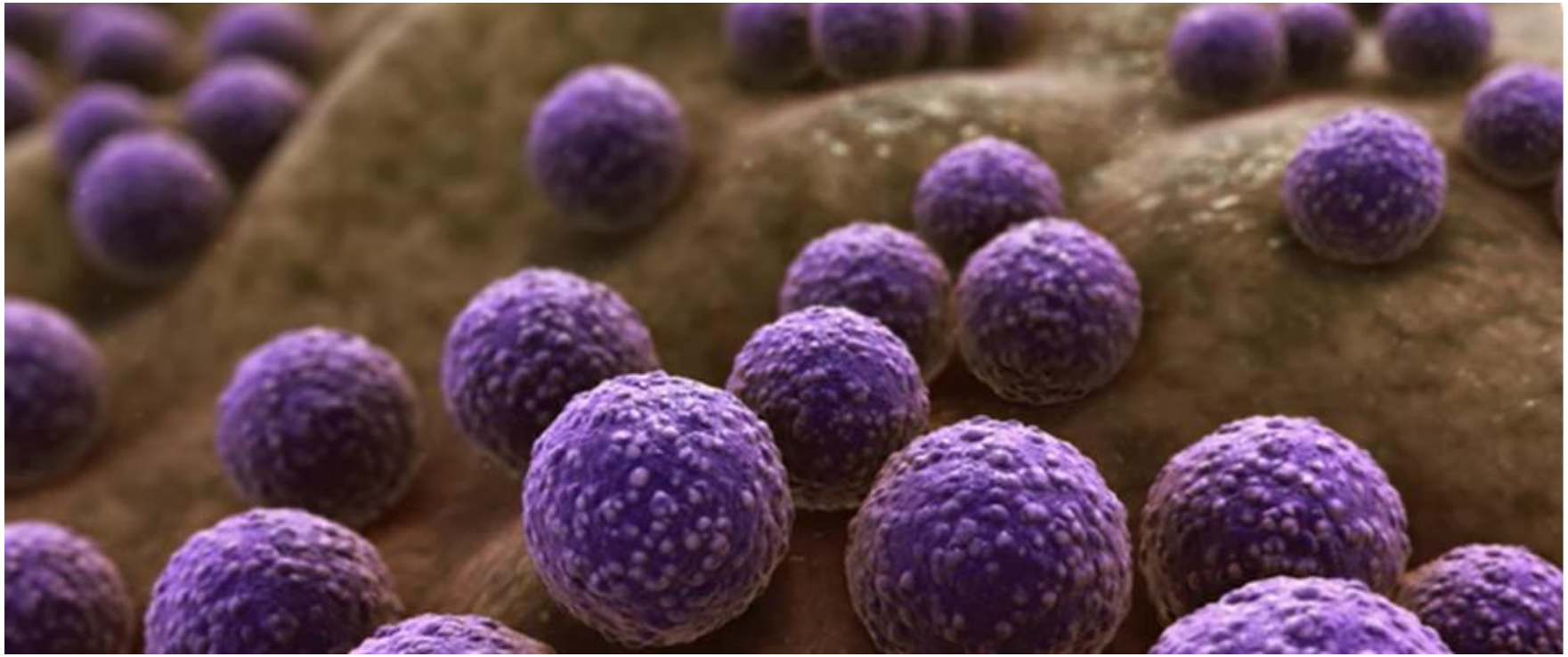
# Gram positive cocci

# *Staphylococcus*



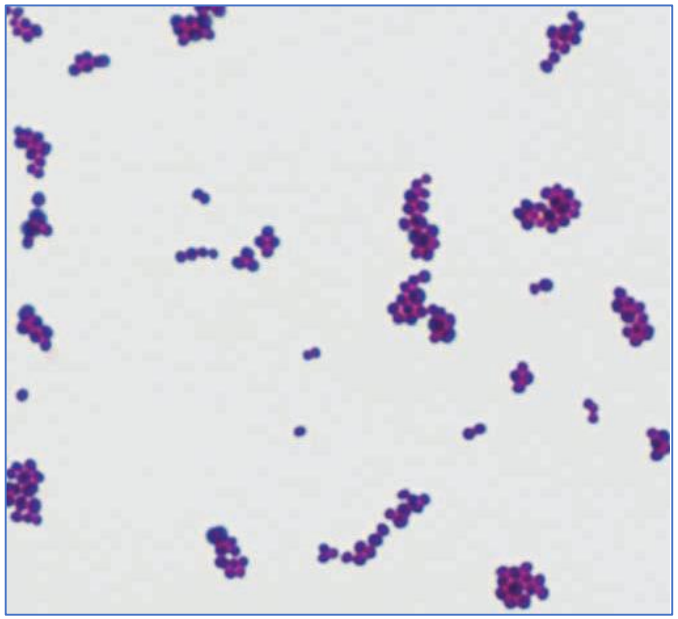
**Prof. Dr. Lamyaa Kadhim Baqer**
**Medical bacteriology**

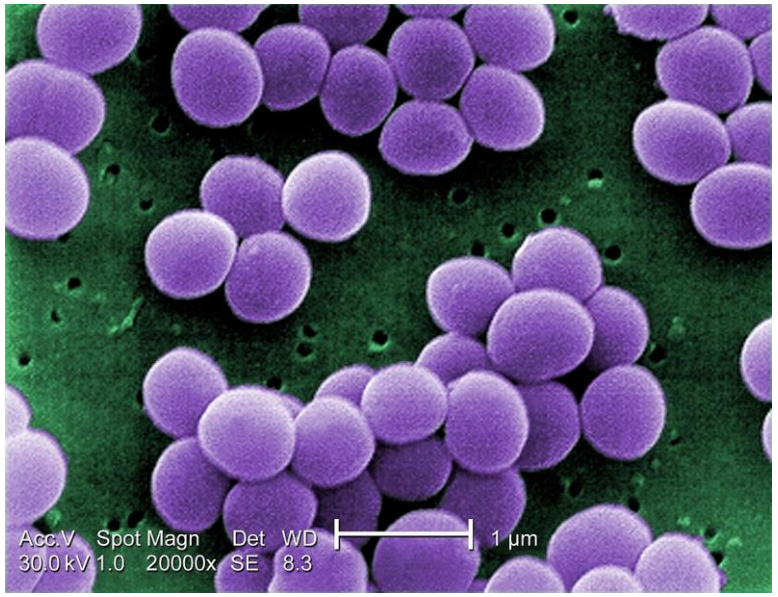
# Learning objectives

-Describe species of ***Staphylococcus.***
-Describe morphology and culture characteristics of ***Staphylococcus aureus.***
-List characteristics of ***Staph. aureus*** strains.
-list and describe toxins and enzymes of ***Staphylococcus aureus.***
-Describe Staphylococcal diseases.
-Discuss laboratory diagnosis of infections caused by ***Staphylococcus aureus.***
Explain methicillin –resistant Staphylococci and its clinical problem.
-Describe the following : Coagulase –negative Staphylococci (CNS).
-Distinguish characteristics of ***Staph. aureus*** ,***Staph. epidermides*** and ***Staph. saprophyticus.***

