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Streptococci

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Textbook of Diagnostic Microbiology (Mahon, Textbook of Diagnostic Microbiology), Connie R. Mahon MS, Donald C. Lehman EdD MLS(ASCP)cm SM(NRCM), George Manuselis Jr. MA MT(ASCP)

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Mims' Medical Microbiology and Immunology, International Edition, Goering.

Streptococci

*Strep*tococci are gram-positive cocci arranged in chains or pairs. They are part of the normal flora of humans and animals. Some of them are human pathogens. The most important of them is *Strep. pyogenes* causing pyogenic infections, with a characteristic tendency to spread, which are typically localized. It is also responsible for the nonsuppurative lesions, acute rheumatic fever and glomerulonephritis.

Classification:

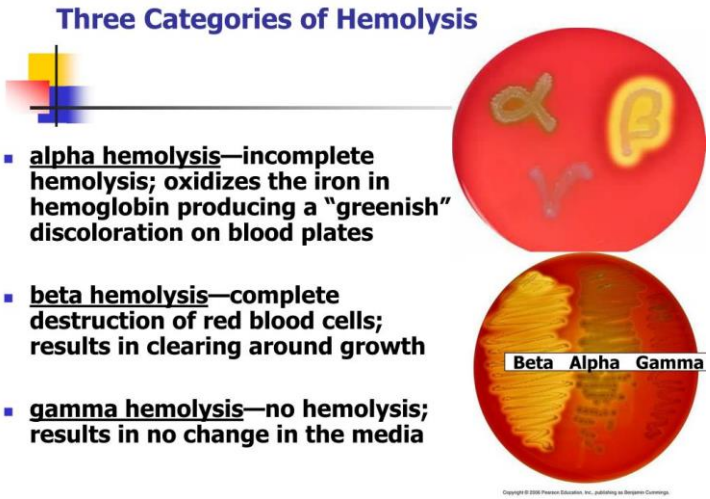
Strep. can be classified according to the type of hemolysis on blood agar or according to the antigenic components, both classification are used and integrated to describe member of genus *Streptococci*.

According to hemolysis:

1. Alpha (α) hemolytic *Strep*. alpha produce a greenish stain with partial hemolysis around the colonies. These are known as 'viridans streptococci' or *Strep. viridans*. viridans *Strep*. are normal commensals in the throat, but may cause opportunist infections rarely. *Strep. pneumonia* is also an alpha hemolytic *Strep*.

2. Beta (β) hemolytic *Strep*. produce a sharply defined, clear, colorless zone of hemolysis around colony, within which red cells are completely lysed. The term 'hemolytic *Strep*.' strictly applied only to beta lytic strains. Most pathogenic *Strep*. belong to this group.

3. Gamma (γ) or non-hemolytic *Strep*. they don't produce any hemolytic zone in the medium. They include the fecal streptococci (enterococci, *Strep*. faecalis) and related species.



Serology (antigenic components)

1. Lancefield Grouping: is a serological method for classifying *Strep*. into one of 20 groups based on the presence of polysaccharide and teichoic acid antigens in the bacterial cell wall.
   - Group A: *S. pyogenes*
   - Group B: *S. agalactiae*
   - Group D: *Enterococci* & non-enterococcal *streptococcus*.
2. Griffith grouping: *Strep. pyogenes* can be typed based on the surface proteins M, T and R. The M Protein is the most important of these Group A (*Strep*. *pyogenes*) have M-protein which is a type specific Ag, classify (group A) into more than (80 serotypes). M protein is a major virulence factor for the group A *Strep*. It protects the organism from phagocytosis. However, it is also the weakest point in the organism's defense, because plasma cells generate antibodies against the M protein. These antibodies bind to the M protein, aiding in the destruction of the organism by macrophages and neutrophils.

Streptococcus pyogenes

Morphology:

Cocci in shape and are arranged in chains because chain formation is due to cocci dividing in one plane & daughter cell failing to separate completely. *Strep*. are gram positive, non-motile, non-spore forming and capsulated.

