

Staphylococcus



Staphylococcus

- Family: Micrococcaceae
- Genus:
 - *Staphylococcus*- **the name** derived from Greek word “staphyle” (means bunch of grapes)
 - This genus Include major human pathogen and skin commensals bacteria
 - *Micrococcus*- skin commensal

Staphylococci

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graph TD; A[Staphylococci] --> B[Coagulase Negative Staphylococci]; A --> C[Coagulase Positive Staphylococci]; B --> D[S. saprophyticus]; B --> E[S. epidermidis]; C --> F[S. aureus];
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The diagram is a hierarchical flowchart. At the top is a box labeled 'Staphylococci'. A horizontal line below it branches into two vertical lines leading to two boxes: 'Coagulase Negative Staphylococci' on the left and 'Coagulase Positive Staphylococci' on the right. Below 'Coagulase Negative Staphylococci', a horizontal line branches into two vertical lines leading to two boxes: '*S. saprophyticus*' and '*S. epidermidis*'. Below 'Coagulase Positive Staphylococci', a single vertical line leads to a box labeled '*S. aureus*'. The text in the boxes is color-coded: blue for the negative group and red for the positive group.

Coagulase Negative
Staphylococci

Coagulase Positive
Staphylococci

S. saprophyticus

S. epidermidis

S. aureus

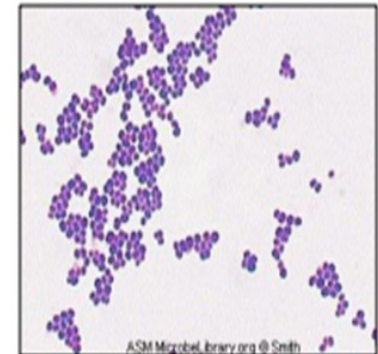
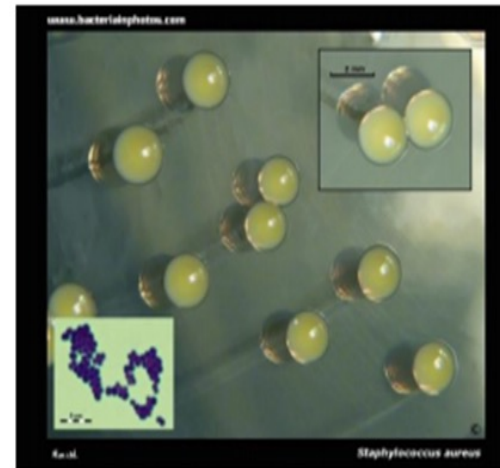
Staphylococcus: General Characteristics

- Gram-positive spherical cells (0.5-1.5 μm) in singles, pairs, and clusters “bunches of grapes”

Gold colonies on tryptic soy agar

These bacteria are G+ so its color is purple in Gram-stained smear

Staphylococci



Staphylococcus: General Characteristics

- Non motile
- Non–spore-forming
- Catalase-producing
- Grow at 15 % NaCl concentrations.
- Oxidase: negative
- Glucose fermenters
- Primarily aerobic, some facultatively anaerobic

Staphylococcus: General Characteristics

- Staphylococcus divided into **coagulase positive** & **coagulase negative** categories
- Colony morphology: buttery looking, cream or white colored on blood agar and Gold colonies on tryptic soy agar
- Optimum temperature at 37°C , however they can grow at a temperature ranged from (15 to 45 °C).
- Some produce Beta-hemolytic colonies on blood agar.
- For Staphylococcus aureus the name (aureus) refers to the gold color of the colonies.

