Streptococci

The streptococci are gram-positive spherical bacteria that characteristically form pairs or chains during growth. They are widely distributed in nature. Some are members of the normal human flora; others are associated with important human diseases, they inhabit various sites, notably the upper respiratory tract, and live harmlessly as commensals.

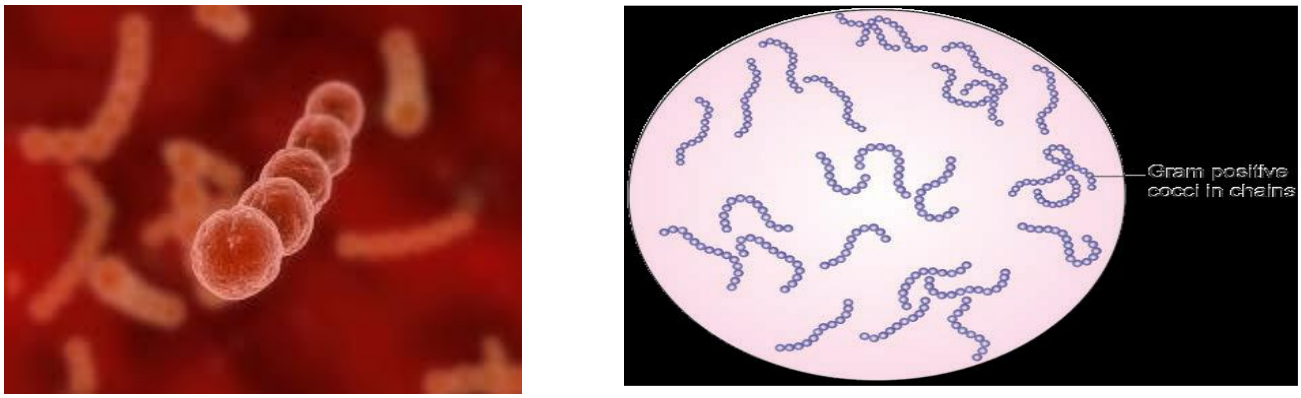

Figure 1-1 gram-positive streptococci form pairs or chains during growth.

Classification of Streptococci

The classification of streptococci into major categories has been based on a series of observations

1. **Hemolytic Activity**

Many streptococci are able to hemolyze red blood cell.

- **Alpha (α)-hemolytic Streptococci**

Greenish zone forms around colonies due to partial hemolysis of erythrocytes

- **Beta (β)-hemolytic Streptococci**

Clear zone forms around colonies due to complete haemolysis of erythrocytes

- **Gamma (γ) or Nonhemolytic Streptococci**

No zone is formed, as erythrocytes are not lysed

Figure 1-2 Colonies of a- (left) and b-haemolytic (right) streptococci on a blood agar plate.

2. Serological detection of cell wall antigens. (Lancefield Classification)

Streptococci can be classified alphabetically according to the possession of carbohydrate antigen of cell wall (Lancefield groups A–H and K–V)

3. Biochemical reactions and resistance to physical and chemical factors

Biochemical tests include sugar fermentation reactions, tests for the presence of enzymes, and tests for susceptibility or resistance to certain chemical agents.

Biochemical Classification	Serologic Classification	Hemolysis Patterns
S. pyogenes	A	Beta
S. anginosus group	A, C, F, G, non-groupable	Beta; occasionally alpha or nonhemolytic
S. agalactiae	B	Beta; occasionally nonhemolytic
S. dysgalactiae	C, G	Beta
S. bovis	D	Alpha; nonhemolytic; occasionally beta
Viridans group streptococci	Nongroupable	Alpha or nonhemolytic
S. pneumoniae	Nongroupable	Alpha

Figure 1-3 Classification of streptococci.

Streptococcus pyogenes

Morphology and culturing.

