Respiratory System Module
Lecture 3

Streptococci

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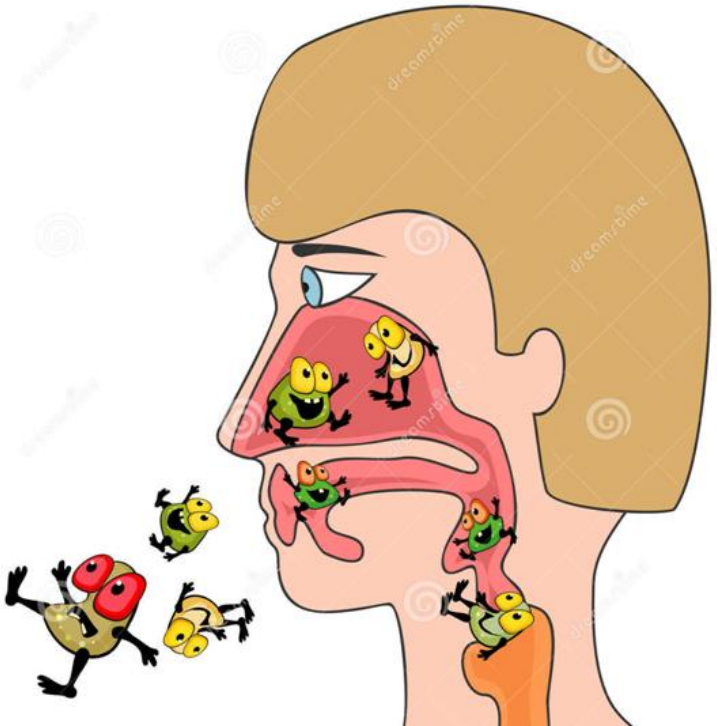
Introduction to Respiratory Infections

What is the importance of studying respiratory infections?

- The respiratory system is the most commonly infected system because it is the major portal of entry for infectious organisms

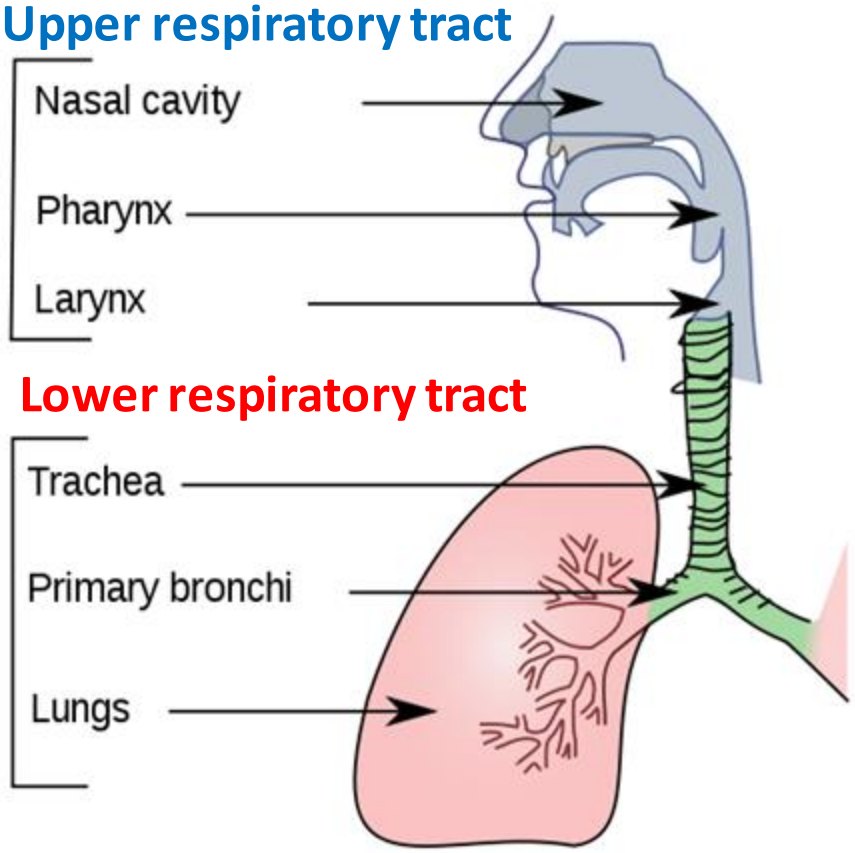
- Respiratory infections are seen more than any other type of infection.