Virulent factors & Pathogenesis:

1. The polysaccharide has been shown to have a toxic effect on connective tissue in experimental animals.

2. M protein is a major virulence factor for the group A *Strep*.

3. Streptolysin O: This enzyme destroys red and white blood cells and is the reason for the beta-hemolytic group A *Strep*. beta-hemolytic ability. This enzyme is also antigenic. Following pharyngeal or systemic beta hemolytic group A *Strep*. infection, anti-streptolysin O (ASO) antibodies develop. On the wards you may order ASO titers on a patient's blood to confirm recent infection.

4. Streptolysin S: This is also responsible for beta-hemolysis but is not antigenic.

5. Pyrogenic exotoxin (also called erythrogenic toxin): This is found in only a few strains of beta hemolytic group A *Strep*., but when these strains invade they can cause scarlet fever. Some strains produce pyrogenic exotoxins that are superantigens. The exotoxins directly super

stimulate T cells to pour out inflammatory cytokines, this is called *Strep*. toxic shock syndrome

6. Streptokinase (activates the proteolytic enzyme plasmin, which breaks up fibrin blood clots).

7. Hyaluronidase (spreading factor)

8. Streptodornases (DNase)

9. (Anti-C5a) peptidase. (anti-inflammatory)

10. The capsule when present inhibits phagocytosis. It is not antigenic in human beings.

Pathogenicity

Strep. *Pyogenes* produces pyrogenic infection that spread locally along with lymphatic & blood serum. They produce mainly two types of lesions. The group A streptococci that cause necrotizing fasciitis have sometimes been termed flesh-eating bacteria.

- Suppurative infection: Respiratory infection, skin and soft tissue, Genital, abscess in liver, lung. Kidney and brain

- Non-suppurative: Acute rheumatic fever and Acute glomerulonephritis.

Respiratory Infection:

The primary site of invasion of the human body of *Strep. pyogenes* is the throat. Sore throat is the most common of the streptococcal diseases. It may be localized as tonsillitis of may involve the pharynx more diffusely (pharyngitis). Virulent group A streptococci adhere to the

pharyngeal epithelium by means of lipoteichoic acid that covering the surface pili. Tonsillitis is more common in older children and adults than in younger children, who commonly develop diffuse pharyngitis.

Skin and soft tissue infections

Strep. pyogenes causes a variety of suppurative infections of the skin, including infection of wounds or burns. Infection of minor abrasions may at times lead to fatal septicemia. The two typical streptococcal infections of the skin are Erysipelas and Impetigo.

Erysipelas: It is a diffuse infection involving the superficial lymphatics. The affected skin, which is red, swollen and indurated, is sharply demarcated from the surrounding healthy area. One attack does not give protection & recurrent infection in same area occurs in some person. **Impetigo**: It is a superficial crushed spot, especially in children. Impetigo it the main cause of acute glomerulonephritis in children in the tropics. It last for 1-2 weeks. It heals spontaneously without leaving scar.

Other suppurative infections:

Strep. pyogenes may cause abscesses in internal organs such as the brain, lungs, liver and kidneys, and also septicemia and pyemia.

Nonsuppurative complications:

Strep. pyogenes infections lead to two important nonsuppurative sequelae : acute rheumatic fever and acute glomerulonephritis.

Rheumatic fever

It usually strikes children 5-15 years of age. When it occurs, it has been shown to follow untreated beta-hemolytic group A *Strep*. pharyngitis. Rheumatic fever is antibody-mediated. There are antigens in the heart that are similar to the antigens of the beta-hemolytic group A *Strep*. Therefore, the antibodies that forms to eradicate this particular *Streptococcus* also cross-react with antigens in the heart. This immunologic attack on the heart tissue causes heart inflammation, called myocarditis. Patients may complain of chest pain and may develop arrhythmias or heart failure.

