

# Gram Positive Cocci

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# Gram Positive Cocci

- Pyogenic Opportunists (normal flora)  
*Staphylococcus, Streptococcus, Enterococcus*
- Contagious Pathogens (few species)  
*Staphylococcus, Streptococcus*
- Nonpathogenic Saprophytes (*Micrococcus*)

# Identification of Gram Positive Cocci

## GRAM POSITIVE COCCI

Note: *Strep. viridans* are alpha hemolytic and negative for all the tests below

### Catalase



**Staphylococcus (Clusters)**

### Coagulase



***S. aureus***  
 hemolytic  
 mannitol  
 yellow










***S. epidermidis*,  
*S. saprophyticus***  
 nonhemolytic (usually)  
 mannitol  
 white



**Streptococcus (pairs & chains)**

### Hemolysis

- (1) BETA: Bacitracin  → ***S. pyogenes* (group A)**  
 CAMP/Hippurate  → ***S. agalactiae* (group B)**
- (2) ALPHA: Optochin/Bile Solubility  → ***S. pneumoniae***
- (3) GAMMA: Bile Esculin  6.5% NaCl  → **Group D\*  
*Enterococcus***  
 Bile Esculin  6.5% NaCl  → **Group D\*  
*Non-Enterococcus***

(\*can also be beta or alpha hemolytic)

# Catalase Test

(catalase: An enzyme that catalyzes the breakdown of hydrogen peroxide to water and oxygen )

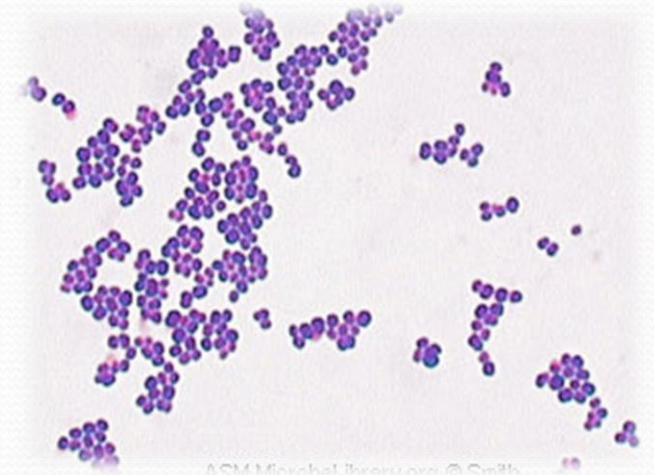
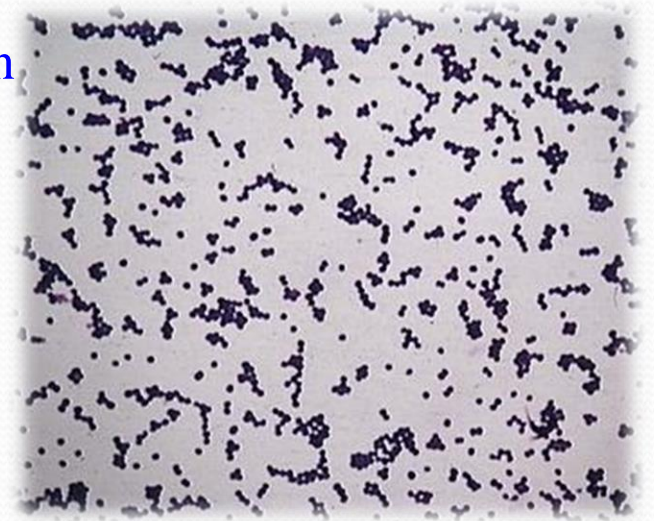


- *Staphylococcus* = Positive
- *Streptococcus* = Negative
- *Enterococcus* = Negative



# Staphylococcus

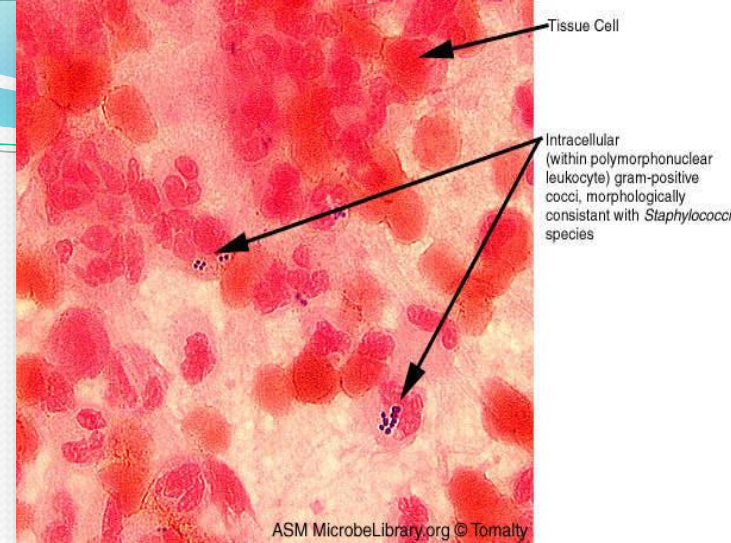
- ❖ One of the most common of all infections
- ❖ Staphylococcus are divided into pathogens and non pathogens based on possession of the enzyme coagulase.
- ❖ Coagulase positive : usually *S. aureus*  
Coagulase negative : like *S. epidermidis*



- Staphylococci - derived from Greek **staphyle** : mean cluster of grapes.

**Cocci** : mean spherical

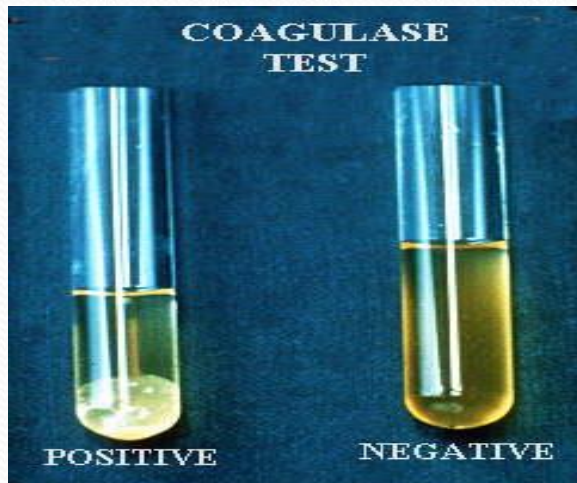
- Gram positive cocci arranged in clusters
- ~ 1 (µm) in diameter
- Hardy organisms surviving many non physiologic conditions
- Include a major human pathogen and skin commensals
- Non motile; Non-spore forming; Facultative anaerobe
- Optimal pH same as the blood (~7)
- Doubles about every half hour
- One of the most common causes of :  
**nosocomial** infections,
  - often causing **postsurgical wound infections**.