Introduction to Respiratory Infections

The respiratory system is divided into

- ✓ Infections are fairly common
- ✓Usually nothing more than an irritation



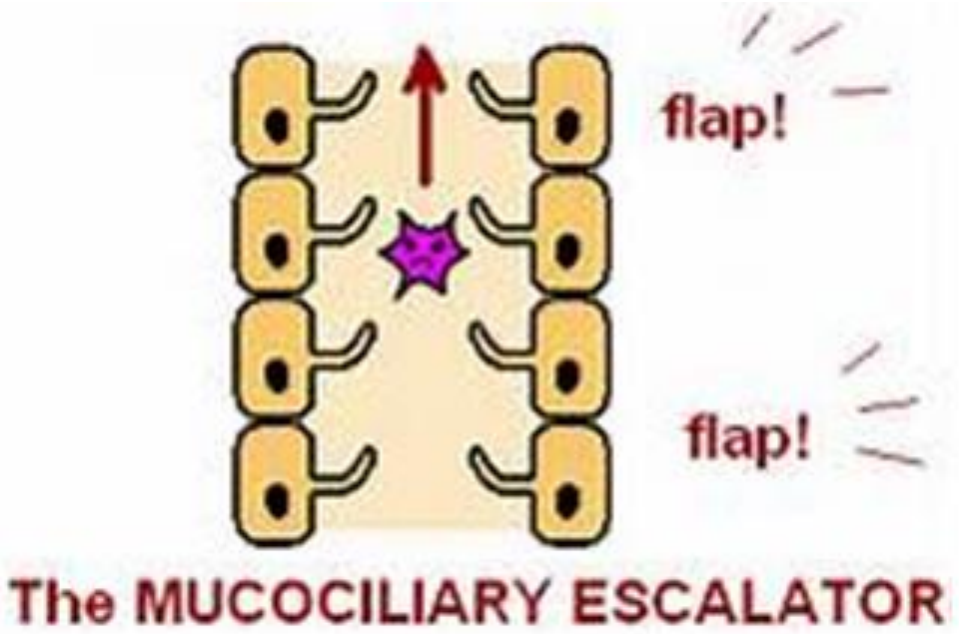
- Infections are more dangerous
- Can be very difficult to treat

Introduction to Respiratory Infections

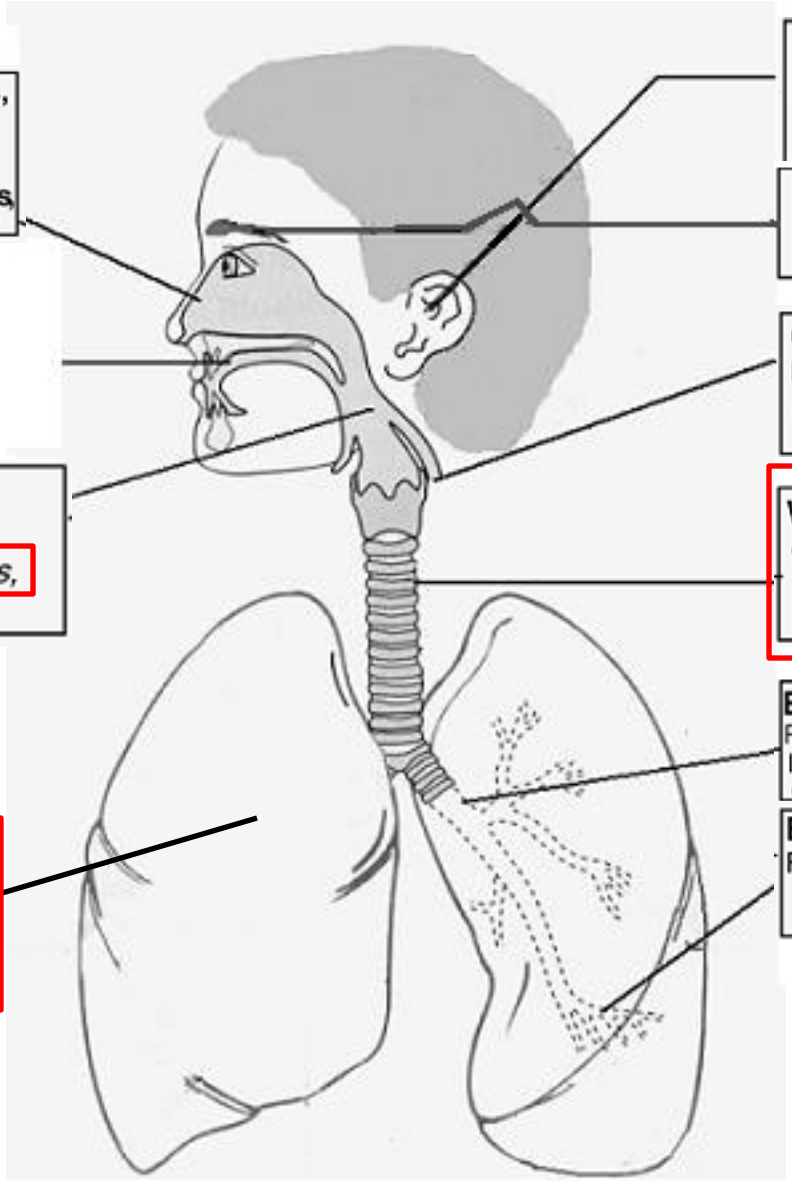
The respiratory system has significant defense mechanisms including:

