

# Introduction to Microbiology

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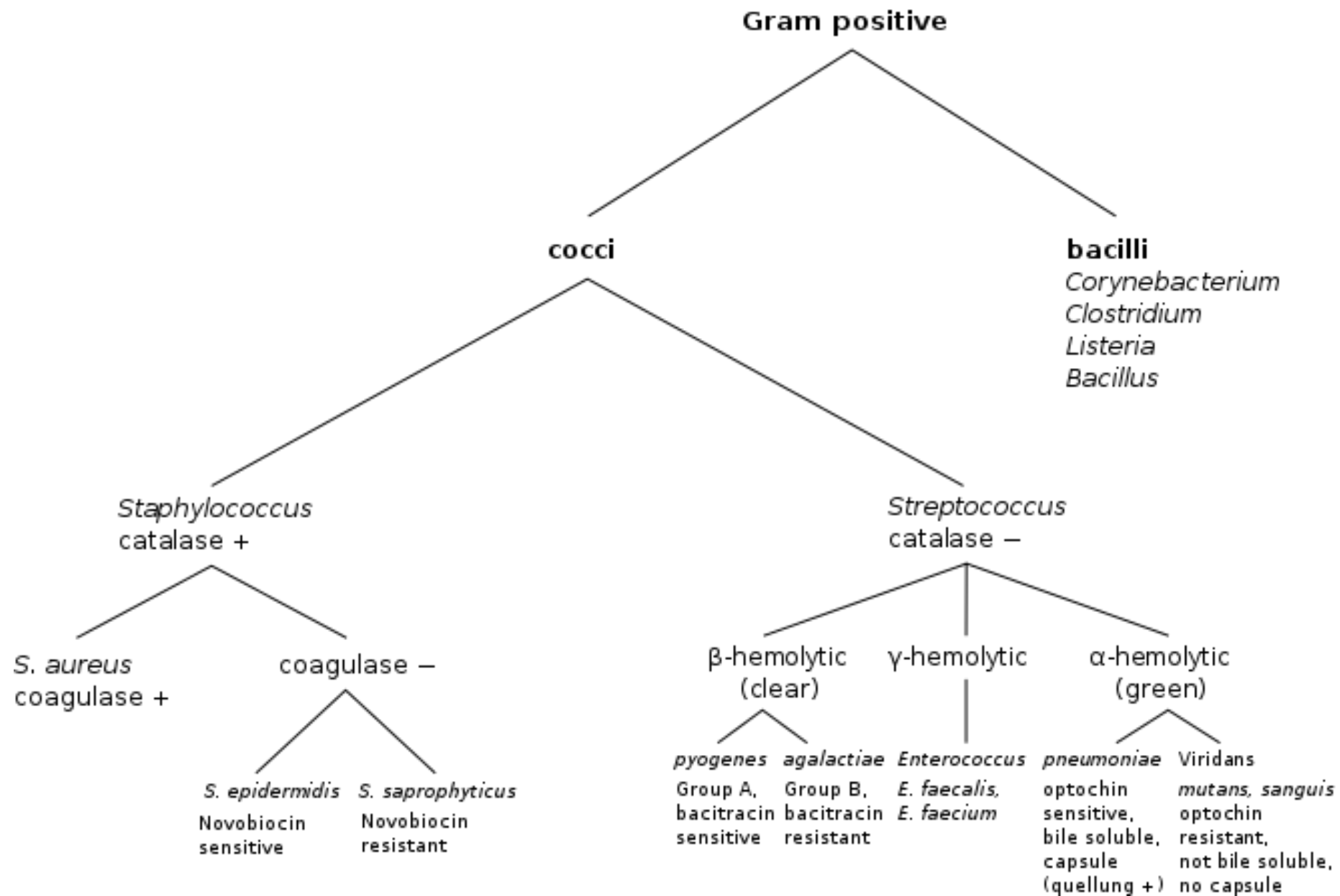
Anas Abu-Humaidan  
M.D. Ph.D.

# Overview

**Bacterial genera that will be discussed this lecture are Gram positive cocci and that cause a variety of infections in the skin and mucus membranes, and can secrete a variety of toxins:**

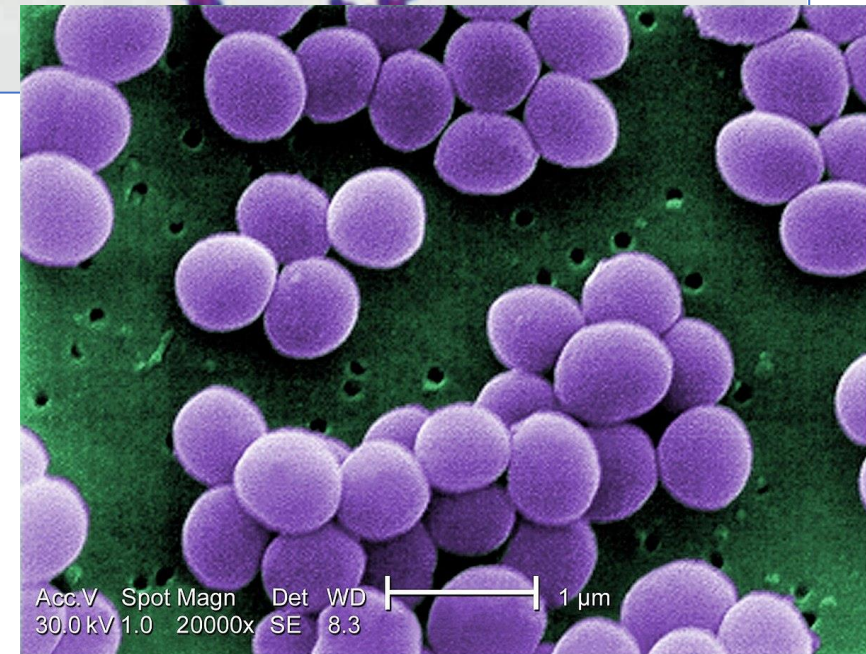
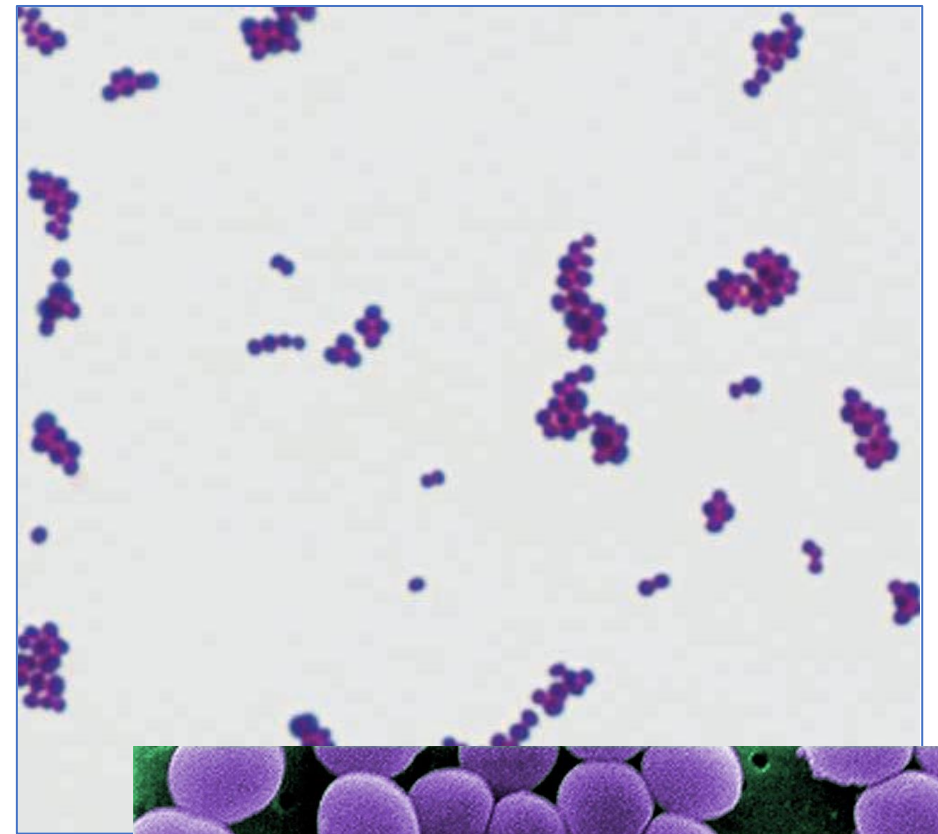
***Staphylococci***