# Classification

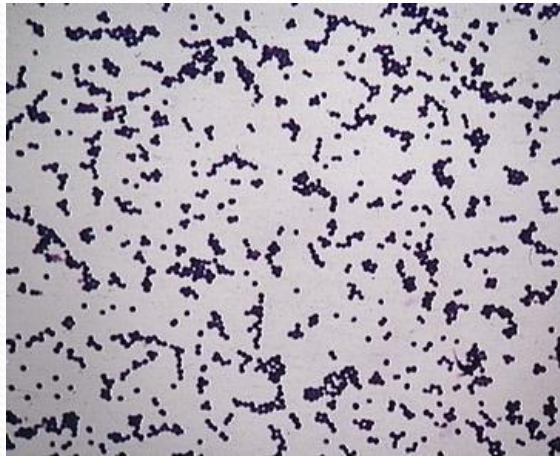
- 1. Coagulase positive staphylococci
  - *Staphylococcus aureus*
- 2. Coagulase negative staphylococci
  - *Staphylococcus epidermidis*
  - *Staphylococcus saprophyticus*

Negative – no change    Positive - clotted

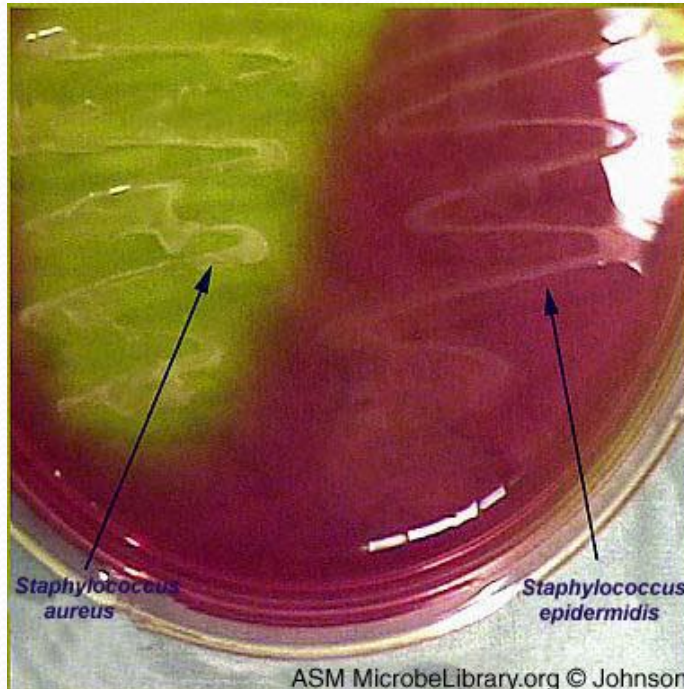


# Staphylococcus

*S. aureus*, *S. epidermidis*, *S. saprophyticus*

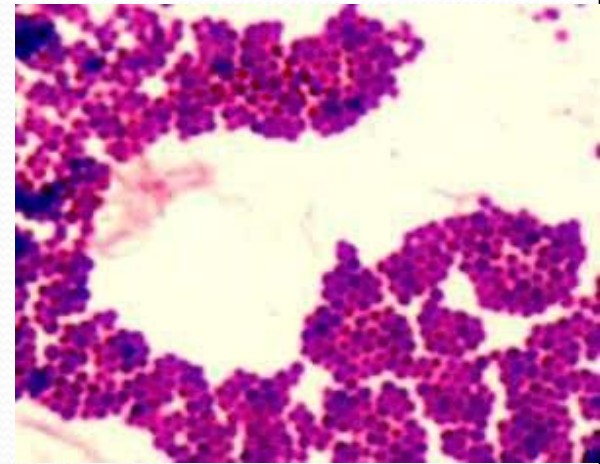


*S. aureus*



*S. aureus*

*S. epidermidis*



*S. epidermidis*



# Classification

- ***S. aureus.***: causes most staphylococcal disease. most important pathogen responsible for most human infections.
- ***S. epidermidis.***: opportunistic infections causes urinary tract infections (UTI) and subacute bacterial endocarditis.
- ***S. saprophyticus.***: opportunistic infections, UTI in sexually active females.