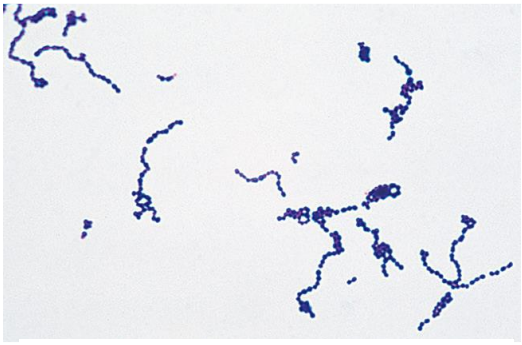

Figure 1-4 Gram stain showing *Strep pyogenes in chains.*

- Gram-positive cocci with a diameter of 1 ı m that form chains
- Nonmotile and nonsporing.
- aerobe and facultative anaerobes
- growing best at a temperature of 37°C (range 22-42°C)
- The optimal pH for growth is 7.4 to 7.6
- Colonies on blood agar show b-hemolysis caused by streptolysins

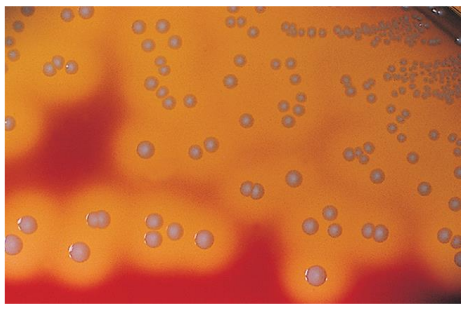

Figure 1-4 Haemolysis by (a) *Strep. pyogenes* (beta)

Pathogenicity

S. pyogenes produces a wide range of virulence factors including:

- **M protein:** is a major virulence factor of group A *S pyogenes* surface proteins which are antiphagocytic and also bind host proteases
- **Fimbriae/pili**: facilitate adherence to host cells
- **Capsule**: composed of hyaluronic acid: provides protection against phagocytosis.
- **F-proteins**: surface proteins that bind to fibronectin.
- **Streptolysins (haemolysins):** streptolysins O and S lyse erythrocytes and are cytotoxic to leukocytes and other cell types.
- **Streptokinase (Fibrinolysin)** Dissolves fibrin; facilitates spread of streptococci in tissues.
- **Hyaluronidase** breaks down a substance that cements tissues together.
- **DNases**: Breakdown of DNA, producing runny pus.