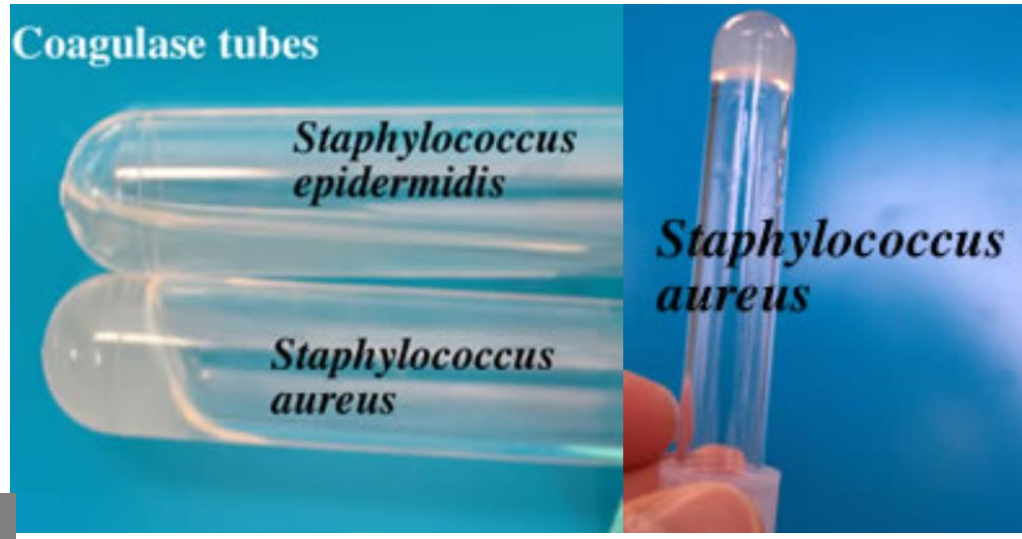
# Staphylococci / Structure and physiology

- **The staphylococci are gram-positive spherical cells, about 1 µm in diameter usually arranged in grapelike irregular clusters, It does not form spores and it is non-motile.**





- **The most frequently encountered species of clinical importance are :**

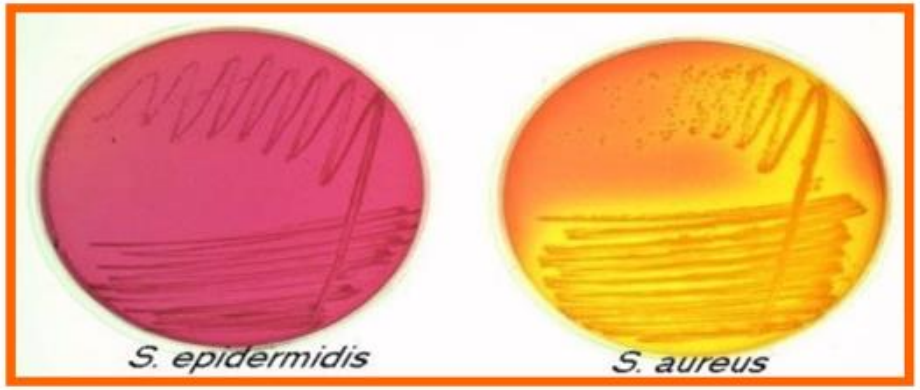



- ***Staphylococcus aureus,***
- ***Staphylococcus epidermidis,***
- **and *Staphylococcus saprophyticus*.**

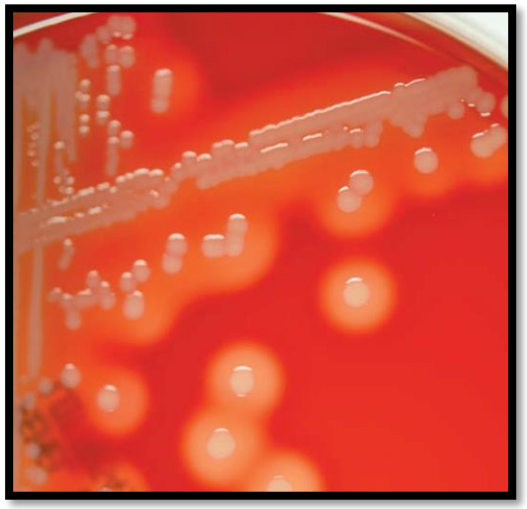
- ***Staph. aureus*** **is coagulase positive, The coagulase-negative staphylococci are normal human microbiota.**

- ***Staph. aureus*** **usually forms gray to deep golden yellow colonies.**

- ***Staph. epidermidis*** **colonies usually are gray to white on primary isolation.**
- **Colonies on solid media are round, smooth, raised, and glistening. Various degrees of hemolysis are produced by *Staph. aureus.***