## Difference between *Staph. aureus* & other species.

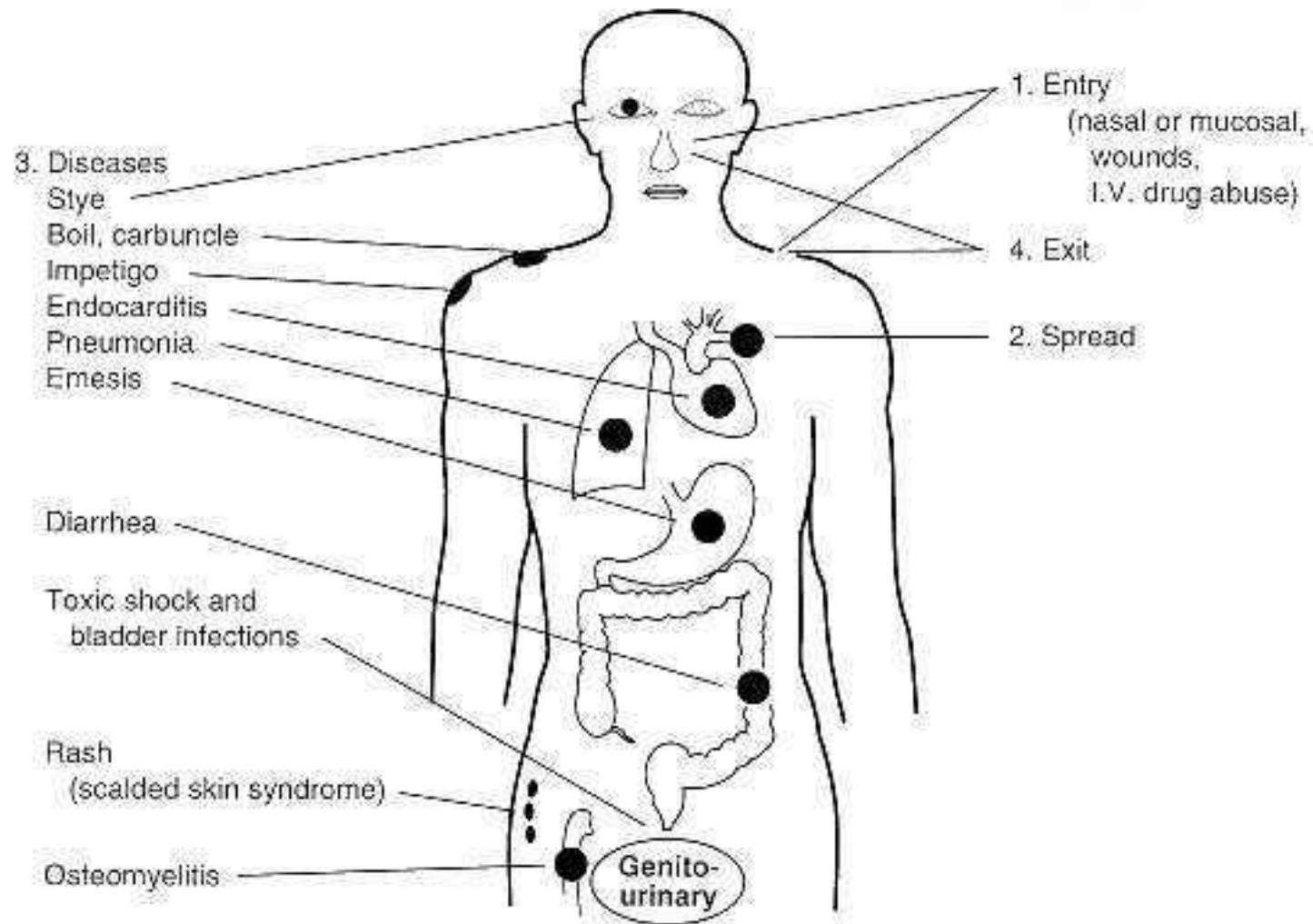
Staph. Sp.	Hemolysis	Coagulase	Protein A	Mannitol salt agar (7.5% NaCl)
<i>Staph. aureus</i>	$\beta$	+	+	Color change
Other species	-	-	-	- No color change

- ***Staphylococcus aureus* can withstand high salt concentration in mannitol salt agar & ferment mannitol converting its color from red → yellow.**
- **$\beta$ -hemolysis → cause complete hemolysis for RBCs.**

Mannitol Salt



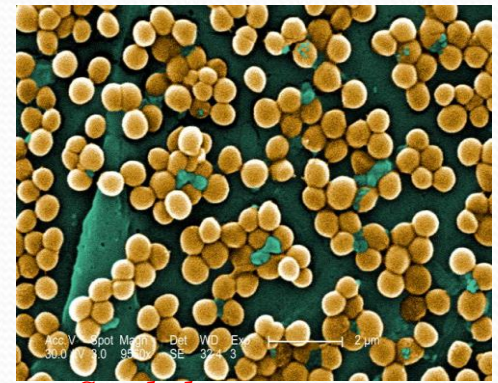
# Pathogenesis of staphylococcal infections



# Pathogenicity of *Staph. aureus*

*S. aureus* can cause illnesses ranging from minor skin infections like pimples, boils and abscesses, to life-threatening diseases, such as meningitis, Toxic shock syndrome (TSS)(Low blood pressure, fever, diarrhea, skin rash can be fatal), septicemia.

Furuncle( infected hair follicle).



*Staphylococcus aureus*,  
Golden staph

- Invasion & adhesion is the most important factor.
- Ability to produce a disease depend on its resistance to phagocytosis and production of extracellular toxins & enzymes.
- MRSA = Methicillin-resistant *Staphylococcus aureus*  
Methicillin-resistant *Staphylococcus aureus* (MRSA) are strains which **are** considered resistant to all beta lactam antibiotics including penicillins(Antibiotic resistance is a **serious global threat**: every year, at least **700,000 people around the world die from infections with superbugs that are resistant to antibiotics**)

# Staphylococcus



Pyogenic infections such as bronchopneumonia, brain abscess, folliculitis and carbuncles.

Impetigo:

- Yellow crusted lesions mainly on the face.



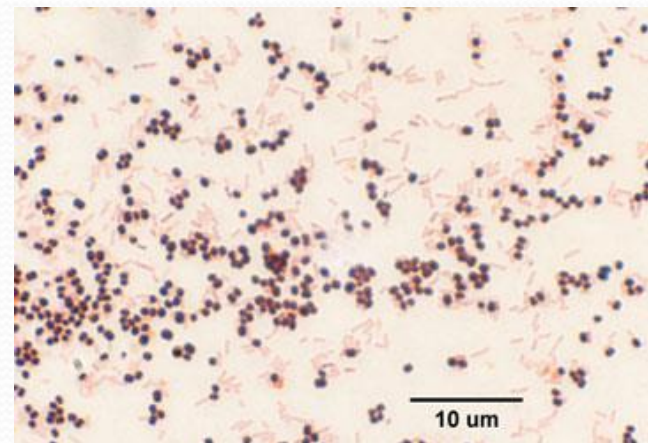
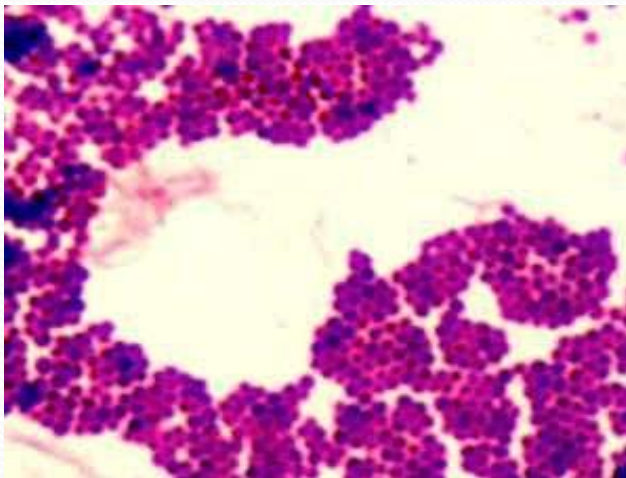
Staphylococcal Infection: Impetigo