***Streptococci***



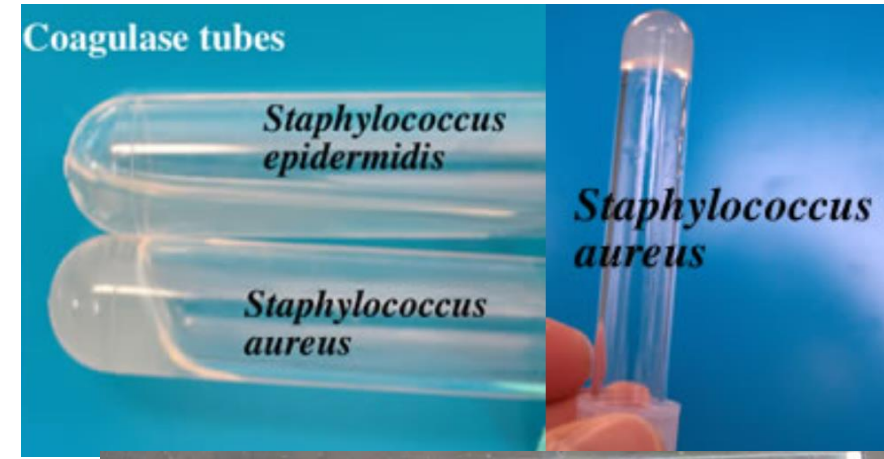
# Staphylococci

- The staphylococci are **gram-positive spherical cells**, about 1  $\mu\text{m}$  in diameter usually arranged in grapelike **irregular clusters**, it is **non-motile**.
- The four most frequently encountered species of clinical importance are *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Staphylococcus lugdunensis*, and *Staphylococcus saprophyticus*.



# Staphylococci

- *S aureus* is **coagulase positive**, The **coagulase-negative** staphylococci are normal human microbiota.
- 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**.
- *S aureus* usually **forms gray to deep golden yellow colonies**. *S epidermidis* colonies usually are **gray to white** on primary isolation
- Various degrees of **hemolysis** are produced by *S aureus*.