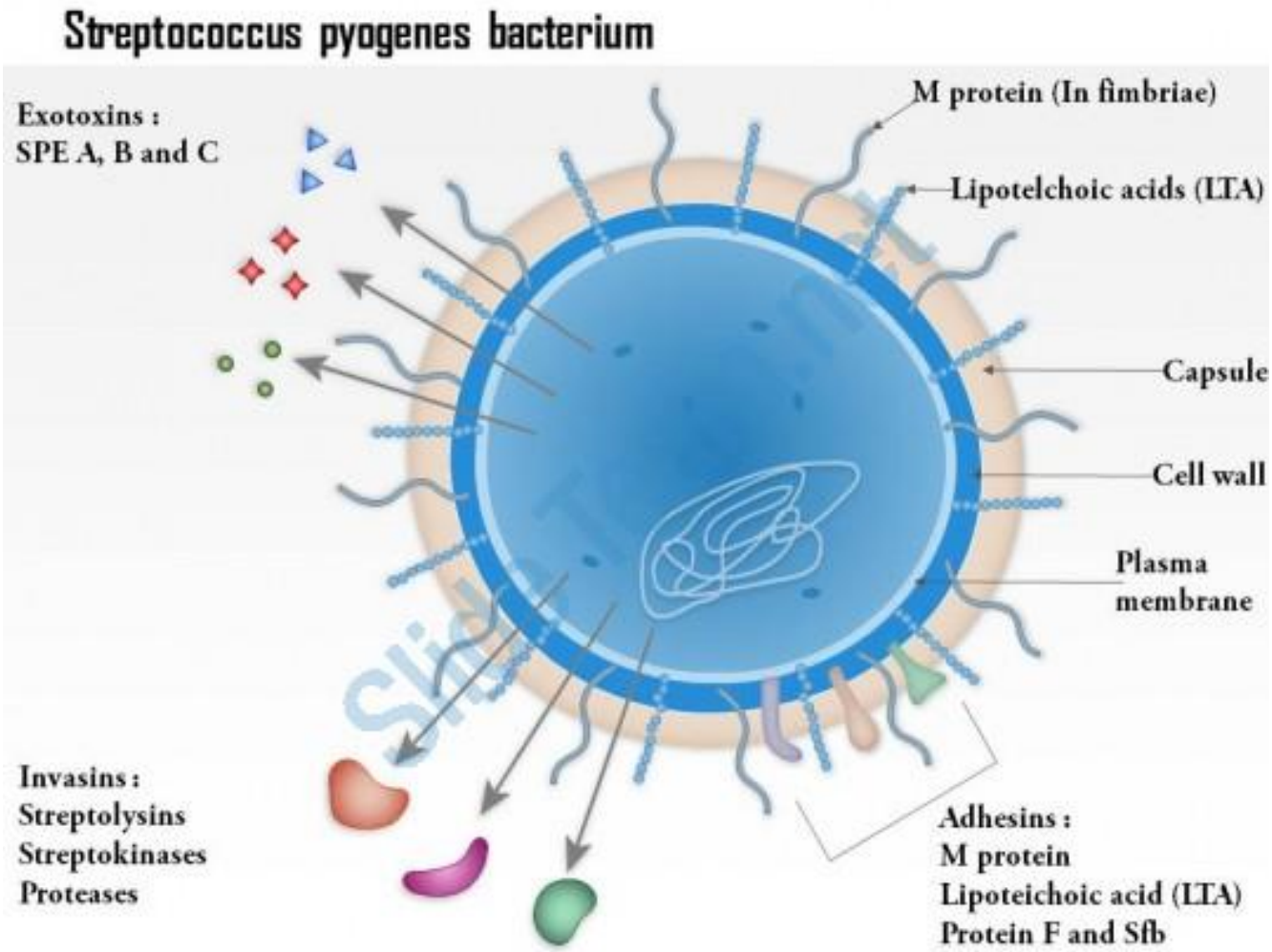

Figure 1-5 ***s.*** pyogenes most important virulence factors

Disease caused by *Streptococcus pyogenes*

1. **Streptococcal pharyngitis** – strep throat (**إلتهاب البلعوم**)
2. **Skin infection**, Impetigo(**الحصف داء جلدي**)
3. **Scarlet fever(حمى قرمزية)**-rash that begins on the chest and spreads across the body
4. **Rheumatic fever**: (**الحمى الروماتيزمية**) Life threatening inflammatory disease that leads to damage of heart valves muscle

Laboratory diagnosis

Specimens

- isolation of the microorganism from infected sites (e.g. throat, skin, blood)

Culture

- Specimens suspected of containing streptococci are cultured on blood agar plates, Blood cultures will grow hemolytic group A streptococci(eg, in sepsis) within hours or a few days

Antigen Detection Tests

- Several commercial kits are available for rapid detection of group A streptococcal antigen from throat swabs.

Serologic Tests

- Detection of serum antibodies to streptolysin O(ASOT: anti-streptolysin O titre) is particularly useful for the diagnosis of post-infection complications, such as rheumatic fever or acute glomerulonephritis.

Treatment

- Penicillin V or amoxicillin used to treat pharyngitis
- oral cephalosporin or macrolide for penicillin-allergic patients

Streptococcus Pneumoniae (Pneumococci)

The pneumococci (*S pneumoniae*) are gram-positive diplococci found as normal inhabitants of the upper respiratory tract of human beings. They are the single most prevalent bacterial agent in pneumonia and in otitis media in children.

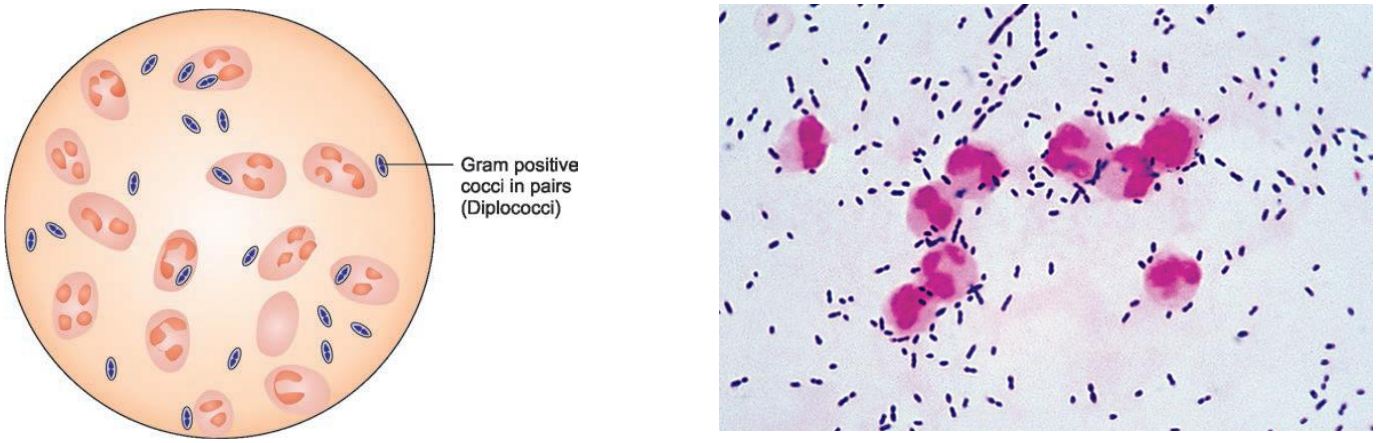

Figure 2-2 Gram stain of *S pneumonia*

Morphology and culturing.