Mannitol Salt Agar(MSA)



**Blood agar**


**Nutrient agar**

# Pathogenicity

**Pathogenicity results from three virulence features:**

- **Structures that enable it to evade phagocytosis**
- **Production of enzymes**
- **Production of toxins**

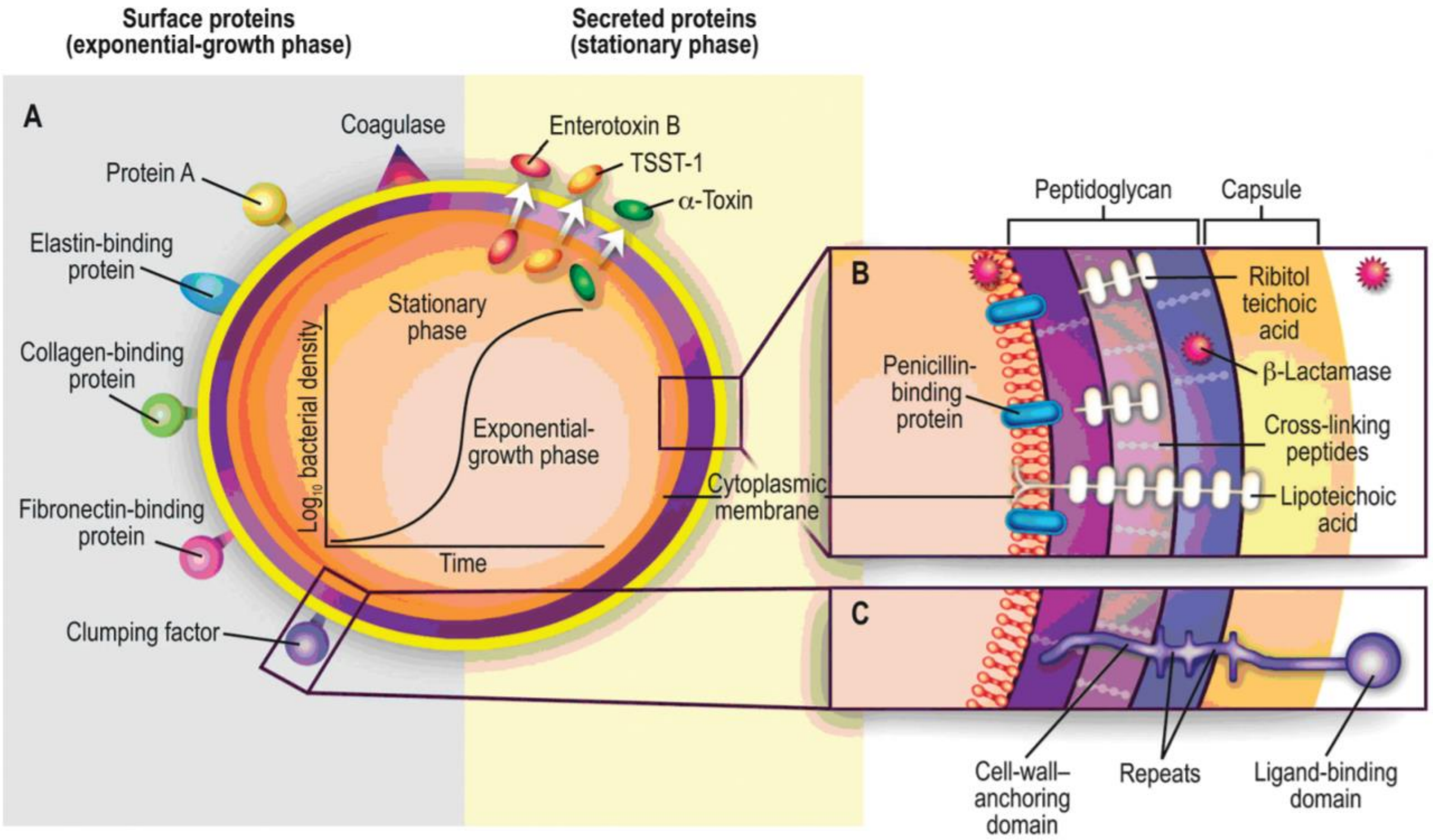
- **Structures that enable it to evade phagocytosis**
- **Peptidoglycan in the cell wall it activates complement and induces release of inflammatory cytokines.**
- **Teichoic acids are cross-linked to the peptidoglycan , facilitates adhesins of the cocci to the host cell surface and protect them from complement –mediated opsonization .**