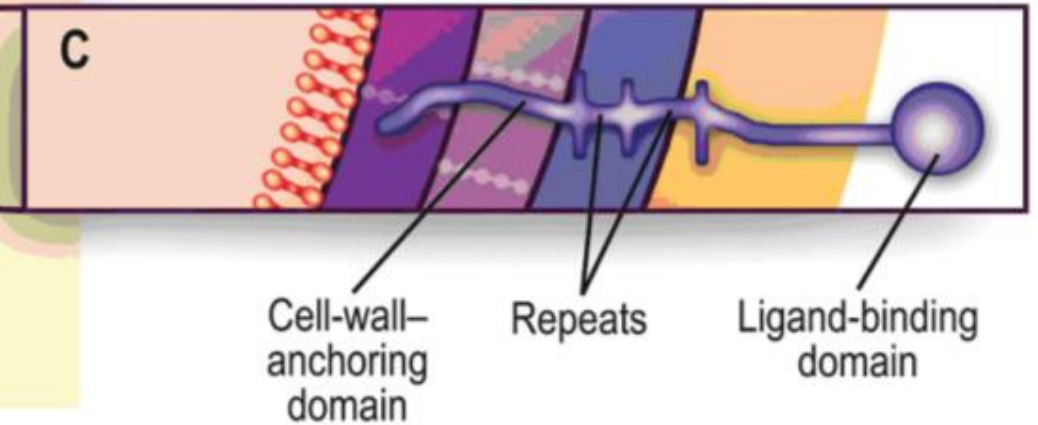
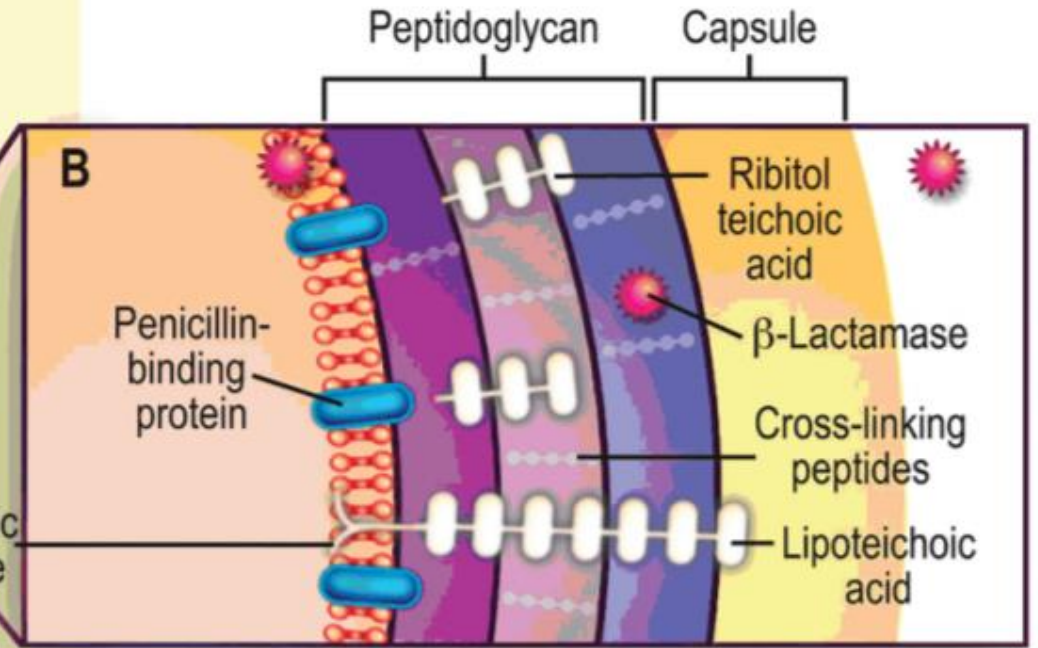
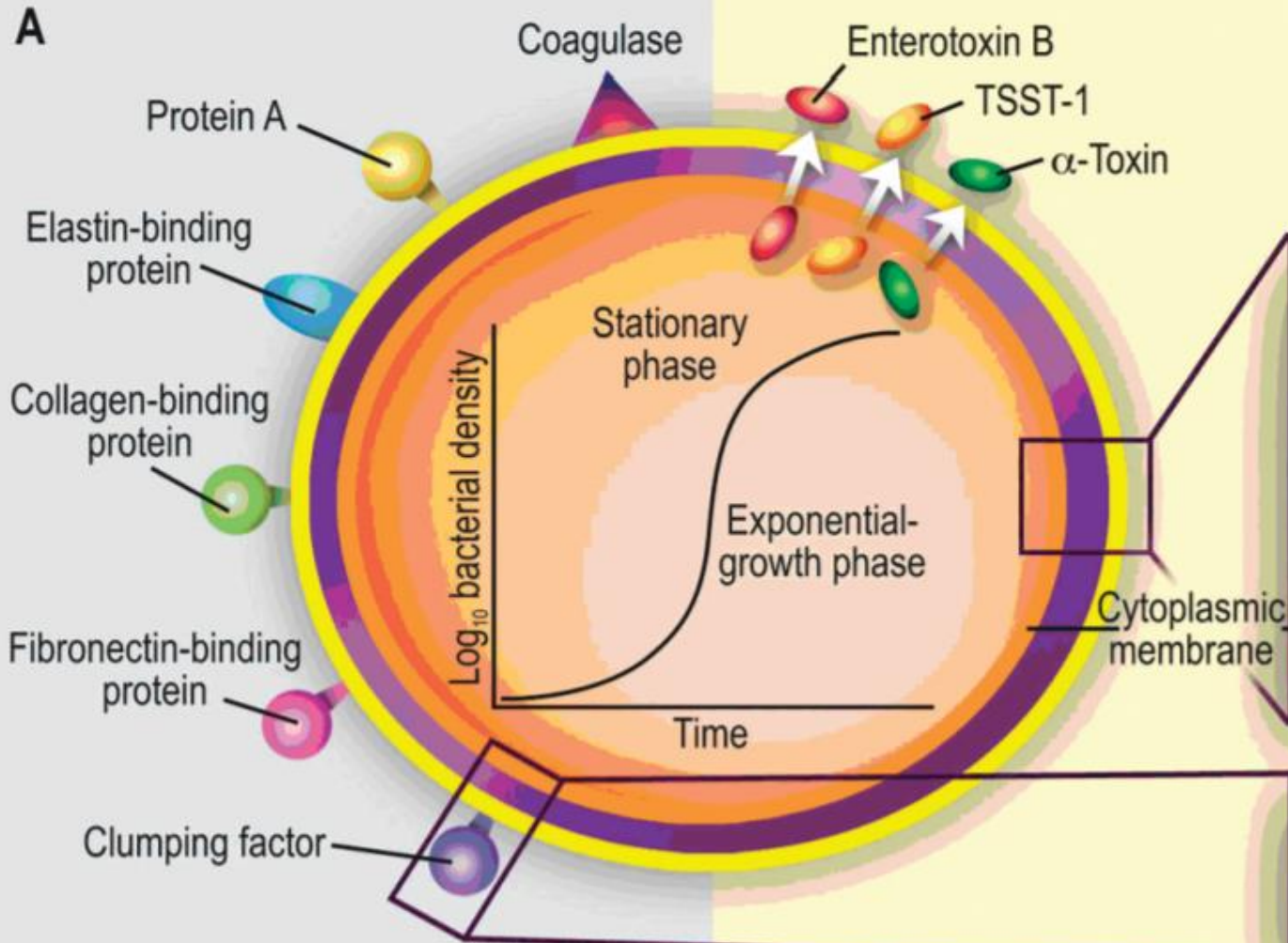


# Staphylococci / Structure and physiology

- **Peptidoglycan in the cell wall activate the immune response** (it can be a chemoattractant for polymorphonuclear leukocytes, have endotoxin-like activity, and activate complement. )
- Bacterial attachment to host cells is mediated by **MSCRAMM (*m*icrobial *s*urface *c*omponents *r*ecognizing *a*dhesive *m*atrix *m*olecules) proteins**. and these are important virulence factors. (e.g. Protein A, clumping factor)
- **Teichoic acids** are cross-linked to the peptidoglycan and can be antigenic.
- **Clumping factor A** is a fibrinogen-binding protein present on the surface of *S. aureus* that binds to fibrinogen and coats the surface of the bacterial cells with fibrinogen molecules, additionally complicating the recognition process.

**Surface proteins  
(exponential-growth phase)**

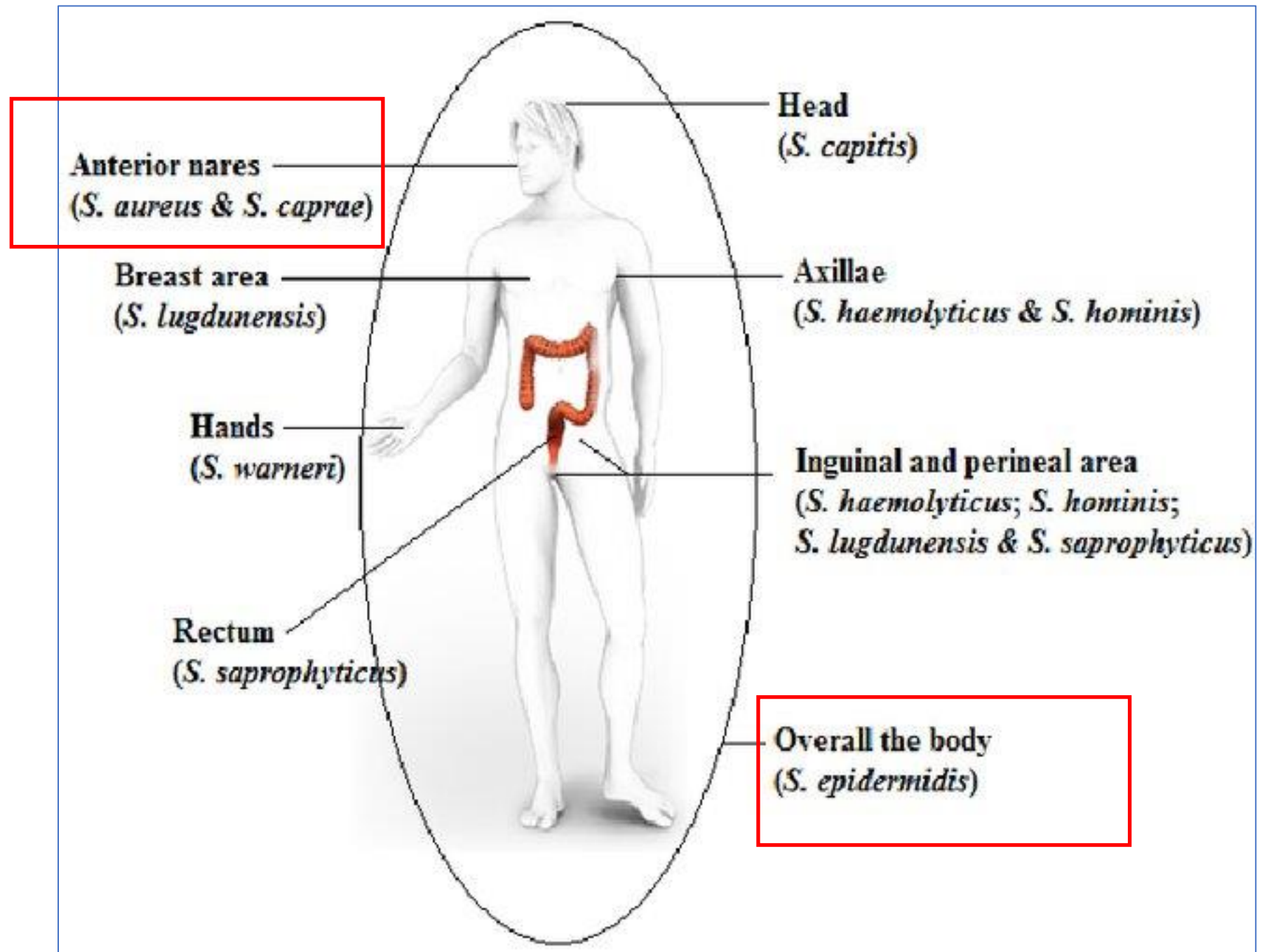
**Secreted proteins  
(stationary phase)**