- Gram-positive diplococci, often lancet-shaped or arranged in chains
- The cells are surrounded by a thick capsule.
- They are no motile & nonsporing.
- When cultured on blood agar
  S. pneumoniae develop a-hemolytic colonies with a mucoid (smooth, shiny) appearance

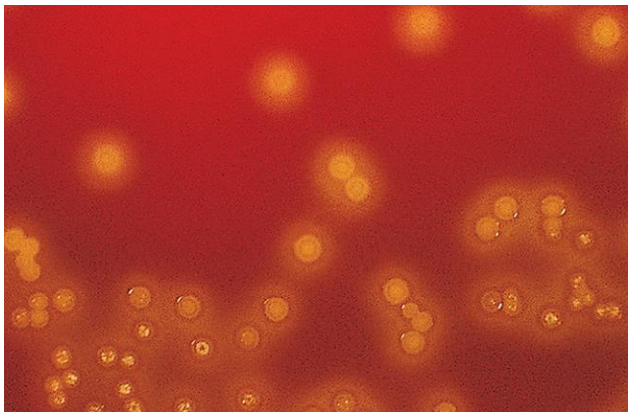

Figure 2-3 Hemolysis by *S pneumonia* ***(alpha).***

Antigen structure.

Pneumococci are classified in 90 different types based on the fine chemical structure of the capsule polysaccharides acting as antigens