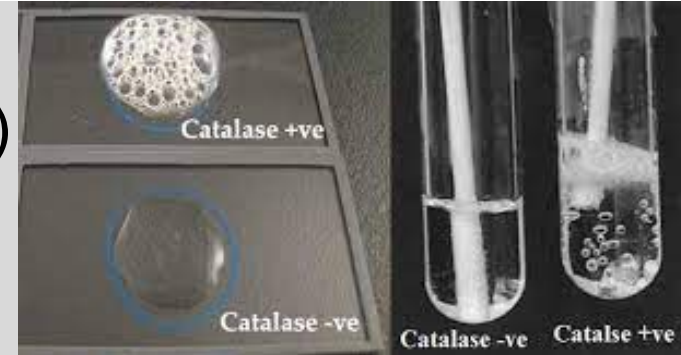


Staphylococcus: General Characteristics

All staphylococci are Catalase positive.
(Catalase converts H_2O_2 to H_2O and O_2)

-The **coagulase** (Coagulase converts fibrinogen to fibrin) and manifold fermentation tests are used to distinguish *S. aureus* from other staphylococcal species.

- Non-Motile and Non spore forming.

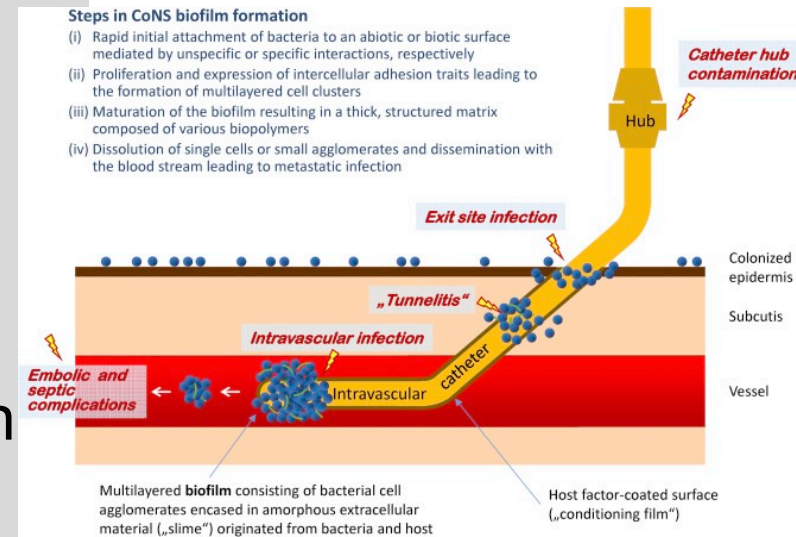


Coagulase Negative Staphylococci (CoNS)

- Are part of normal flora of human skin and mucous membranes
- relatively low virulence
- frequently involved in nosocomial and opportunistic infections
- Clinically significant infection associated with endocarditis, joints infection, wound infections, bacteremia, Urinary tract infections (UTI).

Coagulase Negative Staphylococci (CoNS)

- *S. epidermidis* is an inhabitant of the skin and mucous membranes, mostly nonpathogenic & may play a protective role in humans as normal flora.
- Adherence and colonization of catheters by *S. epidermidis* is a crucial step in the initiation of foreign body infections.
- The production of biofilm, a significant determinant of virulence for *S. epidermidis*.
- *S. saprophyticus* is a leading cause of cystitis in young women. And shares of urinary tract infection



Coagulase Positive Staphylococci (CoPS)

- *S. aureus* can be found in nasal passage as normal flora, but it may be found in other sites (skin, mucous membranes, oral cavity & gastrointestinal tract)
- Always considered a potential pathogen and it significantly can cause nosocomial infections.
- populations known to be at risk of staphylococcal disease including dialysis patients, diabetics and HIV-infected subjects.
- Staphylococci cause infection either as a result of autoinoculation or by transmission from a carrier to a patient.

Staphylococcus aureus

- ***S. aureus* causes a variety of suppurative (pus-forming) and toxigenic infections in humans.**

Staphylococcus aureus

- **These bacteria can produce Superficial skin lesions such as Boils, furuncles, abscess**
- They produce these infection Because of their presence as commensals on the skin and other sites.
- both coagulase positive and negative bacteria frequently cause prosthetic device (e.g. intravascular catheters) related infections.
- Establishment of infection in general requires an ordered sequence of events that involves adherence, colonization, invasion, spread, as well as the host response to this process.

