



Lecture 11. *Streptococci*

Learning objectives

Upon completion of this lecture, student should be able to:

1. Describe the general characteristics of *Streptococcus* spp.
2. Explain the Lancefield classification system for *Streptococcus* spp.
3. Identify the clinical infections associated with *Streptococcus pyogenes*.

Introduction

Family **Streptococcaceae** consists of **catalase negative, gram-positive cocci**.

Streptococci are part of the normal flora in humans and animals.

- They are **non-motile, non-sporing, spherical** or ovoid **cocci**, and have **hyaluronic acid capsules**.
- They are **catalase negative**.
- They are **relatively fastidious bacteria** requiring enriched medium for their growth.

Streptococcaceae consists of seven genera, two of which are of medical importance:

1. *Streptococcus*

- *S. pyogene*, *S. pneumoniae*

2. *Enterococcus*

- *E. faecalis*

Streptococci classification

The streptococci are classified based on:

1. **Oxygen requirement (aerobes and obligate anaerobes).**
2. **Hemolytic properties on blood agar (alpha, beta, and gamma).**
3. **Antigenic structure (lancefield classification).**

	Alpha-hemolytic streptococci	Beta-hemolytic streptococci	Gamma-hemolytic streptococci
Hemolysis on blood agar	Produce a narrow zone (greenish zone) of hemolysis with some partially lysed RBCs.	Produce a well defined, clear, colorless zone of hemolysis around the colonies	Do not produce any hemolysis or on blood agar
Type of infection	Found as commensals in the upper respiratory tract	Pathogenic streptococci	Generally found as commensals
Example	<i>Streptococcus pneumoniae</i>	<i>Streptococcus pyogenes</i>	<i>Enterococcus faecalis</i>

Lancefield classification

Lancefield classification is a **serological classification** of the **beta-hemolytic streptococci**.

It is based on the detection of **group-specific carbohydrate antigen (C antigen)** on the **cell wall** of the streptococci.

The beta-hemolytic streptococci are classified into 21 serological groups known as **Lancefield groups**, designated from **A to W** (with **exception** of **I and J**).

Streptococcus pyogenes

Is the species classified under **group A** streptococci. It is the most important human pathogen causing:

1. **Pyogenic infections**, such as bacterial **pharyngitis** and **cellulitis**.
2. **Toxin-mediated diseases**, such as **scarlet fever** and **toxic shock syndrome**.
3. **Immunologic diseases**, such as acute **glomerulonephritis (AGN)** and **rheumatic fever**.

Morphology

S. pyogene shows following features:

- They are **Gram-positive cocci** arranged in **long chains**.
- They are **non-motile** and **non-sporing**.
- Some strains of *S. pyogenes* produce **hyaluronic acid capsule**, chemically **similar to that of host connective tissue** and is therefore **non-antigenic**.

Virulence factors

Streptococci produce a wide range of virulence factors:

	Virulence factors	Biological functions
1.	Cell wall associated polymers and proteins	
	Capsule	Prevents phagocytosis
	Teichoic acid	Binds to epithelial cells
	M protein	Adhesin and antiphagocytic
	F protein	Mediates attachment to epithelial cells
2.	Enzymes	
	Streptokinase	Breaks down the fibrin barrier around the infected site, thereby facilitating spread of the infection
	Deoxyribonucleases	Depolymerizes free DNA present in the pus
	Hyaluronidase	Hydrolyzes hyaluronic acids in the matrix of the connective tissues
3.	Toxins	
	Streptococcal pyrogenic exotoxins (SPEs)	Dissolves the clot, thrombi, and emboli; thereby facilitates spread of the bacteria in tissues
	Streptolysin O and Streptolysin S	Lyse erythrocytes, leukocytes, and platelets; and stimulate production of lysosomal enzymes
	Pyrogenic exotoxins	Release large amounts of cytokines therefore, rapidly destroying tissues

Pathogenesis of *Streptococcus pyogenes*

S. pyogenes produce suppurative and non-suppurative diseases by the following mechanisms:

- 1. Adherence:** The cocci adhere to the epithelium with the help of pili, lipoteichoic acid, F proteins, and M proteins.
- 2. Invasion:** The cocci invasion is mediated by M protein, F protein, and other antigens.
- 3. Production of toxins and enzymes**

Clinical syndromes

S. pyogenes produces a variety of diseases classified broadly as:

- 1. Suppurative streptococcal diseases**
- 2. Toxin-mediated disease**
- 3. Non-suppurative streptococcal diseases**

Suppurative streptococcal diseases

a. Respiratory infections

- **Pharyngitis (sore throat):** it is characterized by inflammation of pharyngeal mucosa with exudate formation, tender enlarged cervical lymph nodes, fever, and leukocytosis.

b. Skin and soft tissue infections

- **Pyoderma, erysipelas, cellulitis, and necrotizing fasciitis.**
- Necrotizing fasciitis occurs as a rapidly spreading infection of superficial and deep fascia, caused by certain strains called as “**flesh-eating strains**” due to the **extensive destruction of muscle and fascia** caused by them.



Toxin mediated diseases

a. Scarlet fever

- It manifests as fever, pharyngitis, and by a characteristic rash. The rash is followed by desquamation.

b. Streptococcal toxic shock syndrome

- The condition manifests initially as pain at the site of inflammation and non-specific systemic complaints, such as nausea, vomiting, diarrhea, fever, and chills.
- The condition progresses subsequently to multiorgan failure and shock.

Non-suppurative streptococcal diseases

a. Acute glomerulonephritis

- The onset of infection typically occurs 2–3 weeks following skin infection or pharyngitis caused by certain strains of *S. pyogenes*.
- It manifests as hypertension, generalized edema, hematuria, and proteinuria.

b. Rheumatic fever

- It is an immunologically mediated disease, which affects the heart, joints, skin, and brain with a latent period of 2–4 weeks.
- It is characterized by fever, migrating polyarthritits, and carditis, and is frequently associated with subcutaneous nodules.



Epidemiology

- *S. pyogenes* infections are worldwide in distribution.
- Person-to-person transmission is the main route of transmission through:
 1. Respiratory droplets.
 2. Direct contact with infected patient, fomites, or arthropod vectors.
 3. Salivary droplet and nasal discharge of untreated children.

Laboratory diagnosis

Specimens

- The nature of specimens to be collected depends upon the disease manifestations (throat swab, nasal swab, pus, pharyngeal secretions, blood, CSF, abscess fluid).

Microscopy

- The presence of **Gram-positive cocci** in **pairs** and **chains** is suggestive of streptococcal infection.

Identifying features of *S. pyogenes*

1. **Gram-positive cocci** arranged in **short chains** or **pairs**.
2. On **blood agar**, produces **beta-hemolysis**.
3. **Positive** for **bacitracin** susceptibility test.
4. **Positive** for L-pyrrolidonyl-alpha-naphthylamide (**PYR**) test.
5. **Positive** for **group-specific C antigen** by direct antigen detection tests.

Treatment

- **Penicillin** is highly effective against *S. pyogenes*.
- **Erythromycin** and **clindamycin** are given to patients **allergic to penicillins**.