1. **The upper respiratory tract has:**
   - Mucociliary escalator
   - Coughing

2. **The lower respiratory tract has:**
   - Alveolar macrophages



Infections of the Respiratory System



Common Cold - Rhinoviruses, Coronaviruses, Adenoviruses, Myxoviruses, Echoviruses, Coxsackie A and B, Echoviruses, *M. pneumoniae, C. pneumoniae*

Otitis Media - *S. pneumoniae, H. influenzae, M. catarrhalis*
Otitis Externa - *P. aeruginosa*

Sinusitis - *S. pneumoniae, H. influenzae*

Croup - Parainfluenza viruses, Respiratory Syncytial virus
Epiglottitis - *H. influenzae*

Pharyngitis - Adenovirus, Herpes Simplex Virus, Coxsackieviruses, *S. pyogenes, C. diphtheriae*

Whooping Cough
Bordetella pertussis

Bronchitis - Parainfluenza viruses, Respiratory Syncytial virus, Influenza viruses, *M. pneumoniae, C. pneumoniae*

Bronchiolitis
Respiratory Syncytial Virus

Tuberculosis
M. tuberculosis

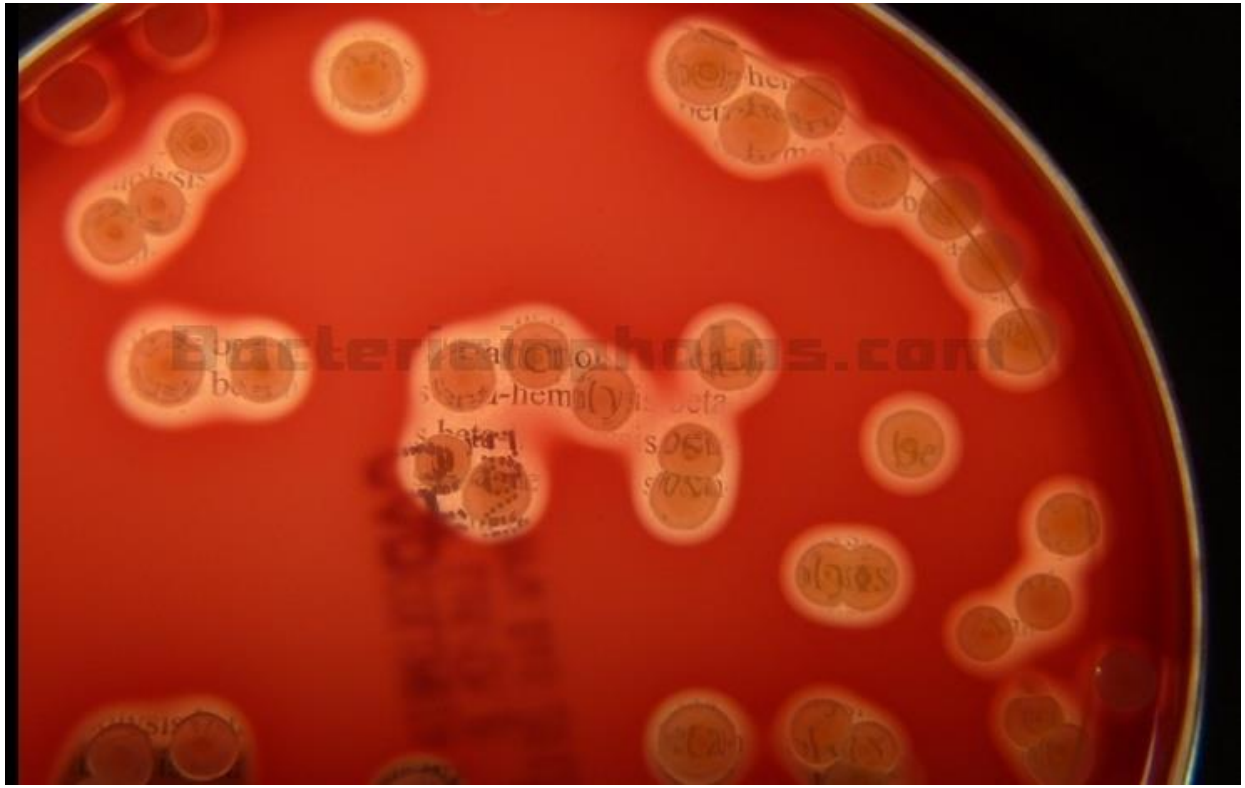
Bacterial vs. viral infections

Headache
Fever
Nausea, vomiting, and abdominal pain