# *Stapylococcus epidermidis*

## Characteristics

- Coagulase-negative
- Colonies: small, white or beige
- Non- spore forming
- Habitat: Host- associated, Opt. temp: 30-37C
- Pathogenic bacteria



## Pathogenicity of *Staph. epidermidis*

- ***S. epidermidis*** is normal flora which inhabits the skin of healthy humans.
- Causes urinary tract infections primarily in old age.
- Sub acute bacterial endocarditis may occur at least 2 months after heart surgery .
- instrumentation or dental work.

# Pathogenicity

- Occurs frequently on the skin and in the mucous membranes of humans and animals.
- Most common species found contaminating laboratory tests.
- Causes infection in patients with immune deficiency, especially in hospital setting.
- Resistant to many antibiotics including penicillin and methicillin.
- Causes infections in wounds

# Diseases

- Catheter infections
- Prosthetic implant infections
- Wound infections
- Urinary tract infections
- Septicemia
- Endocarditis
- Endophthalmitis
- Meningitis



# Symptoms

- Inflammation
- Pus
- Fever
- Pain
- Chills
- Headache
- Tachycardia

# Prevention & Treatment

- Removal of catheters or prosthetic devices
- Sterilization of equipment
- Good Personal Hygiene
  
- Treated with **vancomycin**.

# *Staphylococcus Saprophyticus*

- Causes urinary tract infections primarily in adolescent females.

# Staphylococci – Control

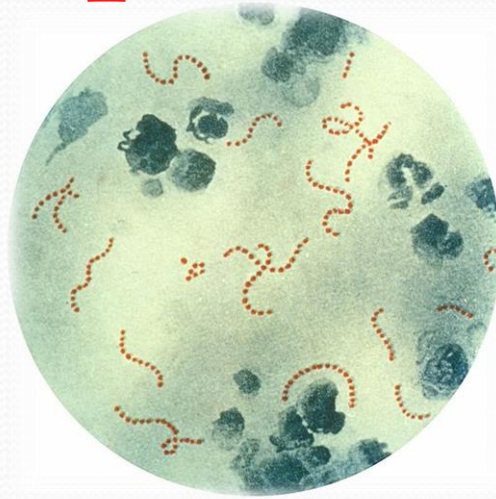
- *Prevention*

- Hand washing is key prevention in hospital environment.
- Hospital problems primarily in operating rooms and nurseries.
- Toxic shock patients should discontinue use of tampons.
- Identify and treat carriers, especially in hospital settings.

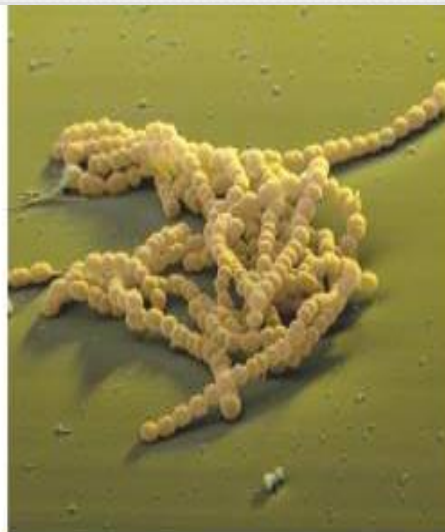
# Staphylococci – Control

- *A- Treatment*
- Isolate organisms and perform antibiotic sensitivity because of widespread resistance.
- Localized infections required **oral** antibiotic for 10 days.
- Disseminated infections require **parenteral** antibiotic for 4 to 6 weeks.
- Drain abscesses, remove foreign body if possible.
- Toxic shock syndrome if severe may require IV fluids and elevation of blood pressure.
- Food poisoning is self-limiting with 24 hours.

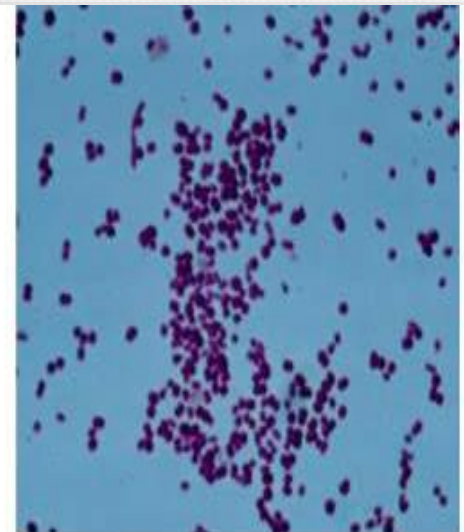
# Streptococci



(a) *Streptococcus pyogenes*



(b) *S. agalactiae*



(c) *S. pneumoniae*

# Identification of Gram Positive Cocci

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**Streptococcus (pairs & chains)**