Furuncles



Boils



Staphylococcus aureus

- **More serious skin** infections such as Impetigo (bubble-like swellings that can break and peel away; common in newborns)
- Staphylococcal scalded skin syndrome (SSSS) or Ritter's disease (relatively rare); (toxin induces bright red flush, blisters, then desquamation of the epidermis)





Staphylococcus aureus

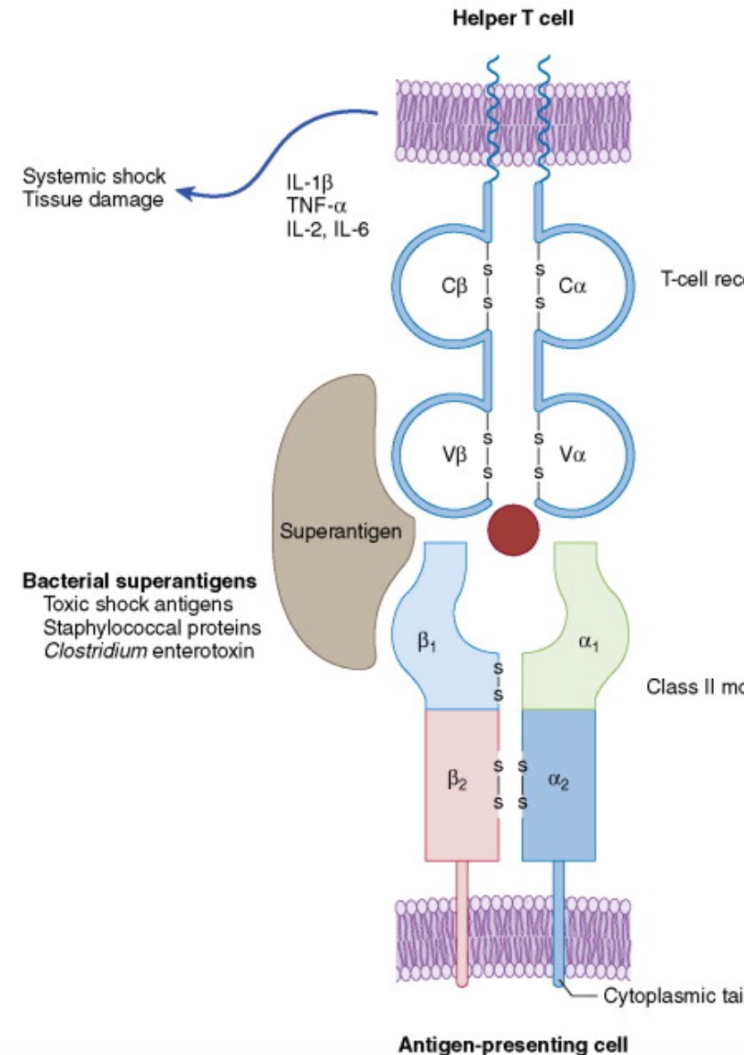
- **Could produce Serious infections (Deep)** such as Pneumonia (infections in the lung), Osteomyelitis (Localized infection of bone), endocarditis, meningitis, skeletal muscle, urinary tract infections.
- *S. aureus* is a major cause of hospital acquired (nosocomial) infections Surgical wounds and infections associated with medical devices. Serious consequences of staphylococcal infections (Systematic infections) occur when the bacteria invade the blood stream. A resulting septicemia may be rapidly fatal or bacteremia.

Staphylococcus aureus

- **Toxigenic infections:** *S aureus* causes food poisoning by releasing heat stable enterotoxins into food.
- These bacteria can produce toxic shock syndrome (leading to shock and organ failure) by release of superantigens into the blood stream.

Staphylococcus aureus

- The superantigens are T cell mitogens. Disease takes place due to the ability of these toxins to bind antigen presenting cells MHC 2 molecule outside the peptide groove. The superantigens then bind T cells via the variable region resulting in massive T cell activation and the release of large quantities of cytokines – a “cytokine storm” including IL-1, IL2, TNF, and interferon gamma. The result is a multiorgan disease similar in clinical presentation to septic shock with significant morbidity and mortality.