Tender enlarged anterior cervical LN

Rhinitis
Conjunctivitis
Cough
Diarrhea

Streptococcus pyogenes

Group A Hemolytic streptococci



Streptococcus pyogenes

Physiology & Metabolism

1. **Facultative anaerobes**

2. **Fastidious growth requirements**

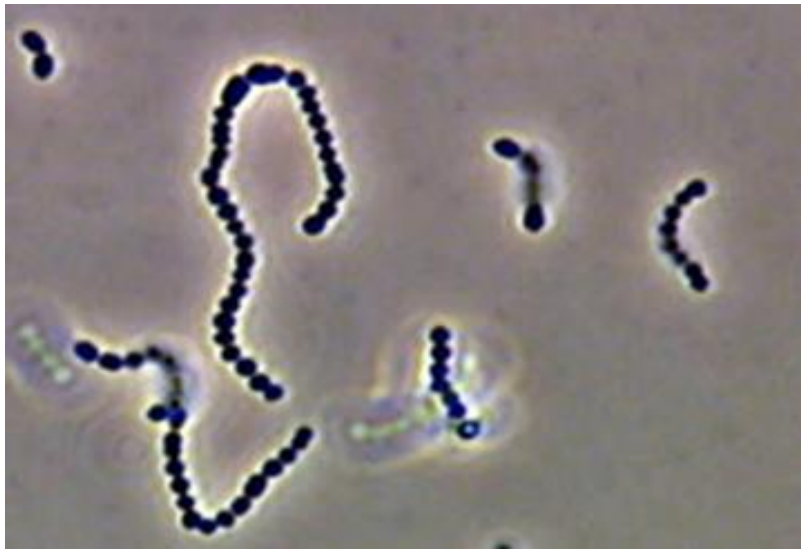
3. **Catalase negative** ($2H_2O_2$ ---> $O_2 + 2H_2O$)
   Separation of streptococci from staphylococci

4. **Oxidase negative**

5. **Beta hemolysis** on blood agar

Morphology

Gram-Positive Cocci in **Pairs or Chains**



Streptococcus pyogenes

Beta-Hemolytic Streptococci in Human Diseases

Suppurative Diseases:

- ❑ Pharyngitis and tonsilitis
- ❑ Scarlet Fever
- ❑ Cutaneous & Soft Tissue Infections
- ❑ Systemic Disease

Non-Suppurative Sequelae:

- ❑ ARF
- ❑ RHD
- ❑ AG

- ❑ Systemic TSS
- ❑ Foodborne Disease

Streptococcus pyogenes

Pathophysiology

1. *S pyogenes* tends to colonize the upper respiratory tract and is highly virulent as it overcomes the host defense system.
2. The antigenic components of the cell are the virulence factors.

