

## Systemic Bacteriology

Cocci bacteria / cocci means “spherical bacteria”

They include:

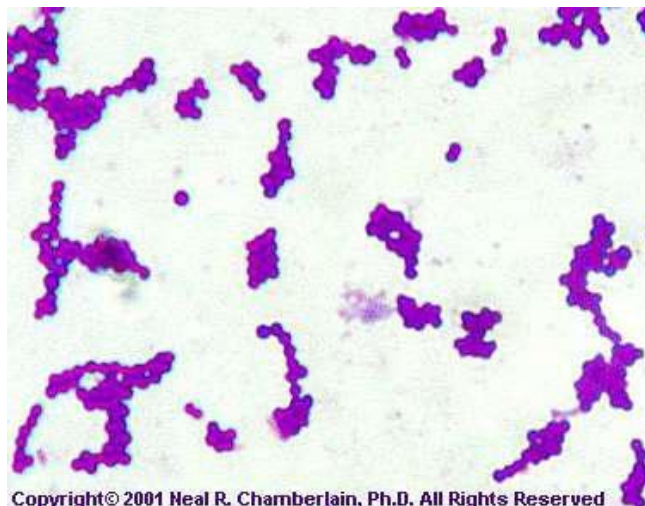
1. Staphylococcus (Gram positive)
2. Streptococcus (Gram positive)
3. Pneumococcus (Gram positive)
4. Neisseria (Gram Negative)

The pathogenic cocci are often called pyogenic cocci because of their ability to form pus (suppuration).

### Genus Staphylococcus

This microorganism is widely distributed in our environment some of them are members of the normal flora of humans, the normal flora include all microorganism which are normally found on the skin and mucous membrane of human beings. Others are important human pathogens like *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Staphylococcus saprophyticus*.

Staphylococci are spherical in shape usually arranged in grape like clusters, grow rapidly on many types of ordinary bacterial media ferment CHO and produced pigments varying from white to deep yellow.



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## Resistance to environmental condition:

*Staphylococcus aureus* considered one of the hardest of all non spore forming bacteria most strain are relatively heat stable, with stand a temperature as high as 60 c for 30 min. also resist a high concentration of salt (7.5% - 9% NaCl).

## Antigenic structure of *Staphylococcus aureus*:

### 1. Peptidoglycan:

The peptidoglycan has endotoxin activity.

### 2. Teichoic acids:

### 3. Protein A :

Is a cell wall component of bacteria that binds antibody.

### 4. Extracellular substances: (enzymes and toxin)

Most extracellular substances produced by *Staphylococcus aureus* are antigenic (stimulate the production of antibodies).

These are:-

1. Catalase : Is an enzyme that breaks hydrogen peroxide  $H_2O_2$  into  $O_2$  and  $H_2O$ .

It's useful in differentiation between members of genus Staphylococcus aureus and genus Streptococcus.

### 2. Coagulase:

This enzyme converts fibrinogen (soluble) into fibrin (insoluble). Fibrin can be deposited on the surface of bacteria forming a wall around the bacteria which has an important role in:

A) Protection of bacteria from phagocytosis.

B) Preventing the action of antibiotics.

### 3. Proteinase:

Is an enzyme which breaks down protein material.

4. Lipase:

Is an enzyme which breaks down lipid in the skin, lipoprotein in blood.

5. Hyaluronidase:

Enzyme breaks down hyaluronic acid (is important substance in binding tissue cells together therefore this enzyme helps the bacteria to spread in the tissues. some time it is called (spreading factor).

6.  $\beta$  - Lactamase:

break down  $\beta$  -lactam ring of penicillin.

## TOXINS

1- Hemolysins (exotoxins):

Include several toxins act on cell membrane of RBCs.

2- Leukocidin :

Toxic substance causes degradation of WBC leading to cell death.

3- Exfoliative toxins:

Toxins that yield the generalized desquamation of the skin in (scaled skin syndrome) this syndrome is common among small children.

4- Enterotoxins:

They are 6 soluble toxins (A, B, C, D, E, and F), resistant to the gut enzymes and acidity, that cause nausea, vomiting and diarrhea. an important cause of food poisoning. Produced by *Staphylococcus aureus* growing in meat and dairy products.

5- Toxic shock syndrome toxin: (TSST)

Associated with toxic shock syndrome TSS which is a systemic infection characterized by high fever, hypotension and shock with multisystem involvement.

This type of bacteria can be found in hospitals because above 90% of hospitals strains of *Staphylococcus aureus* are  $\beta$ -lactamase producer so antibiotics are useless when giving to the patients.