- **Slime layers( Often called capsules)**

**-facilitates attachment of *Staphylococcus* to surfaces inhibit phagocytosis to leukocytes.**

- **Clumping factor A is a fibrinogen-binding protein present on the surface of *Staph. aureus* that converts the soluble blood protein fibrinogen in insoluble fibrin molecules that form blood clots.**

**Bacterial attachment to host cells is mediated by (microbial surface components proteins), and these are important virulence factors, (e.g. Protein A)**


Surface proteins
(exponential-growth phase)
Secreted proteins
(stationary phase)
A
Coagulase
Enterotoxin B
TSST-1
α-Toxin
Protein A
Elastin-binding protein
Collagen-binding protein
Fibronectin-binding protein
Clumping factor
Stationary phase
Exponential-growth phase
Log10 bacterial density
Time
Cytoplasmic membrane
B
Peptidoglycan
Capsule
Ribitol teichoic acid
β-Lactamase
Penicillin-binding protein
Cross-linking peptides
Lipoteichoic acid
C
Cell-wall–anchoring domain
Repeats
Ligand-binding domain

# virulence factors

## Staphylococci / Enzymes


- **1.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.**

**2. coagulase: invasive pathogenic potential factor converts fibrinogen to fibrin in plasma causes clot preventing the bacterial cell from being killed by the immune cells.**

3. **hyaluronidase: spreading factor degrades hyaluronic acid in connective tissue.**

4. **staphylokinase: causes fibrinolysis by degrading fibrin, and facilitates in spreading of bacterial cells.**