A. Extracellular Virulence Factors

- ❑ **Streptolysin O (SLO):** Lytic for variety of cells
- ❑ **Streptolysin S (SLS):** Lytic for red and white blood cells
- ❑ **Nucleases**
- ❑ **Streptokinases**
- ❑ **C5a Peptidase**
- ❑ **Hyaluronidase**

B. Cellular Virulence Factors

❑**M-Protein**

- Adhesin

- Antiphagocytic

-Inhibits alternate Complement pathway and opsonization

❑**Capsule**

Antiphagocytic; Nonspecific adherence

Hyaluronic acid (polysaccharide) mimics animal tissue (immune evasion)

Epidemiology of Acute Streptococcal Infection

- Preference for **upper respiratory tract** or **skin**
- Group A commonly colonize **oropharynx of healthy children**
- **Transmitted** by droplets from respiratory secretions
- Crowding increases risk (e.g., classrooms, day care facilities)

Streptococcus pyogenes

Symptoms of Streptococcal pharyngitis

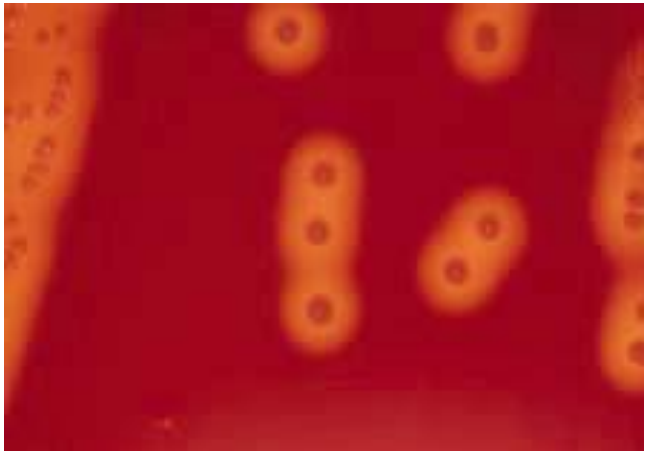
1. Absence of a cough
2. Swollen and tender cervical lymph nodes
3. Temperature >38.0 °C (100.4 °F)
4. Tonsillar exudate or swelling
5. Other symptoms include:
   - ✓ Headache
   - ✓ Nausea
   - ✓ Vomiting
   - ✓ Abdominal pain
   - ✓ Muscle pain
   - ✓ Palatal petechiae: uncommon but highly specific finding.

The incubation period: between 1-3 days post contact.

Strep throat is unlikely when any of the symptoms of red eyes, hoarseness, runny nose, or mouth ulcers are present, and when there is no fever

Streptococcus pyogenes

Lab Identification



1. **Culture**
   - ✓ Encapsulated cells produce mucoid colonies
   - ✓Beta-hemolytic: zone several times greater than diameter of colony

2. **Catalase Negative:**
   Differentiates from Staphylococcus

3. **Bacitracin test:**
   S. pyogenes is bacitracin sensitive

4. **Rapid Identification Tests:**
   Based on extraction of Group A carbohydrate directly from throat swabs
   - ELISA
   - Fluorescent antibody

