen into a sticky substance called fibrin. *Staphylococcus aureus* is coagulase positive, which differentiates it from the other species. *S. aureus* is a major pathogen for humans. Almost every person will have some type of *S. aureus* infection during a lifetime, ranging in severity from food poisoning or minor skin infections to severe lifethreatening infections. The coagulase-negative staphylococci (CoNS) are normal human micro biota and sometimes cause infection, often associated with implanted devices, such as joint prostheses, shunts, and intravascular catheters, especially in very young, old, and immune-compromised patients. Approximately 75% of these infections caused by coagulase-negative staphylococci are caused by *S. epidermidis*; infections caused by *S. lugdunensis*, *Staphylococcus warneri*, *Staphylococcus hominis*, and other species are less common. *S. saprophyticus* is a relatively common cause of urinary tract infections in young women, although it rarely causes infections in hospitalized patients. Other species are important in veterinary medicine.

Generally, significant host compromise is required for *S. aureus* infection, such as a break in the skin or insertion of a foreign body (for example, wounds, surgical infections, or central venous catheters), an obstructed hair follicle (folliculitis), or a compromised immune system. *S. aureus* disease may be:

1. largely or wholly the result of actual invasive infection, overcoming host defense mechanisms, and the production of extracellular substances which facilitate invasion;
2. a result of toxins in the absence of invasive infection (“pure” toxicoses); or

3. a combination of invasive infection and intoxication.



- Epidemiology:

S. aureus is frequently carried by healthy individuals on the skin and mucous membranes. Carriers serve as a source of infection to themselves and others; for example, by direct contact, by contamination of fomites (objects such as a doorknob, which in turn can be a source of infection) or contamination of food, which can then result in food poisoning.

- Pathogenesis:

Virulence factors are the genetic, biochemical, or structural features that enable an organism to produce disease. The clinical outcome of an infection depends on the virulence of the pathogen and the opposing effectiveness of the host defense mechanisms. *S. aureus* expresses many potential virulence factors

(Figure). For the majority of diseases caused by *S. aureus*, pathogenesis depends on the combined actions of several virulence factors, so it is difficult to determine precisely the role of any given factor.

Cellwall associated structures	Extracellular toxins	Enzymes
<ul style="list-style-type: none">• Peptidoglycan• Capsule• Protein A• Clumping factor (bound coagulase)	<ul style="list-style-type: none">• Haemolysin• Panton-Valentine leukocidin• Enterotoxin• TSST• Exfoliatin toxin	<ul style="list-style-type: none">• Coagulase• Catalase• Staphylokinase• DNAase• β-lactamase• lipase• Phospholipase• hyaluronidase• proteinase

Pathogenicity of *Staphylococcus aureus* : depends on:

- 1- The ability of lysis RBCs (hemolysis) by producing hemolysin enzyme.
- 2- The ability to coagulate plasma by the production of the enzyme coagulase which catalyzes the transformation of fibrinogen to fibrin.
- 3- Other enzymes produced by staphylococci include hyaluronidase (spreading factor); staphylokinase (cause fibrinolysis); proteinases; lipases; gelatinase and β -lactamase.
- 4- Ability to produce different types of toxins.