5. **β-lactamase**

6. **proteinase.**

7. **lipase.**

8. **nuclease.**

# Toxins

***Staphylococcus aureus*** **produces exotoxins:-**

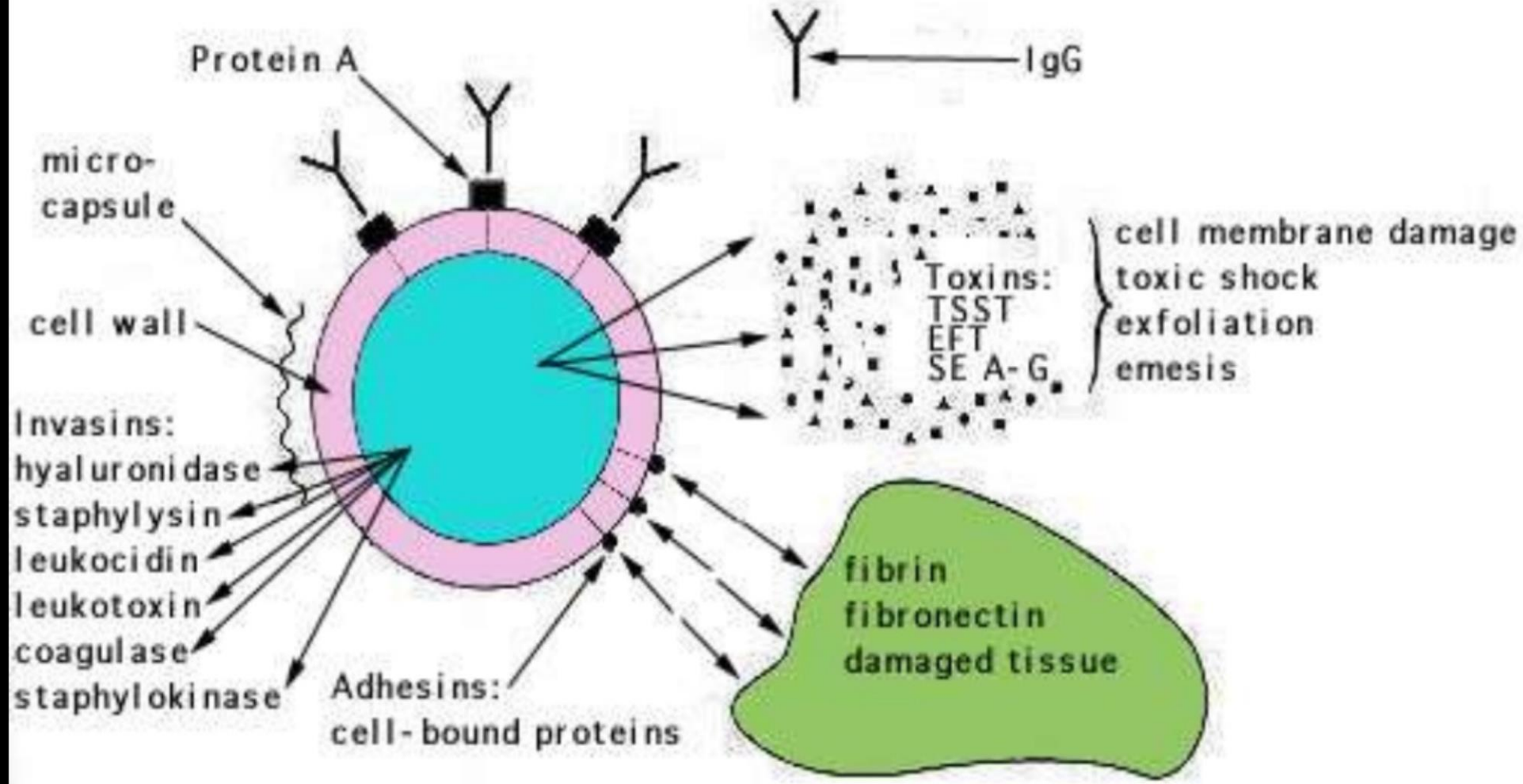
**(1)- cytolytic exotoxins or haemolysin:include toxins(alpha,beta,gamma) that lyses the R.B.Cs ,also it produces the toxin Leucocidin(Panton-Valentine)that lyses the W.B.Cs.**

**2-enterotoxins:- soluble toxins produced by 50% of *Staphylococcus aureus* and responsible for gastroenteritis, food poisoning.**

**3-Toxic Shock Syndrome Toxin-1 (TSST-1):- is the classic cause of toxic shock syndrome ( associated with fever, shock, rash ,desquamative of the skin).**

**4-Exfoliative Toxin (ET) (epidermolytic toxin):- Causes Staphylococcal Scalded Skin Syndrome (SSSS) occurs in young children.**

# Virulence Determinants of *Staphylococcus aureus*



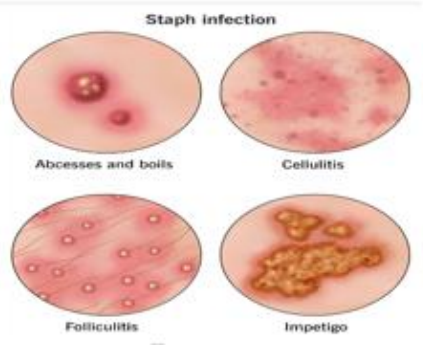
# Staphylococcal diseases

## 1- Noninvasive disease

Food poisoning from the ingestion of enterotoxin-contaminated food.