- The capsule consider as the most important virulent factor for *s. pneumonia*

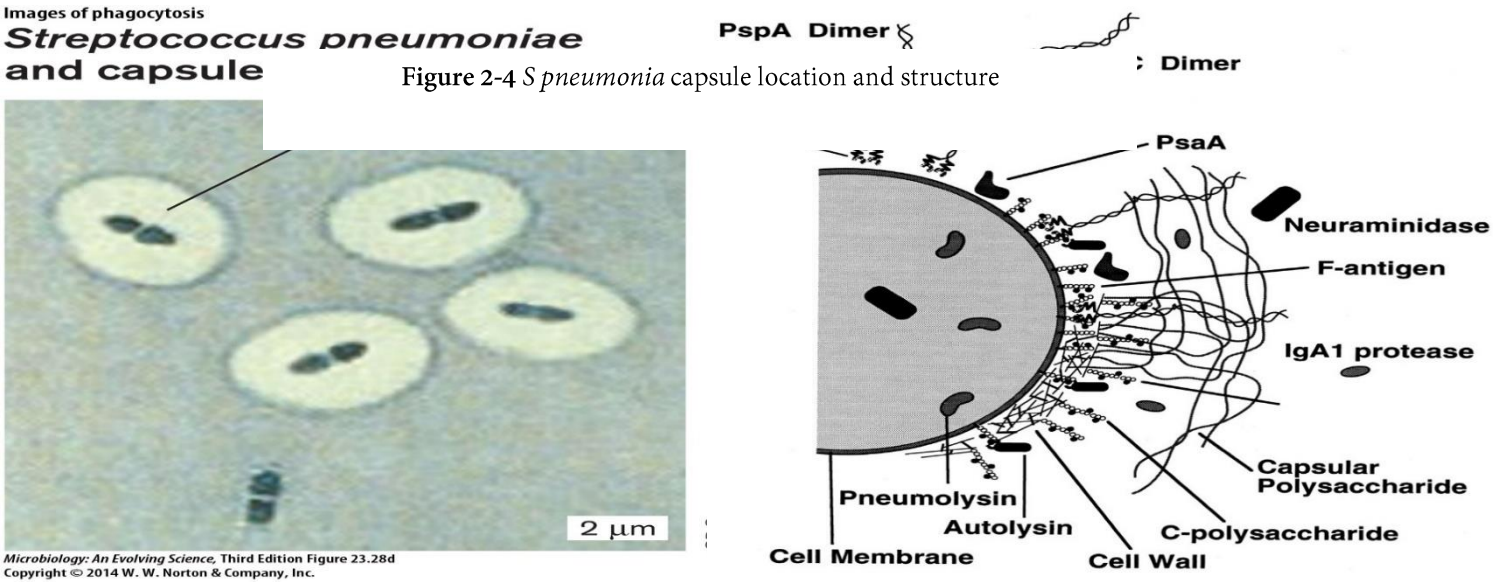

Figure 2-4 *S pneumonia* capsule location and structure

Disease caused by *Streptococcus Pneumoniae*

1. Otitis media & sinusitis (التهاب الأذن الوسطى والتهاب الجيوب الأنفية)
2. Pneumonia (الالتهاب الرئوي)
3. Tracheobronchitis (التهاب الرغامى و القصبات)
4. Meningitis (التهاب السحايا)

Pneumonia disease

Pneumonia is a breathing (respiratory) condition in which there is an infection of the lung**.** Is a common illness that affects millions of people each year. Bacteria, viruses, and fungi may cause pneumonia. In adults, bacteria are the most common cause of pneumonia. Most common type of bacterium is *Streptococcus pneumoniae* (pneumococcus).

Ways you can get pneumonia include:

- Bacteria and viruses living in your nose, sinuses, or mouth may spread to your lungs.
- You may breathe some of these germs directly into your lungs.
- You breathe in (inhale) food, liquids, vomit, or fluids from the mouth into your lung

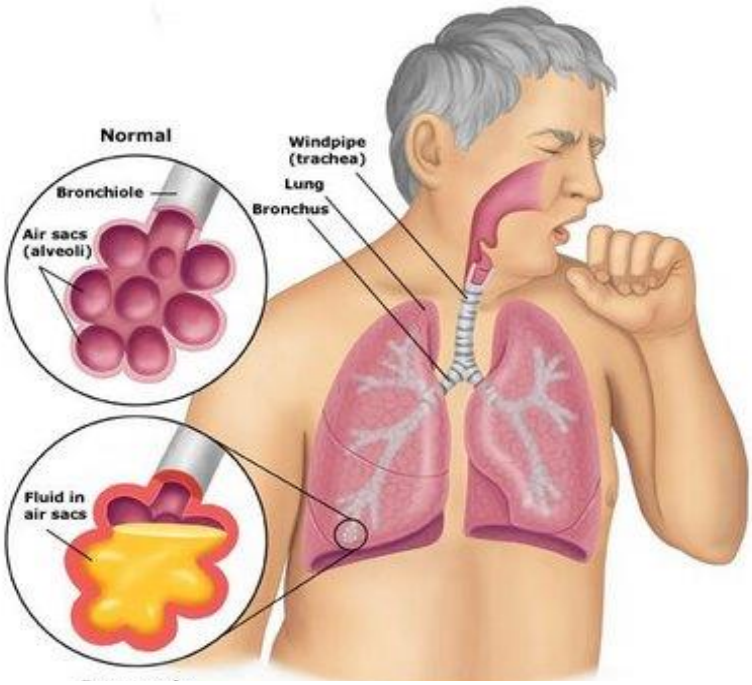

Figure 2-5 pneumonia infection

Main symptoms in pneumonia

1. Cough (with some pneumonias you may cough up greenish or yellow mucus, or even bloody mucus)
2. Fever
3. chest pain
4. Shaking chills
5. Shortness of breath
6. Malaise , Headache