MRSA= methicillin resistant Staph. aureus

VRSA= vancomycin resistant Staph. aureus

### Pathogenicity of Staphylococcus aureus:

*Staphylococcus aureus* produces human infection by its capability to invade and spread into tissue and by production of certain enzymes and toxins.

Disease spectrum: from moderate to severe.

#### Moderate infection:-

Minor skin infection (acne, furuncle, localized abscess, impetigo which is infection in the superficial layer of skin, common in small children).

#### Sever infection:- (Bacteremia)

- A. Osteomyelitis: Infection reaches the bone.
- B. Pneumonia: In post operative patients or following viral infection.
- C. Arthritis.
- D. Deep organ abscess as brain or lung abscess.

#### Diseases associated with toxin production

- \* Staphylococcal food poisoning due to ingestion of enterotoxin.
- \* Scaled skin syndrome SSS - associated with exfoliative toxin.
- \* Toxic shock syndrome toxin associated with TSST.

#### ***Staphylococcus epidermidis* (Coagulase -ve)**

All humans carry these bacteria in the deep layer of skin; it's usually associated with nosocomial infections and with foreign objects (i.e. catheters, shunts, pacemaker wires, heart valves replacement).

#### ***Staphylococcus saprophytics*: (Coagulase -ve)**

Normal flora when become pathogenic, it causes upper and lower urinary tract infection in young women.

## **Laboratory Diagnosis**

Staph. aureus should be grown under aerobic conditions. On blood agar, a zone of B-haemolysis may be present. Fermentation of mannitol and growth in high salt concentration provide further suggestive evidence. Staph. aureus can only be definitively identified by the presence of coagulase.

## **Treatment**

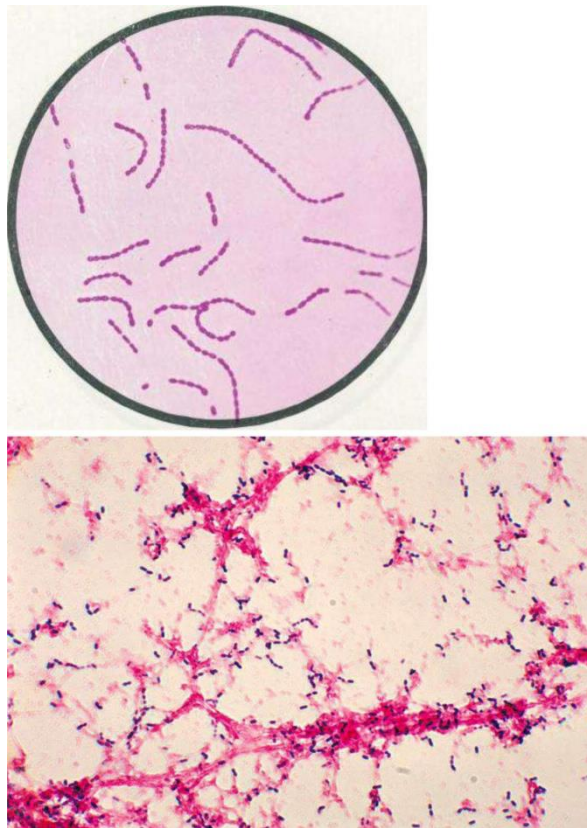
Minor lesions do not generally require anti-microbial treatment. Localized abscesses should be drained. Penicillin is the drug of choice should the strain responsible be sensitive to it. Otherwise, in the absence of sensitivity data, treatment may be started with a penicillinase-resistant agent such as ampicillin.

In certain hospital settings throughout the world, serious nosocomial epidemics are caused by *S. aureus* strains resistant to all antibiotics, one of them sensitive to methicillin (MRSA) and another sensitive to vancomycin (VRSA).

### Genus: Streptococcus

Members of this genus are widely distributed in environment, some are non pathogenic and could be a part of normal flora present in pharynx, mouth, intestine and female genital tract. Members of this group are aerobic, non motile, non spore forming, some are capsulated.

Nutritionally streptococci are fastidious m.o. and only grow on enriched media for example blood agar, chocolate agar and can't grow on simple media like nutrient agar, it arranged in chains or in pairs.



### Classification of Streptococcus:

Specific criteria are used in classification of Streptococci which include:

1. Type of growth on blood agar medium.
2. Serologic specificity.
3. Biochemical and physiological factors.
4. Capsular polysaccharide.