Puerperal fever—the *Strep*. enter the uterus after delivery, puerperal fever develops, which is essentially a septicemia originating in the infected wound.

Bacteremia or sepsis—Infection of traumatic or surgical wounds with *Strep*. results in bacteremia, which can rapidly be fatal. *Strep. pyogenes* bacteremia can also occur with skin infections, such as cellulitis and rarely pharyngitis.

Acute post-streptococcal glomerulonephritis

This is an antibody-mediated inflammatory disease of the glomeruli of the kidney. It occurs about one week after infection of either the pharynx or skin by nephritogenic (having the ability to cause glomerulonephritis) strains of beta-hemolytic group A *Strep*. Certain antigens from these nephritogenic streptococci induce an antibody response. The resulting antigen-antibody complexes travel to and are deposited in the glomerular basement

membrane, where they activate the complement cascade. This leads to local glomerular destruction in the kidney.

OTHER HEMOLYTIC STREPTOCOCCI

Group B *Streptococci* (*Strep. agalactiae*)

Normal flora in female in genital tract (15-25% of woman) and male urethra, leading cause for neonatal sepsis, pneumonia & meningitis (acquire these bacteria during delivery).

Virulence factors:

- Capsule
- hemolysin and cAMP factor
- Bacitracin resistant.

Group D streptococci (Enterococci and Non-enterococci)

Enterococcus (*E.faecalis, E.faecium*)

- Normal flora of GIT and oral mucosa.
- Causes UTI, biliary tract infection, and endocarditis.
- Varies Hemolysis

Non-enterococcus (Streptococcus bovis, Streptococcus equinus)

It lives in the G.I. tract, and it causes similar diseases

Name	Group-Specific Substance[a]	Hemolysis[b]	Habitat	Important Laboratory Criteria	Common and Important Diseases
Pyogenic Streptococci					
Streptococcus pyogenes	A	β	Throat, skin	Large colonies (>0.5 mm), PYR[c] test positive, inhibited by bacitracin	Pharyngitis, impetigo, deep soft tissue infections; bacteremia; rheumatic fever, glomerulonephritis, toxic shock
Streptococcus agalactiae	B	β	Urogenital tract, lower GI tract	Hippurate hydrolysis, CAMP-factor positive[d]	Neonatal sepsis and meningitis; bacteremia, UTIs,[e] meningitis in adults
Streptococcus dysgalactiae subspecies *equisimilis*; others	C, G	β (human) infections), α, none	Throat	Large (>0.5 mm) colonies	Pharyngitis, pyogenic infections similar to group A streptococci
Viridans Streptococci					
Streptococcus bovis group[f]	D	None	Colon, biliary tree	Growth in presence of bile, hydrolyze esculin, no growth in 6.5% NaCl, degrades starch	Endocarditis, common blood isolate in colon cancer, biliary disease
Streptococcus anginosus group (*S anginosus*, *Streptococcus intermedius*, *Streptococcus constellatus*)	F (A, C, G) and untypeable	α, β, none	Throat, colon, urogenital tract	Small (<0.5 mm) colony variants of β-hemolytic species; group A are bacitracin resistant and PYR negative; carbohydrate fermentation patterns; arginine, esculin, VP[g] positive	Pyogenic infections, including brain, liver, lung abscesses
Mutans group	Usually not typed	α, none	Oral cavity	carbohydrate fermentation patterns; esculin, VP positive	Dental caries (*S mutans*), endocarditis; abscesses (with many other bacterial species)
Mitis-Sanguinis group					
Streptococcus pneumoniae	None[h]	α	Nasopharynx	Susceptible to optochin; colonies soluble in bile; quellung reaction positive	Pneumonia, meningitis, bacteremia, otitis media, sinusitis
Streptococcus mitis	None	α, none	Oral cavity	VP negative[g]; carbohydrate fermentation patterns	Endocarditis; bacteremia, sepsis in immunocompromised patients; high-level resistance to penicillin