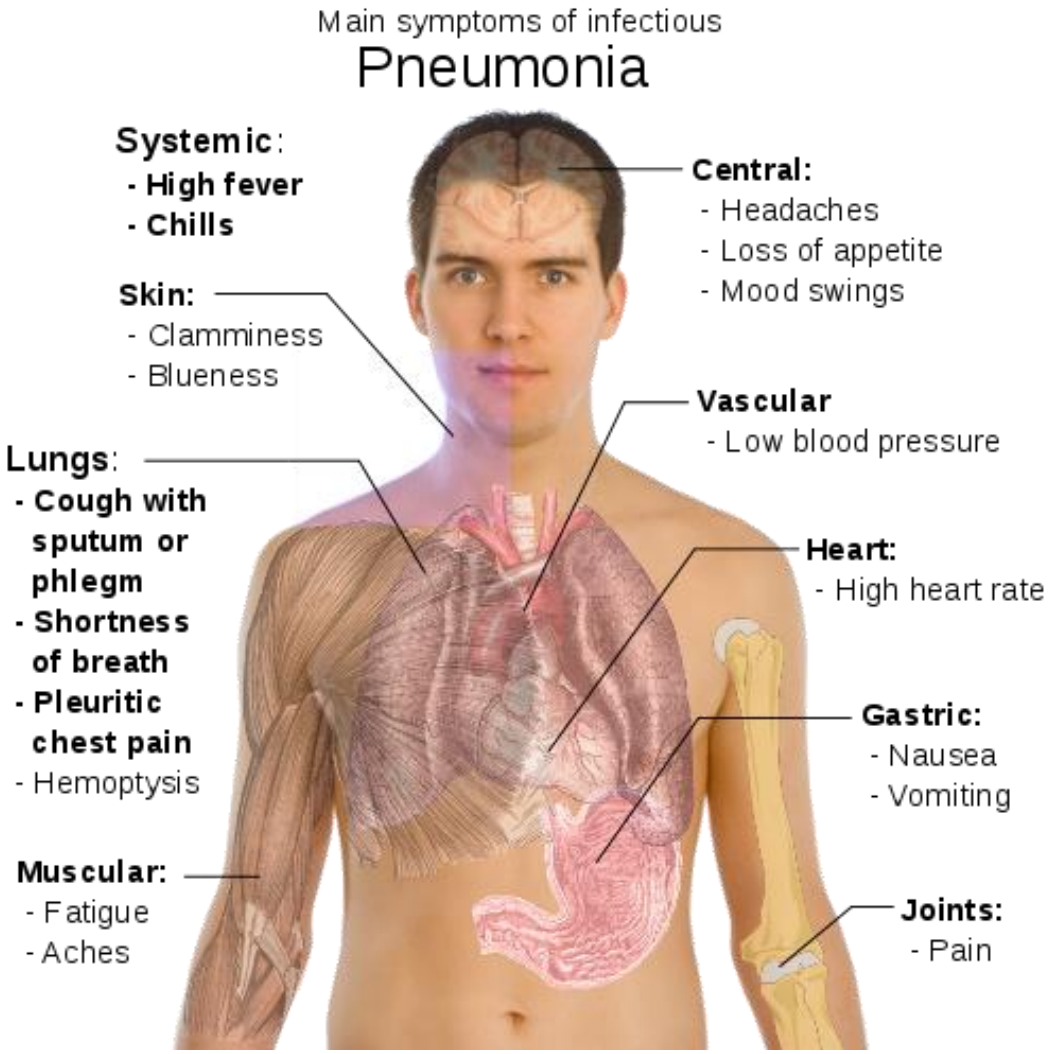

Figure 2-6 main symptoms caused by *S. pneumoniae*

Laboratory Diagnosis:

- **Specimens**

Sputum, CSF, Blood, Synovial fluid,

- **Culture**

The culture is created by sputum cultured on blood agar and incubated in CO_2 or a candle jar

- **Capsule Swelling Tests**

Fresh emulsified sputum mixed with antiserum causes capsule swelling (the quellung reaction) for identification of pneumococci.

- **Antigen detection**

Capsular polysaccharide antigen in blood, CSF & urine can detected by Passive latex agglutination

Treatment

- For penicillin sensitive strains Penicillin is drug of choice for serious cases & Amoxycillin for milder ones.
- For penicillin resistant strains a third generation cephalosporin is indicated.
- Vancomycin is to be reserved for life threatening illness with highly resistant strains.

- Two vaccines available for high risk individuals:

– Capsular antigen vaccine for older adults and other high risk individuals – effective 5 years

– Conjugate vaccine for children 2 to 23 months

Note: There are a lot of similarities between *Streptococcus* (Strep) and *Staphylococcus* (Staph) the key differentiating characteristics between these two groups of bacteria are:

1. their ability to produce catalase (enzyme to break down hydrogen peroxide) e.g. Strep is catalase negative vs Staph is catalase positive
2. their need for enriched media for growth (e.g. Strep needs enriched media (fastidious) vs Staph does not need enriched media (not fastidious))
3. Most staphylococci are found on the skin whereas most streptococci are found in the respiratory tract.

For further information you can refer to

1. Kayser, Medical Microbiology © 2005
2. Jawetz, Melnick, & Adelberg's Medical Microbiology 23ed.
3. Jaypee_Textbook of Microbiology 1st ed 2012.
4. Lecture notes. Medical microbiology and infection 5th ed -Wiley-Blackwell (2011).