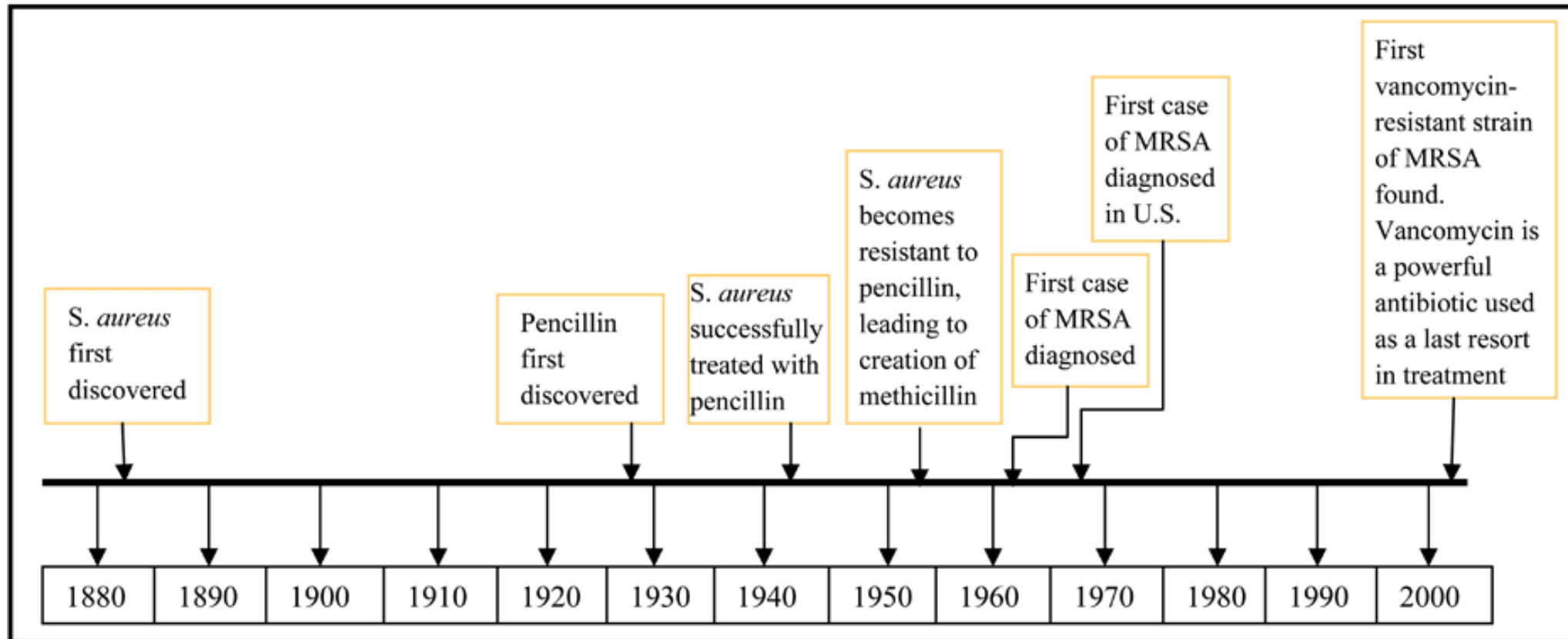


# Staphylococci / Epidemiology

- 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, with a **higher incidence** reported for **hospitalized patients, medical personnel**, persons with **eczematous skin diseases**. Staphylococci are also found regularly on clothing, bed linens, and other **fomites** in human environments.







- Beginning in the 1980s, strains of Methicillin-resistant *Staphylococcus aureus* (**MRSA**) **spread rapidly in susceptible hospitalized patients**, dramatically changing the therapy available for preventing and treating staphylococcal infections.
- MRSA began as a hospital-acquired infection, but has become **community-acquired** as well as **livestock-acquired**.
- People with compromised immune systems ( elderly, diabetics, HIV/AIDS ), hospitalized patients and children are some of the susceptible groups to MRSA.

# Staphylococci / Clinical correlations

A localized staphylococcal infection appears as a “**pimple,**” **hair follicle infection,** or **abscess.** There is usually an intense, localized, painful inflammatory reaction that undergoes central suppuration and heals quickly when the pus is drained.