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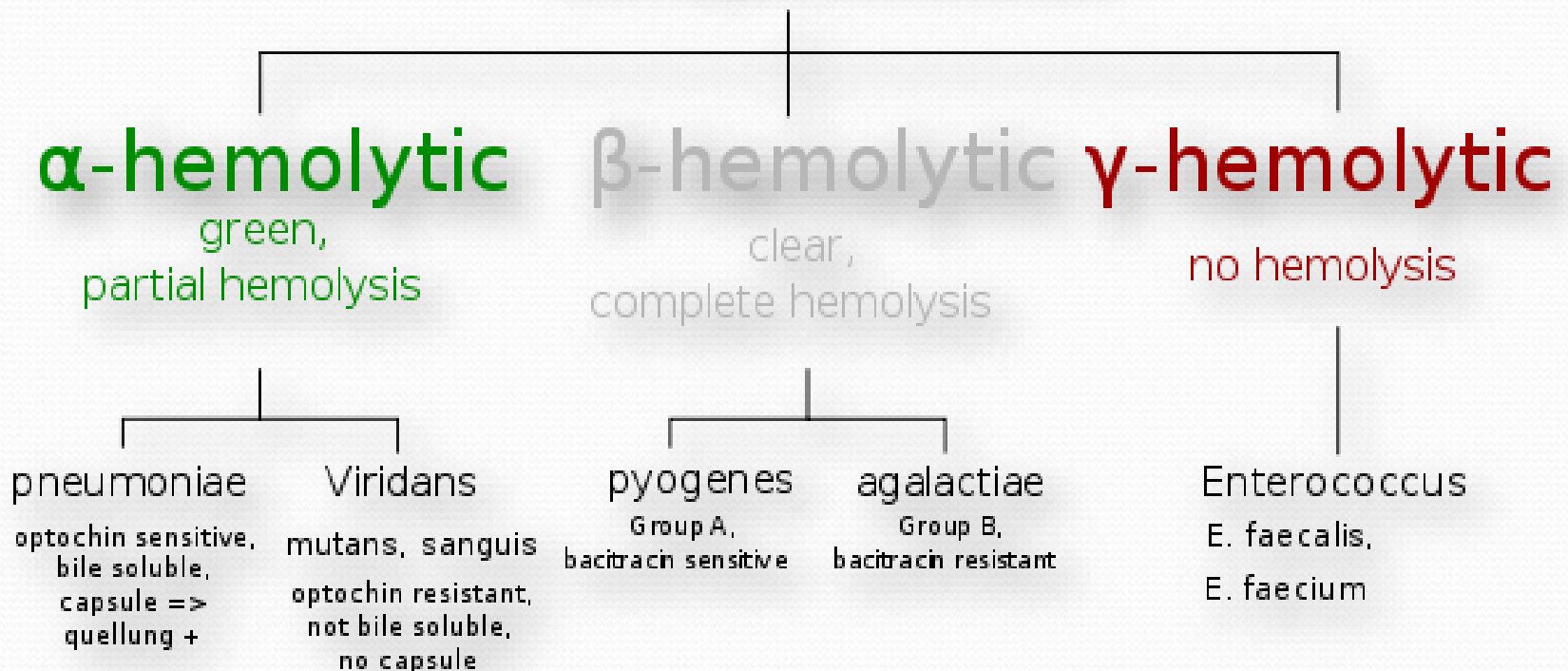
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 Bile Esculin  6.5% NaCl  → **Group D\* Non-Enterococcus**

(\*can also be beta or alpha hemolytic)

# Classification of Streptococcus According to Hemolytic Reactions

## Streptococcus





# Streptococci

## General Characteristics

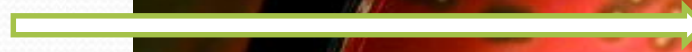
- **Gram-positive**. Diverse genus, some normal flora, some pathogens that produce **toxins**.
- Occur as single, paired, or chained .
- cocci, depending on environment.
- ● Are facultative anaerobes.
- ● catalase negative
- Attach to epithelial surfaces via lipotechoic acid portion of fimbriae (pili).
- ● Are classified into groups by serology.
- • They are differentiated into about 100 serotype by their **M-protein** which cover cell wall of it.
- • M-protein layer & capsule of it act as antiphagocytic structure Capsule only antiphagocytic and made of Hyaluronic acid which is present normally in human body so human body does not recognize the capsule as foreign so **no antibodies against capsule is produced**.

# Streptococci Classification

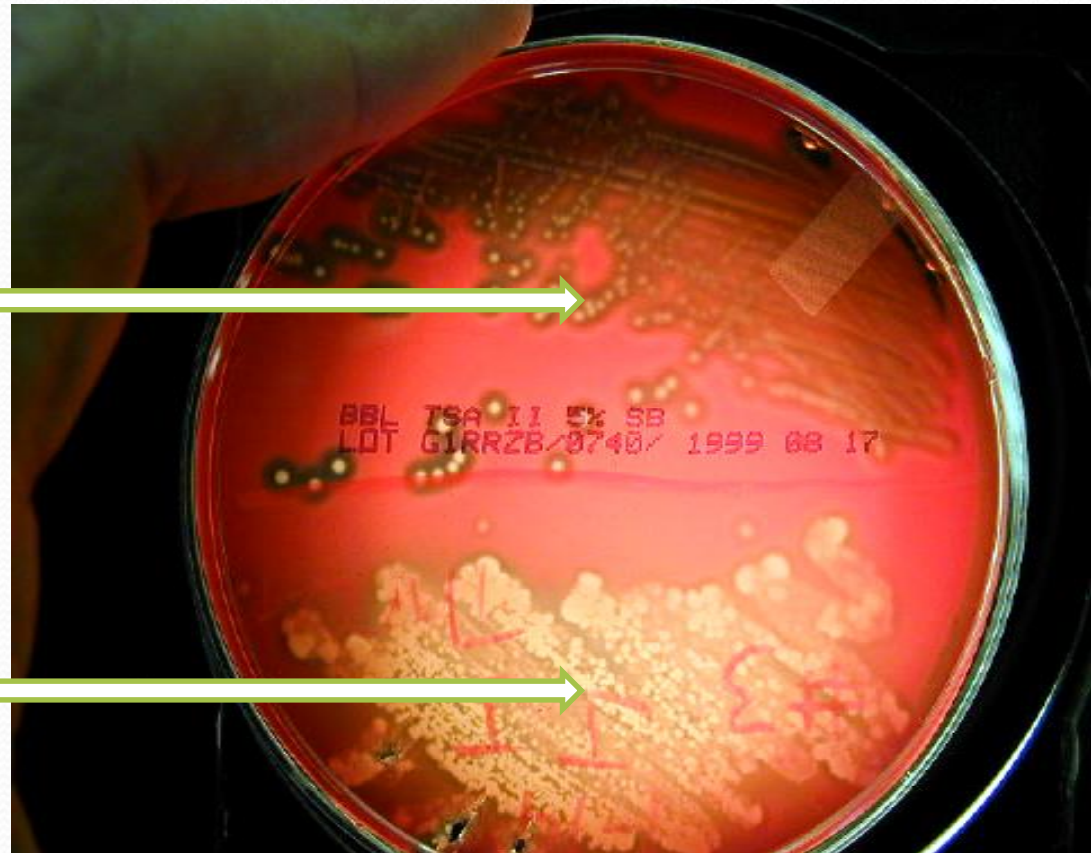
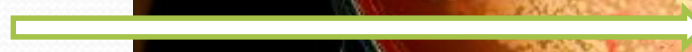
- Classified into 21 groups .
- through slight differences in specific cell wall carbohydrates.
- • Also classified according to type of enzymatic hemolysis (**Hemolytic Reactions**) of red blood cells produced on blood (**Sheep, Horse, Rabbit**) agar plates into:
  - a)  **$\alpha$ -hemolysis** : *Greening of blood agar due to partial lysis of red cells*  
*Ex: Viridans type & strep. pneumonia*
  - b)  **$\beta$ -hemolysis** : complete lysis and release of hemoglobin; clear area around colony. *Ex: Strep. pyogenes*
  - c)  **$\gamma$ -hemolysis**: absence of any lysis. No Hemolysis. *Ex. Enterococcus faecalis*