DISEASES

- **Due to direct effect of organism**

- Local - skin
- Deep abscesses
- Systemic infections

- **Toxin mediated**

- Food poisoning
- toxic shock syndrome
- Scalded skin syndrome

Staphylococcus aureus

virulence factors

(1) **Surface proteins** that facilitate bacterial adherence to host cell surfaces. These surface proteins facilitate attachment to molecules found in the extracellular matrix including fibronectin, fibrinogen, and collagen. They may help explain the tropism of this bacterial species to invade particular tissue sites

Staphylococcus aureus

virulence factors

- **(2) Invasions** Promote bacterial spread in tissues (leukocidin, kinases, hyaluronidase). Hyaluronidases hydrolyze hyaluronic acids and may contribute to tissue breakdown and spread of staphylococci across tissue barriers

Staphylococcus aureus

virulence factors

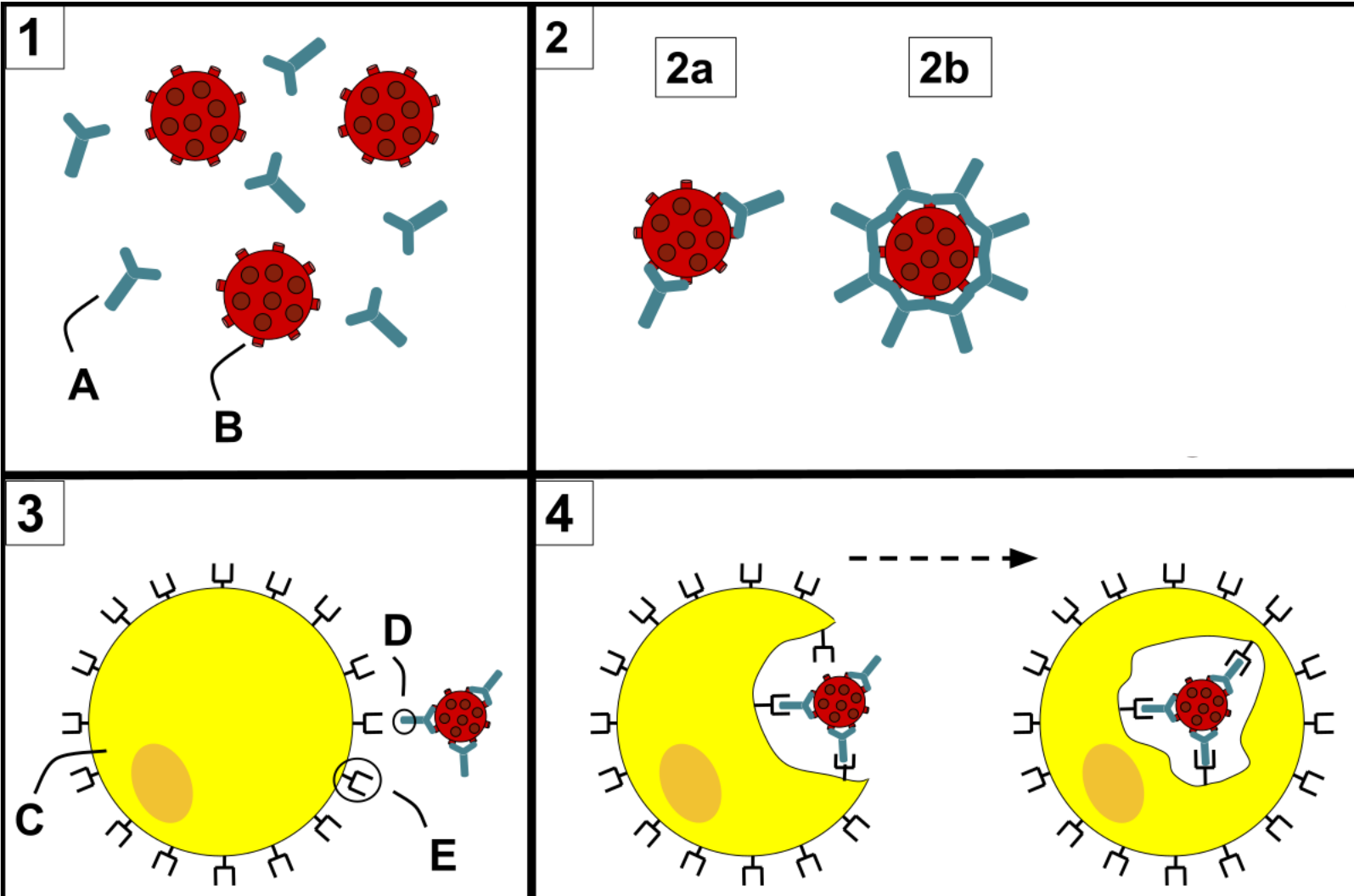
- **(3) DNase** Digests DNA
- **(4) Lipases** Digest oils; enhances colonization on skin .
- **(5) Surface factors Avoidance of host defenses**; Inhibit phagocytic engulfment (capsule, Protein A).