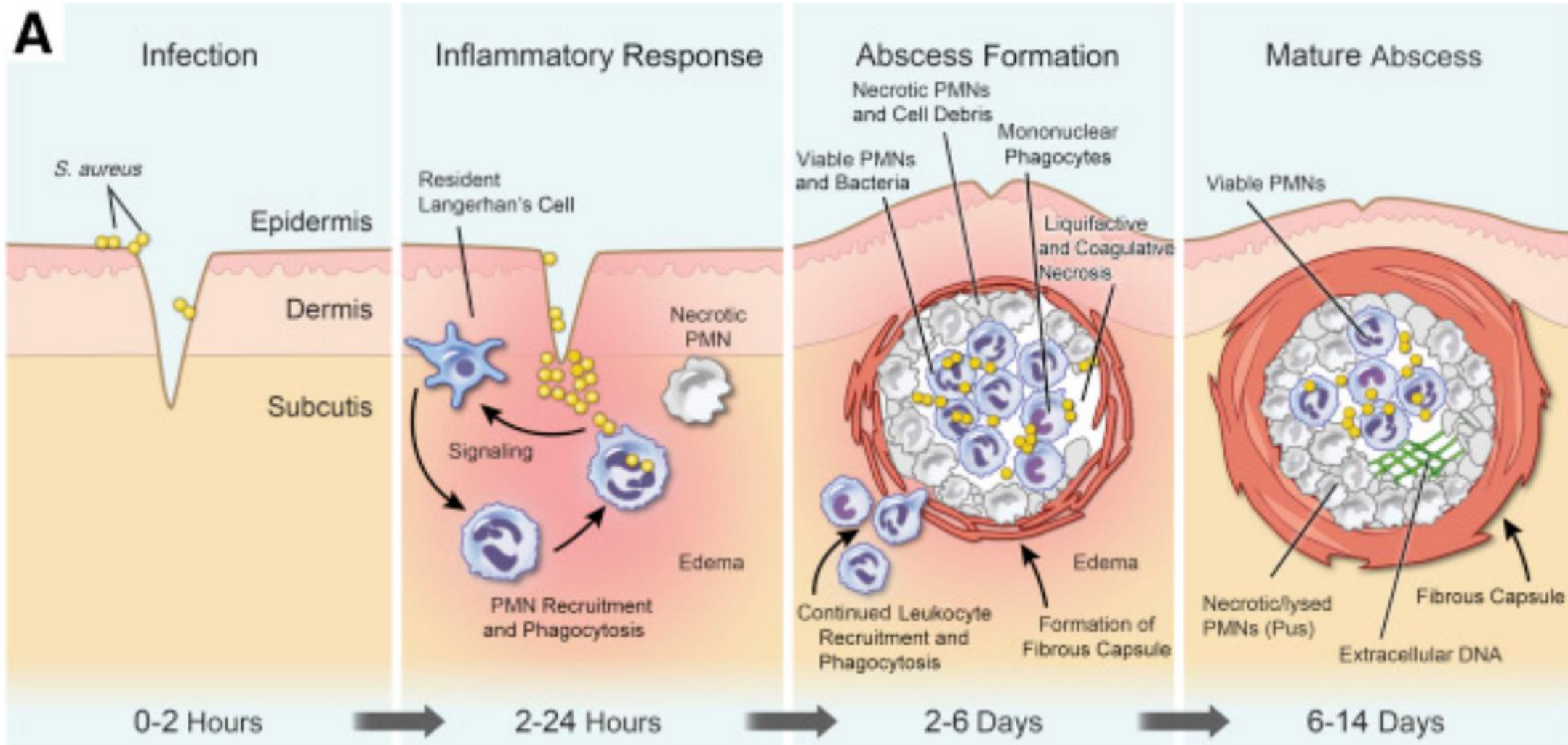


**Impetigo:** localized cutaneous infection characterized by pus-filled vesicle on an erythematous base

**Folliculitis:** impetigo involving hair follicles

**Furuncles or boils:** large, painful, pus-filled cutaneous nodules

**Carbuncles:** Coalescence of furuncles with extension into subcutaneous tissues and evidence of systemic disease (fever, chills, bacteremia)



# Staphylococci / Clinical correlations / Toxin mediated

- Staphylococcal food poisoning, one of the most common foodborne illnesses, is an **intoxication** rather than an infection, Disease is caused by **heat stable bacterial toxin** present in food rather than from a direct effect of the organisms on the patient. With a **short incubation period (1–8 hours)**; violent nausea, vomiting, and diarrhea; and **rapid convalescence**.
- **Staphylococcal scalded skin syndrome** is a condition which predominantly affects **infants** and **children** and causes a spectrum of skin lesions.

## Toxin-Mediated Diseases

**Scalded skin syndrome:** Disseminated desquamation of epithelium in infants; blisters with no organisms or leukocytes

**Food poisoning:** After consumption of food contaminated with heat-stable enterotoxin, rapid onset of severe vomiting, diarrhea, and abdominal cramping, with resolution within 24 hours

**Toxic shock:** multisystem intoxication characterized initially by fever, hypotension, and a diffuse, macular, erythematous rash; high mortality without prompt antibiotic therapy and elimination of the focus of infection



# Staphylococci / Clinical correlations / Coagulase negative

- *S epidermidis* infections are difficult to cure because they occur in **prosthetic devices** where the bacteria can sequester themselves in a **biofilm**. staphylococci are a major cause of **endocarditis of artificial valves**.
- More than 50% of all infections of **catheters and shunts** are caused by **coagulase-negative staphylococci**. These infections have become a major medical problem because long-dwelling catheters and shunts are used commonly for the medical management of critically ill patients.

## Coagulase-Negative *Staphylococcus* Species

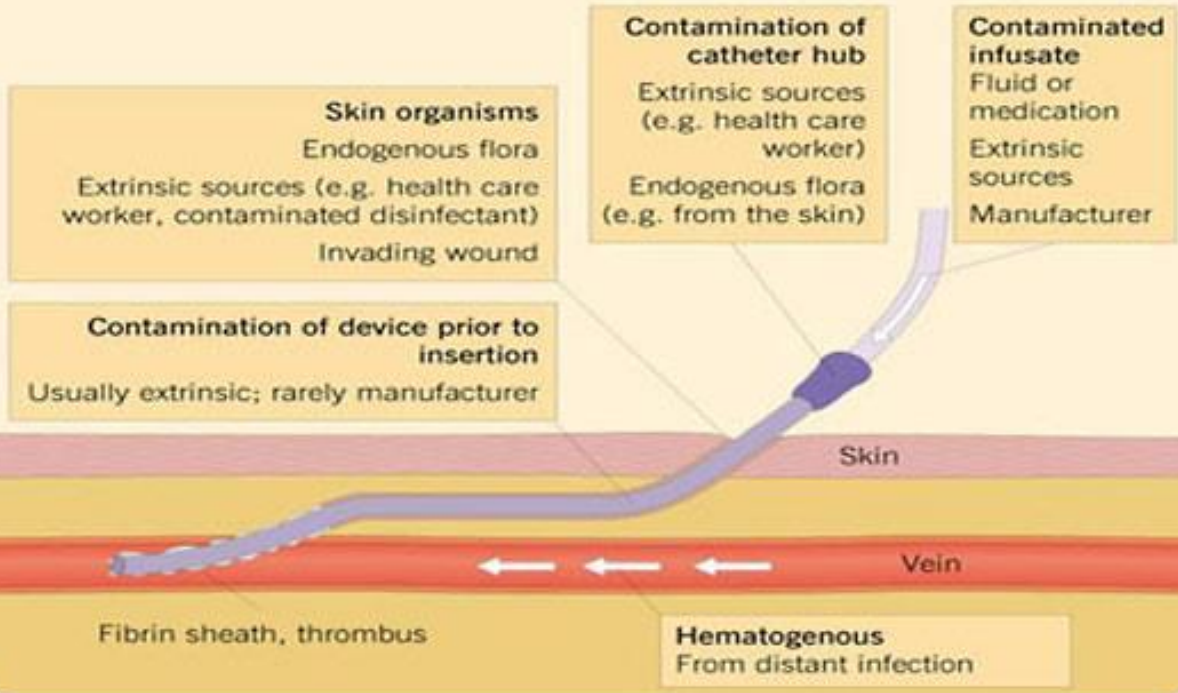
**Wound infections:** Characterized by erythema and pus at the site of a traumatic or surgical wound; infections with foreign bodies can be caused by *S. aureus* and coagulase-negative staphylococci