# Hemolysis on blood agar

Alpha hemolysis



Beta hemolysis



# Lancefield Grouping Streptococcus

TABLE 13-1 Medically Important Streptococci

Type species	Lancefield serogroup	Normal habitat	Significant human disease
<i>S pyogenes</i>	A	Humans,	Acute pharyngitis and others
<i>S agalactiae</i>	B	Cattle, humans	Neonatal meningitis and sepsis and infections in adults
<i>S equisimilis</i>	C	Wide human and animal distribution	Endocarditis, bacteremia, pneumonia, meningitis, mild upper respiratory infection
<i>E faecalis</i> <i>S bovis (nonenterococcus)</i>	D	Human and animal intestinal tracts, dairy products bacteremia	Biliary or urinary tract infection, endocarditis,
<i>S anginosus</i>	F, G <sup>a</sup>	Humans, animals	Subcutaneous or organ abscesses, endocarditis, mild upper respiratory infection
<i>S sanguis</i> <sup>b</sup>	H	Humans	Endocarditis, caries
<i>S salivarius</i>	K	Humans	Endocarditis, caries
None	O	Humans	Endocarditis
<i>S suis</i>	R	Swine	Meningitis
"viridans" <i>S mitis</i> , <i>S mutans</i> <sup>c</sup>	None identified	Humans	Caries, endocarditis
Anaerobic or micro-aerophilic	None identified	Wide human and animal distribution	Brain and pulmonary abscesses, gynecologic infections
<i>S pneumoniae</i>	None identified	Humans	Lobar pneumonia and others

<sup>a</sup> Strains of the "*S milleri*" group (*S constellatus*, *S intermedius*, *S anginosus*, *minute strains*) may possess antigens of groups A, C, F, or G, or no identifiable Lancefield group antigens; a heterogeneous group, genetically related but with a wide variety of phenotypic and biochemical characteristics

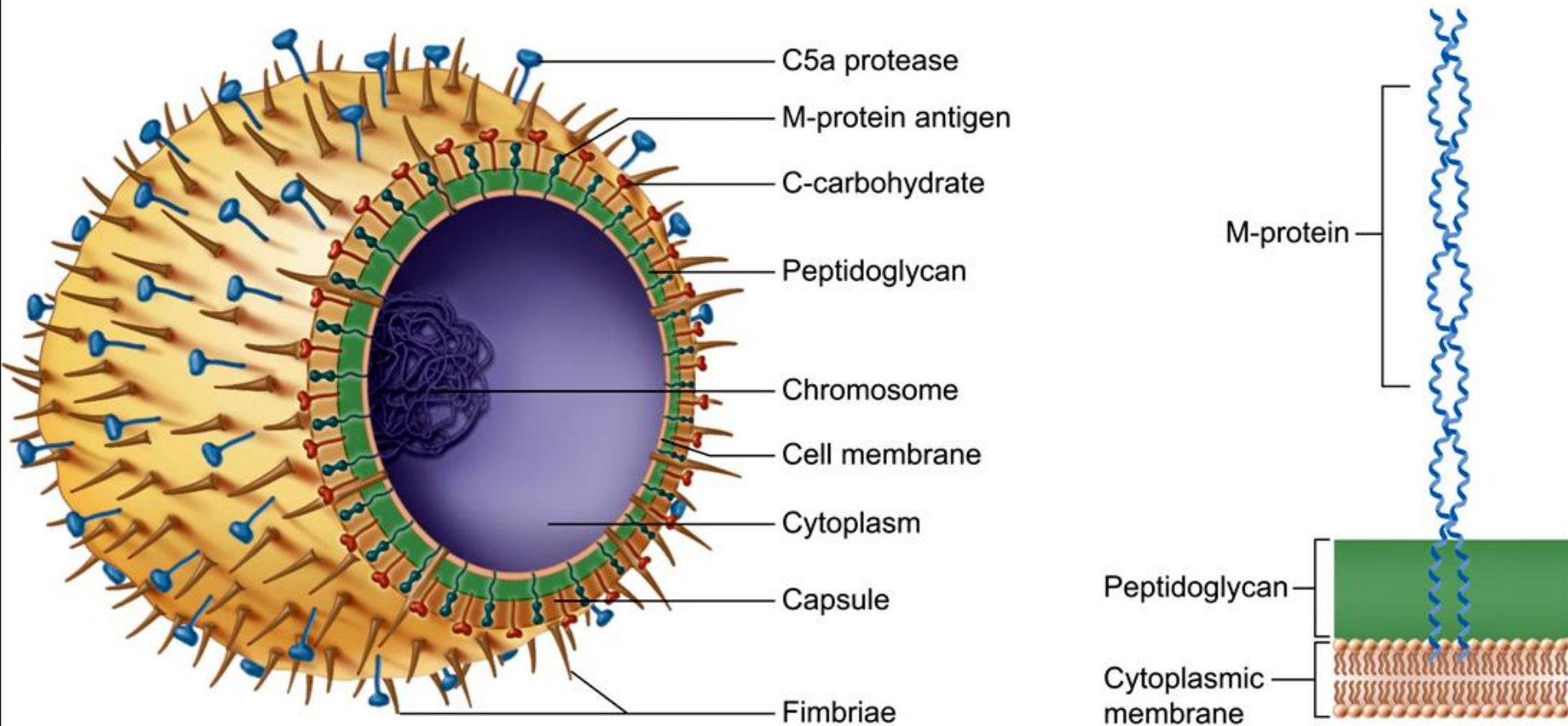
<sup>b</sup> Disparate grouping undergoing further definition.