## 2- Cutaneous diseases

Various skin conditions including scalded skin syndrome ,impetigo , folliculitis and furuncles .




scalded skin syndrome

# 3- systemic disease

-toxic shock syndrome

-Bacteremia

-Endocarditis

-Pneumonia

-Osteomyelitis-inflammation of the bone marrow and the surrounding bone

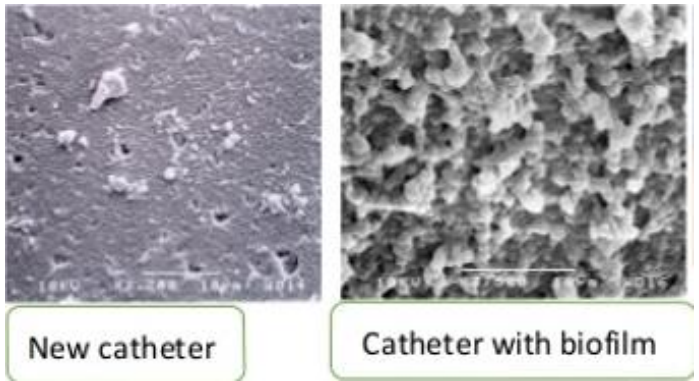
- Diabetic foot infection

toxic shock syndrome

# Coagulase-negative *Staphylococci*:-

## 1- *Staphylococcus epidermidis:*

- Present in large numbers of the normal flora of the skin, recovered from blood contaminant from skin.
- Despite its low virulence, it can cause infection of heart valves and catheters.
- *Staph. epidermidis* produce slime that facilitates adherence to intravenous catheters acts as barrier for antimicrobial agents.
- It is sensitive to novobiocin




## 2- *Staphylococcus saprophyticus*:

- Cause cystitis in women, probably related to its occurrence as a part of normal vaginal flora.

- Sensitive to penicillin G.

- it can be distinguished from *Staph. epidermidis* and most coagulase –ve staph by its resistance to novobiocin.


More than 17 mm = Sensitive

Less than 17 mm = Resistant

## Treatment

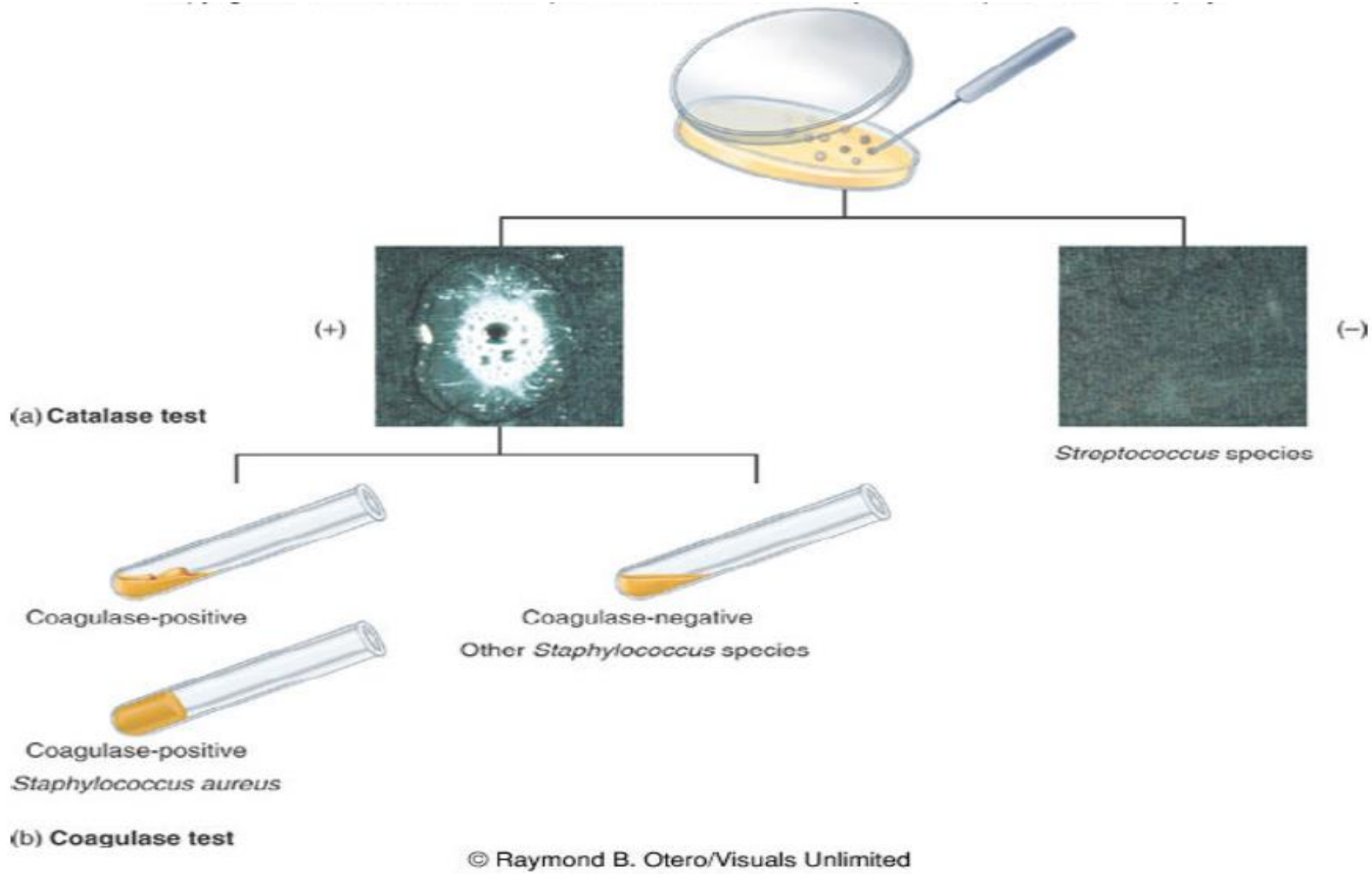
**Vancomycin and Methicillin is the drug of choice to treat Staphylococcal hospital and non hospital acquired infections**