**Urinary tract infections:** Dysuria and pyuria in young sexually active women (*S. saprophyticus*), in patients with urinary catheters (other coagulase-negative staphylococci), or following seeding of the urinary tract by bacteremia (*S. aureus*)

**Catheter and shunt infections:** Chronic inflammatory response to bacteria coating a catheter or shunt (most commonly with coagulase-negative staphylococci)

**Prosthetic device infections:** Chronic infection of device characterized by localized pain and mechanical failure of the device (most commonly with coagulase-negative staphylococci)

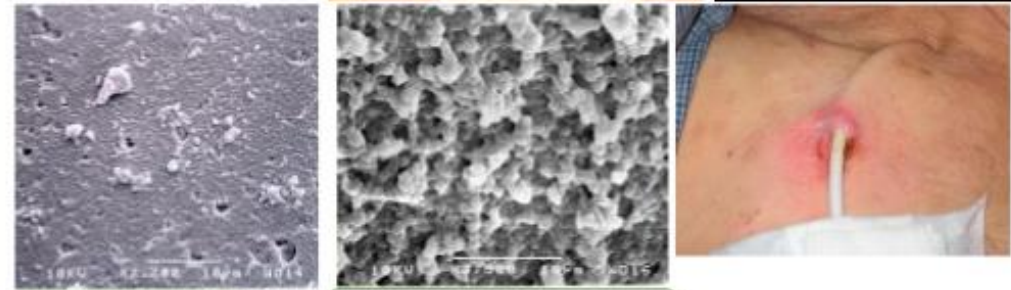
## POTENTIAL ROUTES OF INFECTION



Catheter Exit Site infection



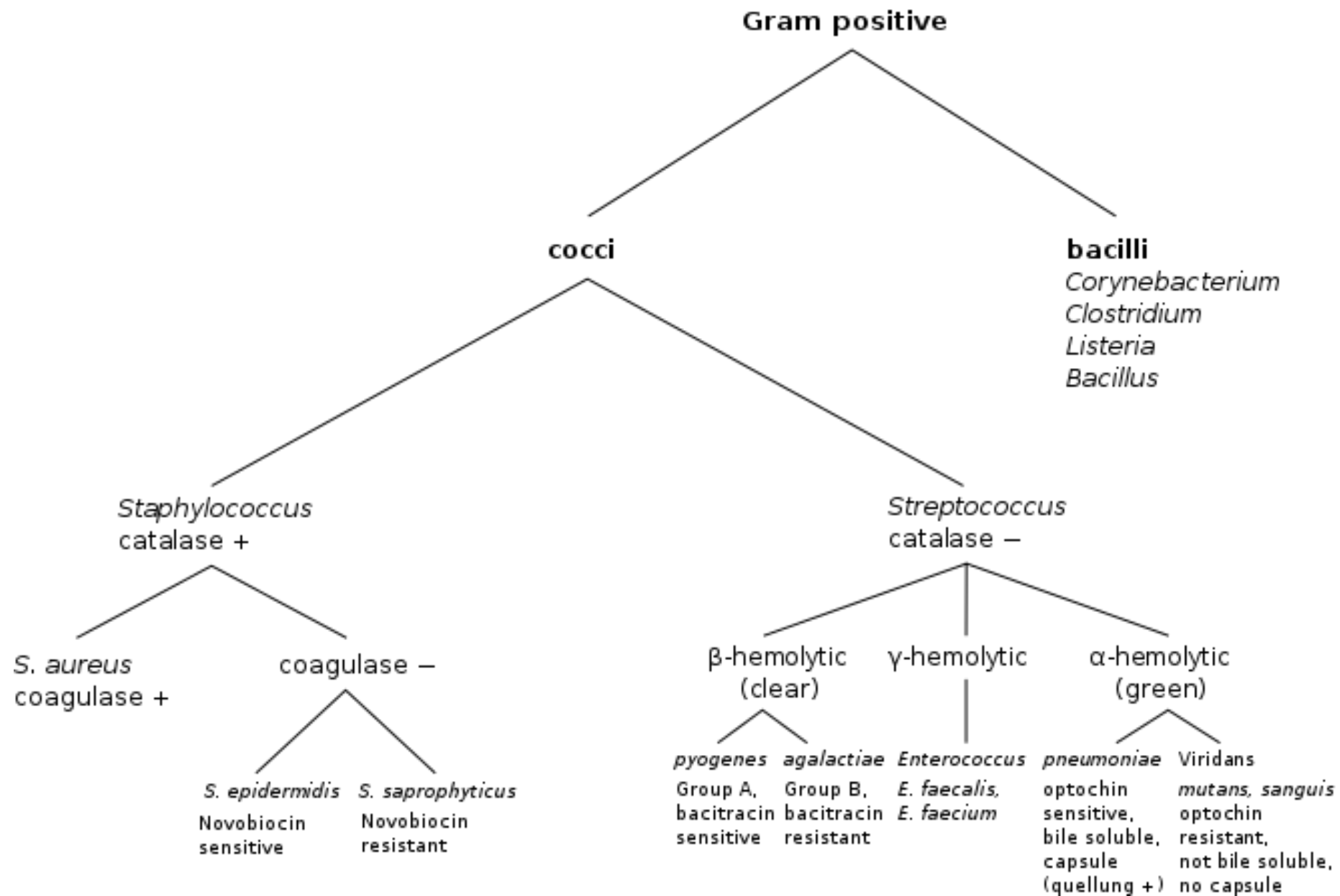
Catheter Tunnel infection



New catheter

Catheter with biofilm

Photo provided by Stephanie Booth, used with permission

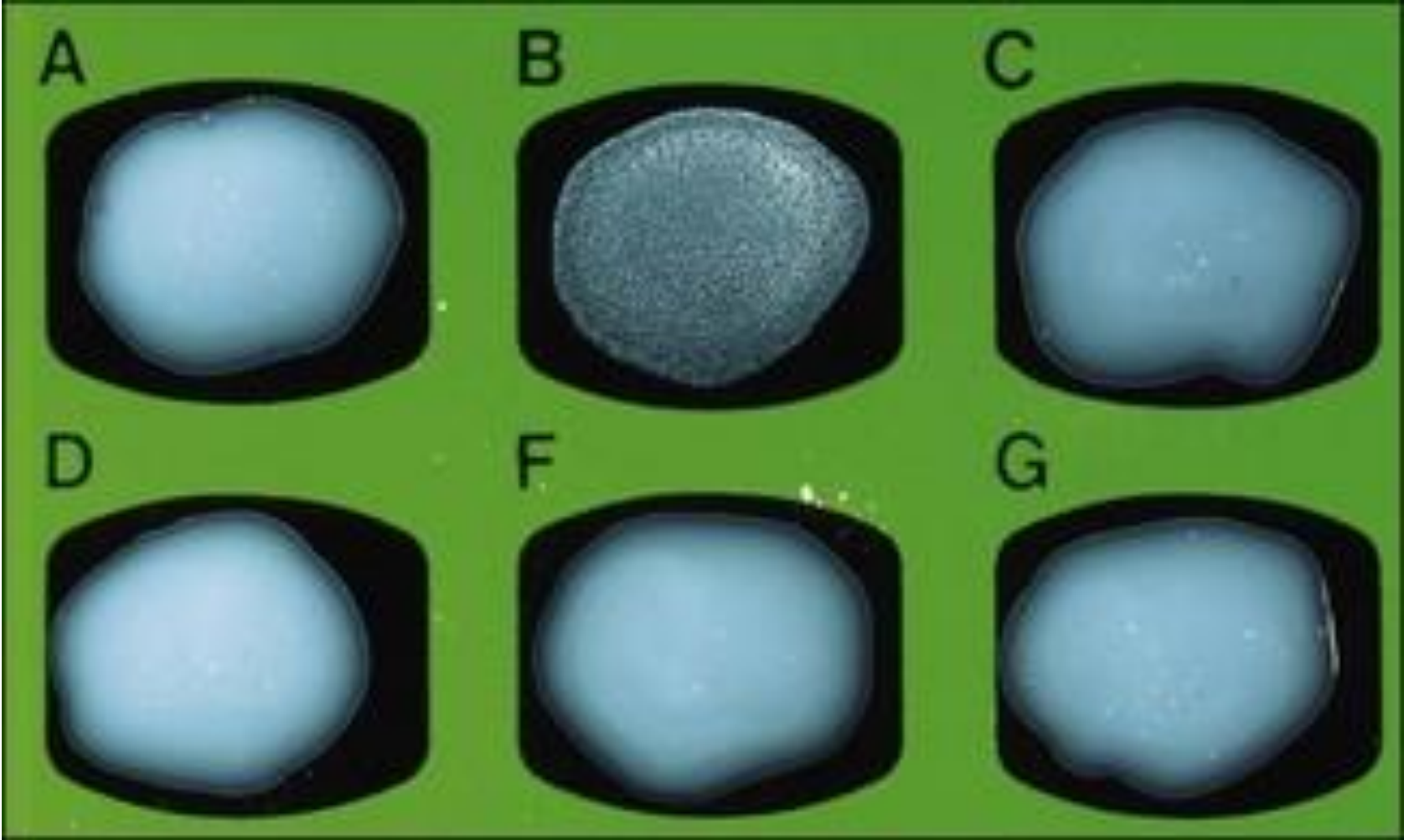