## Types of streptococcal growth on blood agar

1.  $\beta$ -hemolytic Streptococci: clear zones of hemolysis around the colonies.
2.  $\alpha$  – hemolytic Streptococci: partial or incomplete hemolysis around the colony ex. *Viridans streptococci* , *Streptococcus pneumoniae*.
3.  $\gamma$  type of hemolysis ( Non hemolytic) streptococci : no change on surface of blood agar.

(Group  $\beta$  streptococci is the most important group of streptococci)

### Antigenic structure of hemolytic streptococci:

#### 1- Carbohydrate antigen (C antigen):

Its group specific cell wall antigen which is carbohydrate in nature and it's located in the cell wall of many streptococci and form the basis of serologic grouping (Lancefield grouping). On basis of this antigen  $\beta$ -hemolytic Streptococci are divided in to 19 groups from A-U except I and J

A B C D E F G H      K L M N O P Q R S T U (Lancefield groups)



#### Group A streptococci (*Streptococcus pyogenes*)

Is the most important human pathogen it can cause pharyngitis, tonsillitis.

## Group B streptococci (*Streptococcus agalactiae*)

Normal flora of female genital tract and can cause neonatal sepsis and meningitis.

## Group D streptococci include:

(May called Enterococci)

e.g *Enterococcus faecalis* it resist bile, 6.5% NaCl and penicillin G.

**Non Enterococcus** e.g *Streptococcus bovis* it is inhibited by 6.5% NaCl and killed by penicillin G.

## 2. M- protein:

It's associated with virulence of group A streptococci. Group A streptococci are subdivided into 60 types. It appears as hair like projection of the cell wall, it help the bacteria to resist phagocytosis.

## 3. Nucleoprotein:

Antigens associated with streptococcal cell body.

## Toxins and enzymes of group A streptococci (Extracellular product):

- a- Hemolysins (streptolysins).
- b- Streptokinase (fibrinolysin).
- c- Streptodornase (DNase).
- d- Hyaluronidase (spreading factor).
- e- Erythrogenic toxin.

## 1. Streptolysin O \*sensitive to oxygen

\* antigenic ASO

The ASO titer can be applied in the diagnosis of streptococcal infections.

Serum titer >200 I.U. is considered abnormal.



### Disease caused by *Streptococcus pyogenes*:

Can be divided into two groups:

1. Suppurative infection (pus forming).
2. Non suppurative sequelae.

### Suppurative infection include:-

A) *Strep. Pharyngitis*: most common in infants and small children, there is extension to the surrounding tissue causing otitis media, meningitis. The tonsils are usually enlarged with enlarged tender cervical lymph nodes.

B) *Strep. Infection*: can involve URT causing pneumonia which most commonly occurs after viral infection.

C) *Streptococcus pyoderma*.

D) *Erysipilas*: which is spreading infection of the skin or mucous membrane usually seen on the face and legs.

E) *Surgical wound infection*.

F) *Puerperal sepsis*: streptococcus enter the uterus after delivery causing puerperal fever.

G) *Scarlet fever*.

H) *Streptococcus toxic shock syndrome*.

### Non suppurative infection: Post Streptococcal disease

1. Acute rheumatic fever.
2. Acute glomerulonephritis.

$\alpha$  – **hemolytic Streptococci:** It includes:

1. *Viridans streptococci*
2. *Streptococcus pneumoniae*

### *Viridans streptococci*

This microorganism has low virulence and often colonizes in the URT. They considered as commensal microorganisms of the mouth and they can act as opportunistic pathogen and attack tissue. It is associated with dental caries and they are the leading cause of subacute bacterial endocarditis (SBE) following dental extraction it include:

*Streptococcus mitis, Streptococcus mutans and Streptococcus salivaris*

### *Streptococcus pneumoniae:*

Also called (*Diplococcus pneumoniae* or pneumococcus).

-Normal inhabitant of the upper respiratory tract (URT) of human i.e. 40%-70% of normal individuals are carriers of these bacteria.

- No animal reservoir, i.e. transmission is from infected to normal persons by direct route.

- some times may cause important human diseases such as pneumonia, bronchitis, sinusitis, otitis media and less frequently it invades blood stream producing bacteremia, and the most important complication of bacteremia includes: meningitis and septic arthritis.

### **Laboratory diagnosis**

Streptococci are readily cultured from blood agar plates where a or B haemolysis may be seen. The antistreptolysin test measures Abs against streptolysin O. Antibodies against streptokinase, hyaluronidase, or DNase may be also be used.

### **Treatment**

Penicillin is the drug of choice in the treatment of *S. pyogenes* infection. Where a history of hypersensitivity to penicillin exists, erythromycin may be used instead.