Staphylococcus aureus

virulence factors

- The majority of clinical isolates of *S aureus* express a surface polysaccharide (microcapsule) which can be visualized only by electron microscopy. *S. aureus* strains isolated from infections express high levels of the capsule but rapidly lose it when cultured in the laboratory.
- - **Protein A**: binds IgG antibody in the wrong orientation (Fc region), which disrupts opsonization and phagocytosis.

Staphylococcus aureus virulence factors



Staphylococcus aureus

virulence factors

- **(6)** Staphyloxanthin; carotenoid pigment which responsible for golden colonies, and it has an antioxidant action that helps bacteria to evade reactive oxygen species by the host immune system. Catalase production.
- **(7) Membrane-damaging toxins** Lyse eukaryotic cell membranes. Hemolysin lysis red blood cells. Leukocidin; lysis neutrophils and macrophages.

Staphylococcus aureus

virulence factors

- **Exfoliative toxins (ETs)**; responsible for Staphylococcal scalded skin syndrome (SSSS); separates the epidermis from the dermis. –
- Pantan-Valentine Leukocidin (PVL) cytotoxin creates pores in the membranes of infected cells. It is associated with severe necrotizing pneumonia in children.
- **(10)** Inherent & acquired resistance to antimicrobial agents (Penicillinase- inactivates penicillin).
- Beta-lactamases are released by staphylococci and can hydrolyze the beta-lactam ring of penicillins and cephalosporins rendering the antibiotics useless.

Host Defense against Staphylococcal Infections

- Phagocytosis: Neutrophil is the primary cellular defenses of innate immunity against Staphylococcal infections.
- Antibodies are produced which neutralize toxins and promote opsonization.
- Staphylococci may be difficult to kill after phagocytic engulfment because they produce catalase which neutralize the superoxide (on of reactive oxygen species) which is primary phagocytic killing mechanisms within the phagolysosome



Treatment

- Hospital acquired infection of *S. aureus* is often caused by antibiotic resistant strains (e.g. MRSA) and can be treated with vancomycin or an alternative.
- The term MRSA refers to Methicillin resistant *S. aureus* and related beta-lactam antibiotics (e.g. penicillin, oxacillin, amoxicillin). Some MRSA are resistant to vancomycin (VRSA). The infections have been treated with combination therapy using sulfa drugs and/or rifampin.
- (CoNS); can also produce beta lactamase enzyme that makes them resistant to methicillin and oxacillin. Vancomycin is the most common antibiotic used to treat infections caused by CoNS. Rifampin and gentamicin may be added to prevent highly antibiotic resistance.

Vaccines :-No vaccine is generally available •
that stimulates active immunity against
staphylococcal infections in humans.



Staphylococci and micrococci in Oral cavity

Staphylococci and micrococci are also not commonly isolated in large numbers from the oral cavity although the former are found in denture plaque, as well as in immunocompromised patients and individuals suffering from a variety of oral infections. Although these bacteria are not usually considered to be members of the resident oral microflora, they may be present transiently, and they have been isolated from some sites with root surface caries and from some periodontal pockets that fail to respond to conventional therapy.