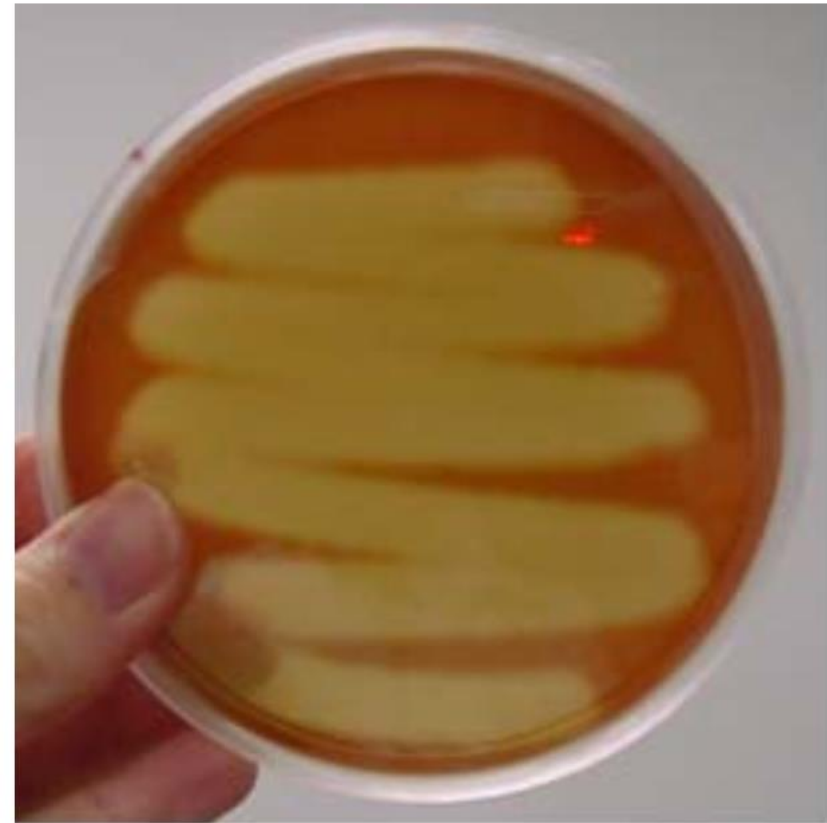
# Streptococci / Classification

- The classification of more than 100 species within the genus *Streptococcus* is complicated because three different overlapping schemes are used:
- (1) serologic properties: **Lancefield groupings** (originally A to W);
- (2) **hemolytic patterns**: complete (beta [ $\beta$ ]) hemolysis, incomplete (alpha [ $\alpha$ ]) hemolysis, and no (gamma [ $\gamma$ ]) hemolysis;
- (3) **biochemical (physiologic) properties.**
- The most important pathogenic streptococcal species for humans include ***Streptococcus pyogenes*** (group A streptococcus/ GAS) , ***Streptococcus agalactiae*** (GBS), ~~group D streptococcus (enterococci)~~, ***Streptococcus pneumoniae***, and ***Streptococcus viridans***.

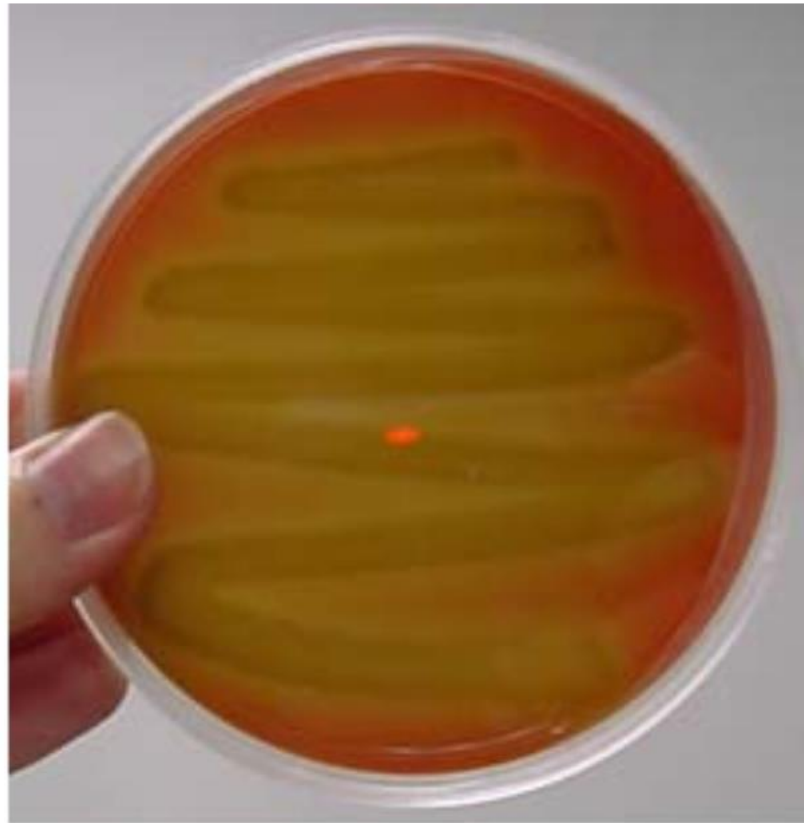
# Streptococci / Classification / Lancefield groupings