**-Methicillin is a semisynthetic from of penicillin and is not inactivated by β-lactamase .**

**MRSA(ORSA): methicillin(oxacillin)- multiresistant *Staph.aureus* resulting from acquisition of *mecA.***

**-MRSA strains are usually also resistant to tetracycline , erythromycins and aminoglycosides .**

**VERSA: vancomycin intermediated resistant staph aureus two vancomycin-resistant strains(VRSA),have been isolated in USA since 2002.**




(a) **Catalase test**

(b) **Coagulase test**

# Summary (lab diagnosis of Staphylococci infection)

**Specimens**

↓

**Direct microscopy**

↓

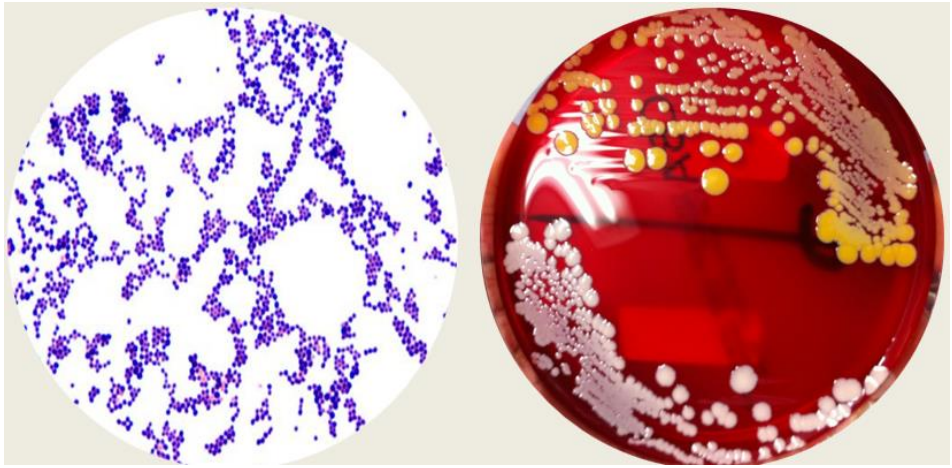
**Culture**

↓

**Biochemical test**

↓

**Antibiotic sensitivity test**




THANKS