<sup>c</sup> Other viridans streptococci (*S sanguis*, *S salivarius* "*S milleri*," *S bovis*) have identified group antigen(s); nutritionally variant streptococci may be included in this diverse category.

# Lancefield Grouping Streptococcus




# Streptococcus Virulence Factors



(a)

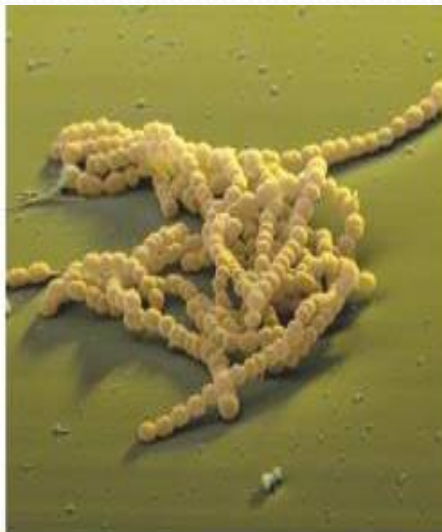
(b)

- 
- Streptolysin ( Hemolysin)
  - Pyogenic and erthrogenic exotoxin
  - Hyaluronidase
  - Streptokinase
  - DNase

- ***Streptococcus pyogenes*** : Pharyngitis
- ***Streptococcus agalactiae*** : Neonatal sepsis and meningitis associated with maternal infection of the fetus by *Streptococcus agalactiae* during transvaginal delivery .
- ***Streptococcus dysgalactiae*** : causes bacteremia and endocarditis
- ***Streptococcus pneumoniae*** : most common bacterial cause of community-acquired pneumonia with and without bacteremia
- ***Streptococcus bovis*** : bacteremia strongly associated with gastrointestinal tract cancer.
- ***Streptococcus salivarius***: Sub-acute bacterial endocarditis
- ***Streptococcus mutans***; dental caries .



(a) *Streptococcus pyogenes*



(b) *S. agalactiae*

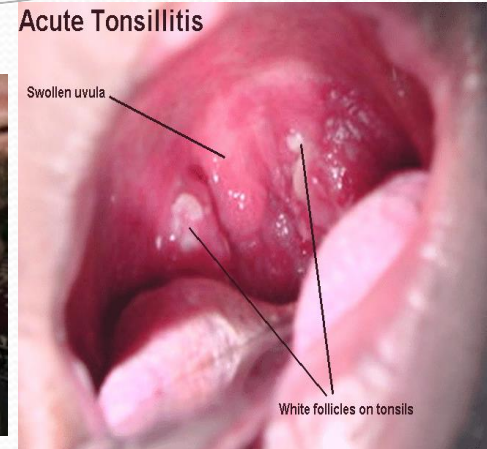
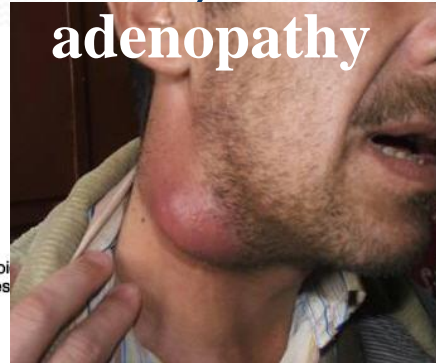
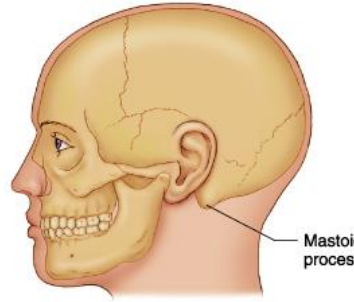


(c) *S. pneumoniae*



# *Streptococcus pyogenes* (GABHS) - adenopathy

- Gram positive cocci
- Catalase negative
- Beta hemolytic strep.



***Streptococcus pyogenes* is one of the most virulent bacterial pathogens, and causes acute pharyngitis, impetigo, cellulitis (Soft tissue infections), necrotizing fasciitis and myositis (flesh-eating bacteria), pneumonia, bacteremia, and streptococcal toxic shock syndrome (STSS) (TSS) .**

## ***Streptococcal Pharyngitis.***

- • Is characterized by sore throat, fever, headache, nausea, cervical adenopathy, leucocytosis.
- • Can result in complications (e.g., tonsillar abscesses, mastoiditis, septicemia, osteomyelitis, rheumatic fever).
- • **Treat** with penicillin; preferably one effective for 3 weeks.



# Non-Beta Hemolytic Streptococci

- 1- ***Streptococcus pneumoniae***, the cause of pneumococcal pneumonia and meningitis in elderly. These are gram positive capsulated diplococci
- 2- ***Viridans streptococci*** : *that cause subacute* bacterial endocarditis of abnormal heart valves.
  - Dental caries is caused by ***Strept mutans*** which is a type of viridans group.
- 3- ***Enterococci*** are normal flora of the lower intestinal tract and therefore present in stools. The most important is ***Enterococcus faecalis***.