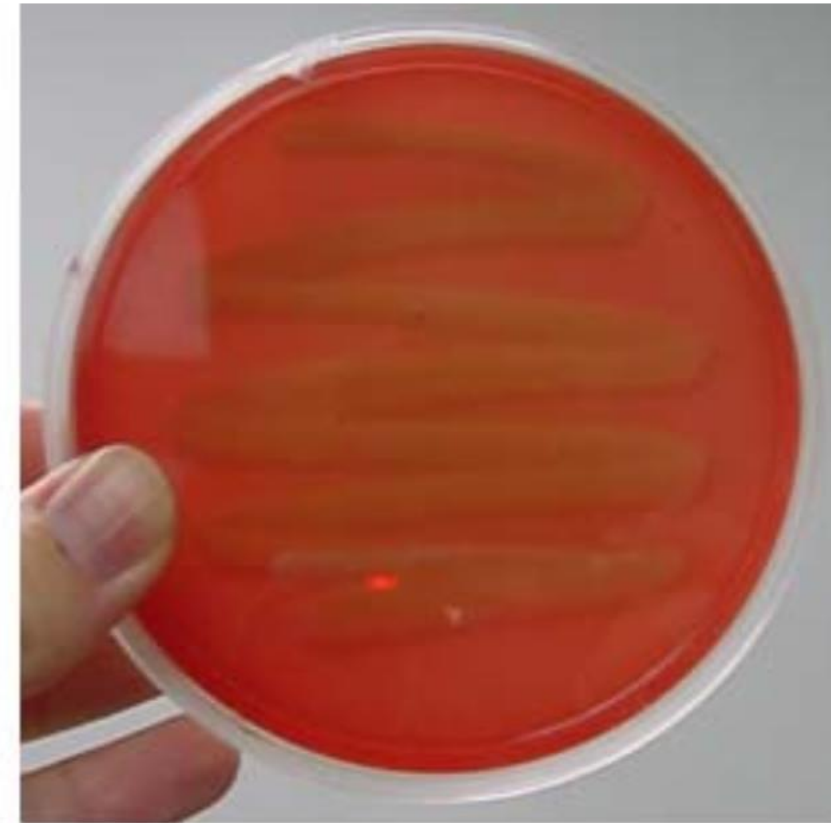
# Streptococci / Classification / hemolytic patterns



**Beta Hemolysis**

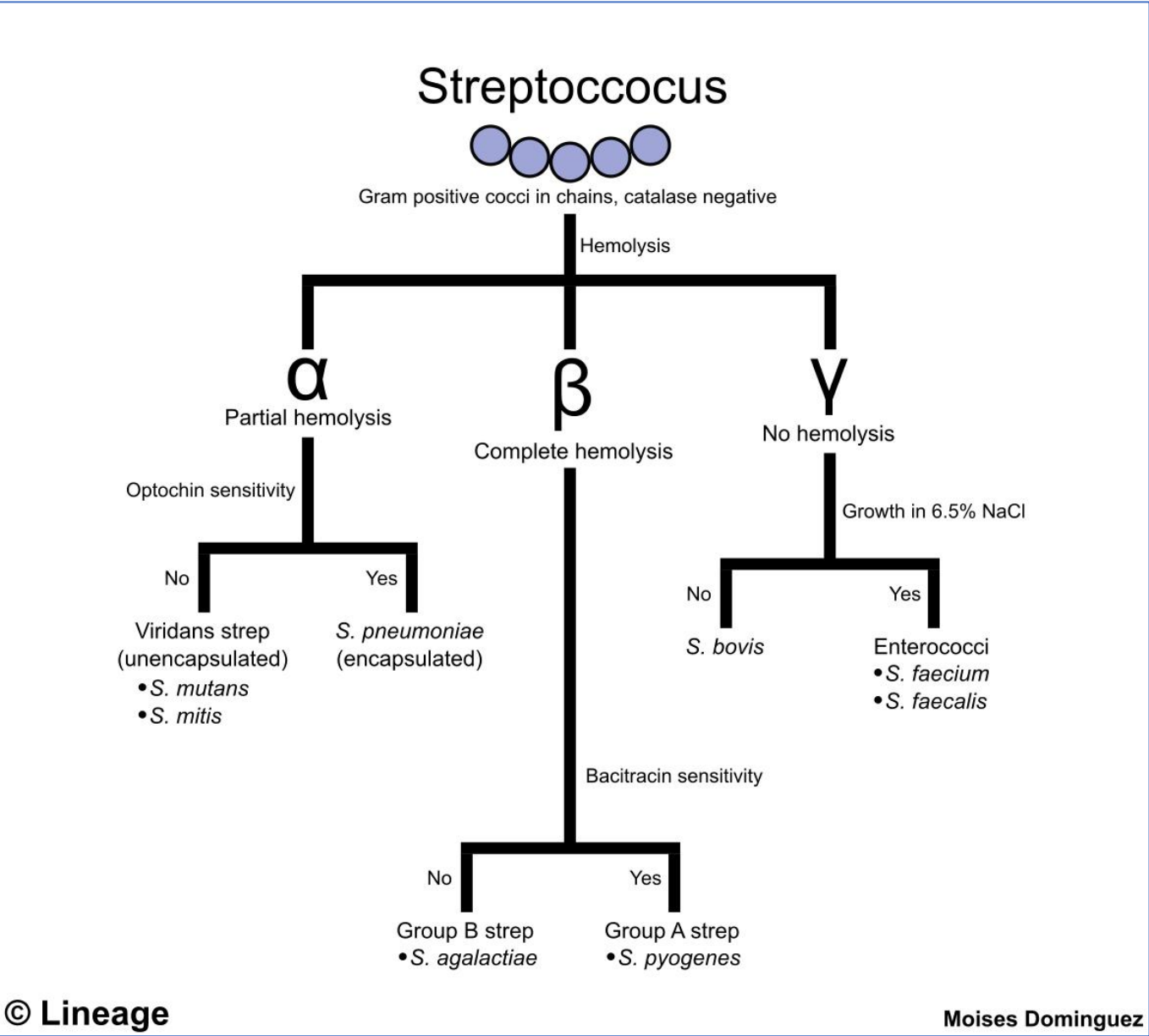


**Alpha Hemolysis**



**Gamma Hemolysis**

# Streptococci / Classification / biochemical (physiologic) properties



## Further reading:

- Jawetz, Melnick & Adelberg's Medical Microbiology, 26th edition-  
Section 3: Bacteriology-  
Chapter 13: The Staphylococci
- Murray - Medical Microbiology 8th Edition  
Section 4: Bacteriology  
Chapter 18: STAPHYLOCOCCUS AND RELATED GRAM-POSITIVE COCCI