# *Pneumonia*

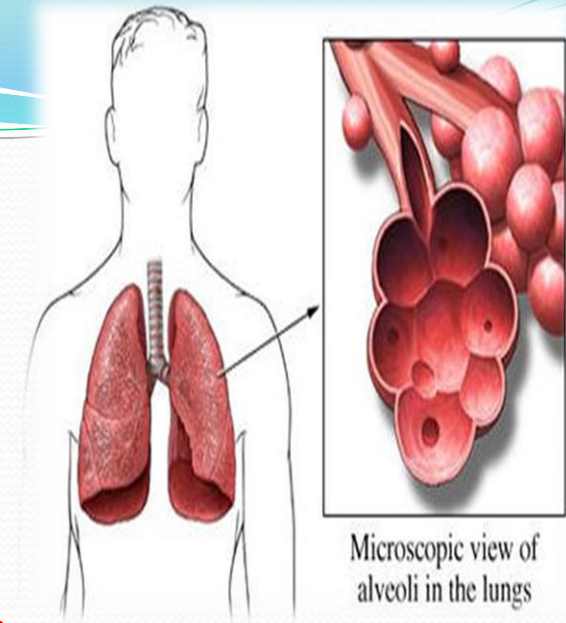
- Pneumonia is an acute infection of the parenchyma of the lung, caused by bacteria, fungi, virus, parasite... etc.
- Pneumonia may also be caused by other factors including X-ray, chemical, allergen



(c) *S. pneumoniae*

# *S. pneumoniae*

- Gram positive coccus. “diplococci”
- $\alpha$ -haemolytic
- Catalase negative
- Mucoid colonies due to large capsule
- *Streptococcus pneumoniae* an important cause of:
  - Pneumonia
  - Septicaemia and Meningitis
  - Soft tissue infections(**cellulitis**)
  - Peri-orbital cellulitis
  - Sinusitis
  - Otitis media
  - Most prevalent in young children (<5yrs) and elderly (>65yrs)
- **Virulence factor : Capsule**



## Periorbital Cellulitis

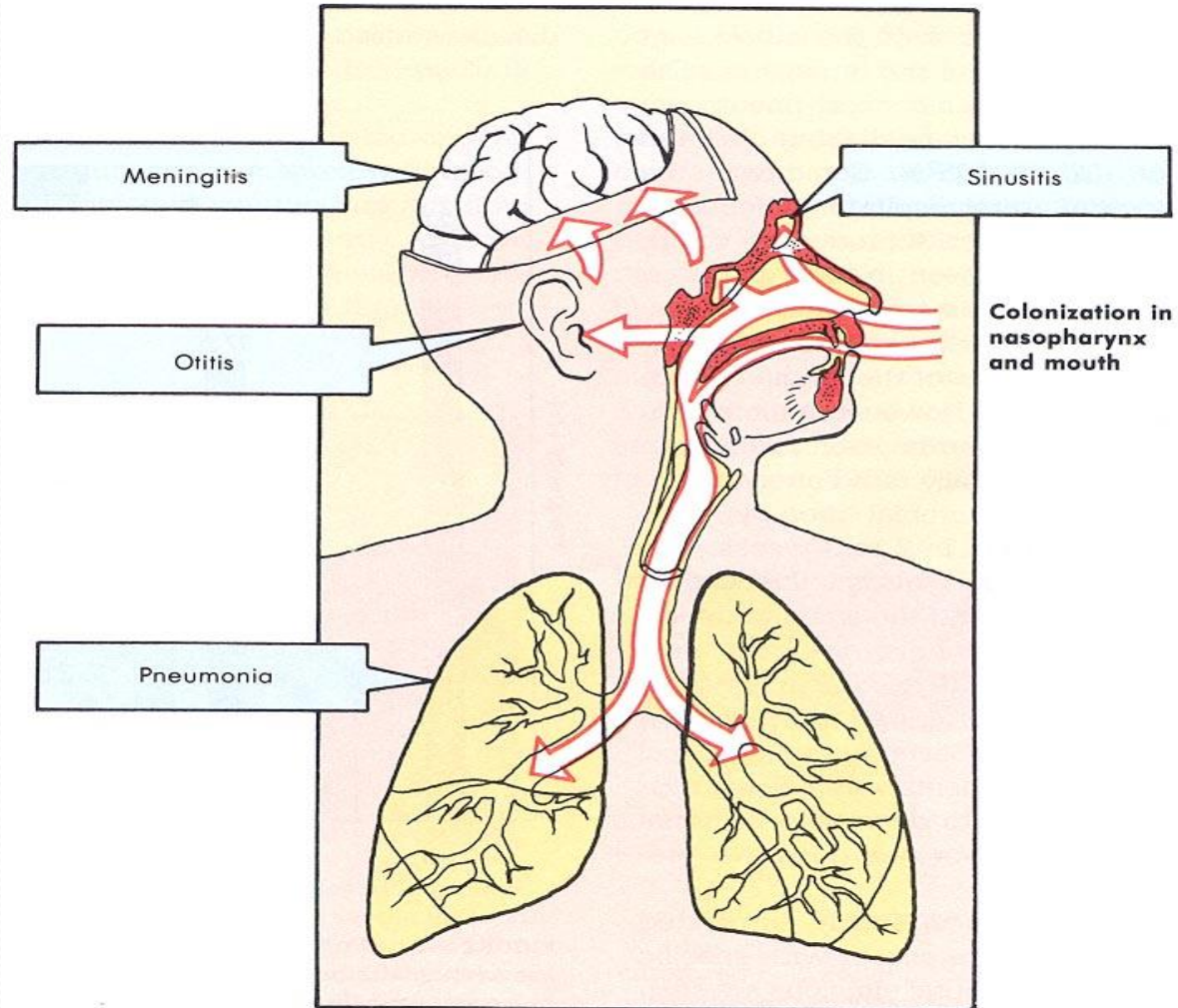


Infection of the superficial structures surrounding the eye

Stems from a scratch, bug bite or injury to the eye

Develops from infection of the face such as sinus infection

# *S. pneumoniae*



# Non-Beta Hemolytic Streptococci

## *Enterococcus spp.*

- Gram positive cocci/catalase negative
- Normal flora in gut( *the lower intestinal*) tract and therefore present in stools. The most important is *Enterococcus faecalis*.
- 2 species may cause infections, usually hospital acquired, commonly UTI
  - – *E. faecalis*
  - – *E. faecium*
- Vancomycin resistance becoming a problem (VRE)

Any Questions????