5. **A rapid strep test (also called rapid antigen detection testing or RADT):**

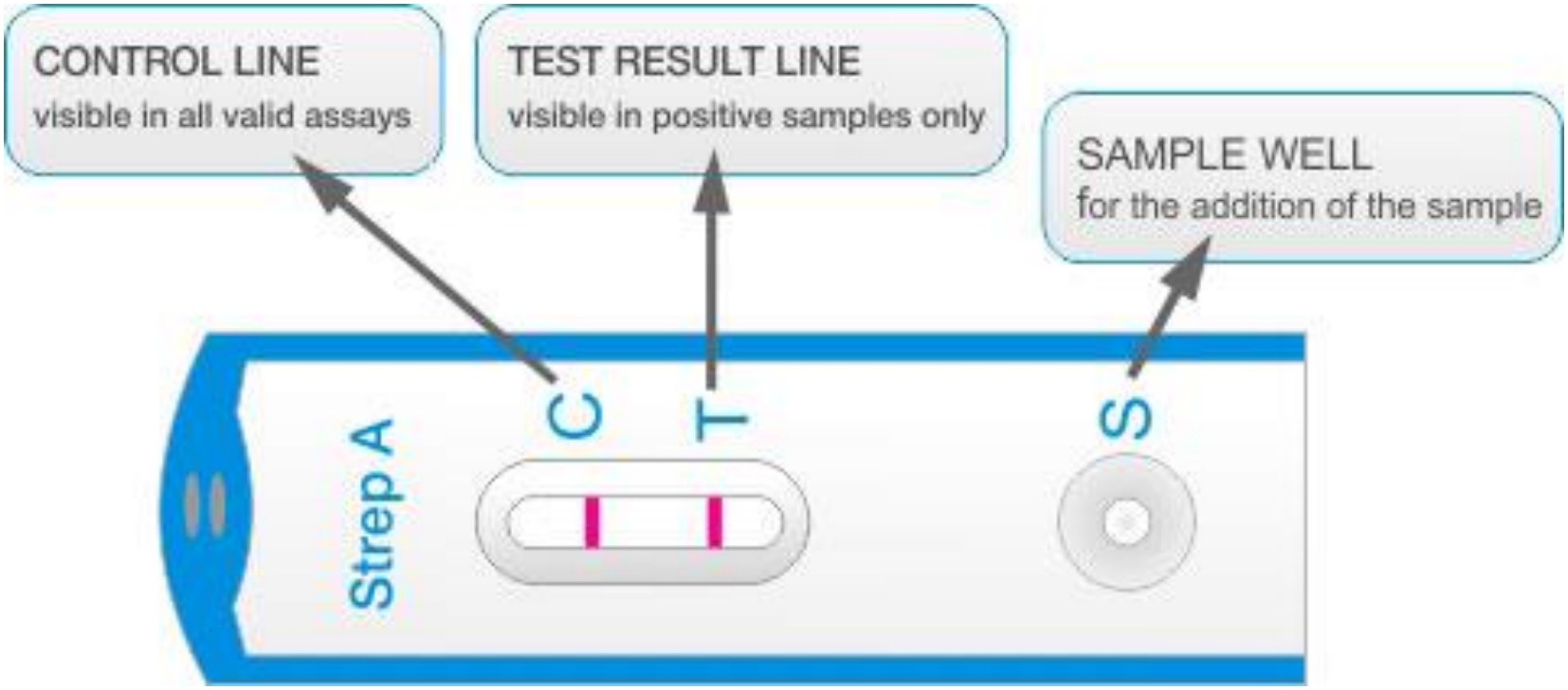
It employs latex beads covered with antigens that will visibly agglutinate around GAS antibodies if these are present

Streptococcus pyogenes

Lab Identification

A rapid strep test

1. The patient's throat is first swabbed to collect a sample of mucus.
2. The sample is applied to a strip of nitrocellulose film and, if GAS antigens are present, these will migrate along the film to form a visible line of antigen bound to labeled antibodies



Streptococcus pyogenes

Treatment

Table 3. Recommended Antibiotics for Treatment of GABHS Pharyngitis

Drug	*Dosage*	*Duration*	*Cost**
First-line treatments			
Amoxicillin	Children: 50 mg per kg per day orally (maximum: 1,000 mg per day)	10 days	$4
	Adults with mild to moderate GABHS pharyngitis: 500 mg orally two times per day		
	Adults with severe GABHS pharyngitis: 875 mg orally two times per day		
Penicillin G benzathine	Children < 60 lb (27 kg): 6.0×10^5 units intramuscularly	One dose	Varies
	Children ≥ 60 lb and adults: 1.2×10^6 units intramuscularly		
Penicillin V	Children with mild to moderate GABHS pharyngitis: 25 mg per kg per day orally, in two divided doses (maximum: 1,000 mg per day)	10 days	$5
	Children with severe GABHS pharyngitis: 50 mg per kg per day orally, in two divided doses (maximum: 1,000 mg per day)		
	Adults: 500 mg orally two times per day		
Treatment for patients with type IV hypersensitivity to penicillin			
Cephalexin (Keflex)	Children: 25 to 50 mg per kg per day orally, in two divided doses (maximum: 1,000 mg per day)	10 days	$4 ($190)
	Adults: 500 mg orally two times per day		
Treatments for patients with type I hypersensitivity to penicillin			
Azithromycin (Zithromax)	Children: 12 mg per kg per day orally (maximum: 500 mg per day)	5 days	$10 ($148)
	Adults: 500 mg orally on day 1, then 250 mg on days 2 through 5		
Clarithromycin (Biaxin)	Children: 7.5 mg per kg every 12 hours (maximum: 500 mg per dose)	10 days	$23 ($202)
	Adults: 250 mg orally every 12 hours		
Clindamycin	Children: 21 mg per kg per day orally, divided every eight hours (maximum: 300 mg per dose)	10 days	$17
	Adults: 300 mg orally every eight hours		

GABHS = group A beta-hemolytic streptococcal.

**—Estimated retail cost for one treatment course based on prices obtained at http://www.goodrx.com (accessed April 18, 2016). Generic price listed first; brand name in parentheses, if available.*

Information from references 1, 3, 23, 24, and 28 through 35.

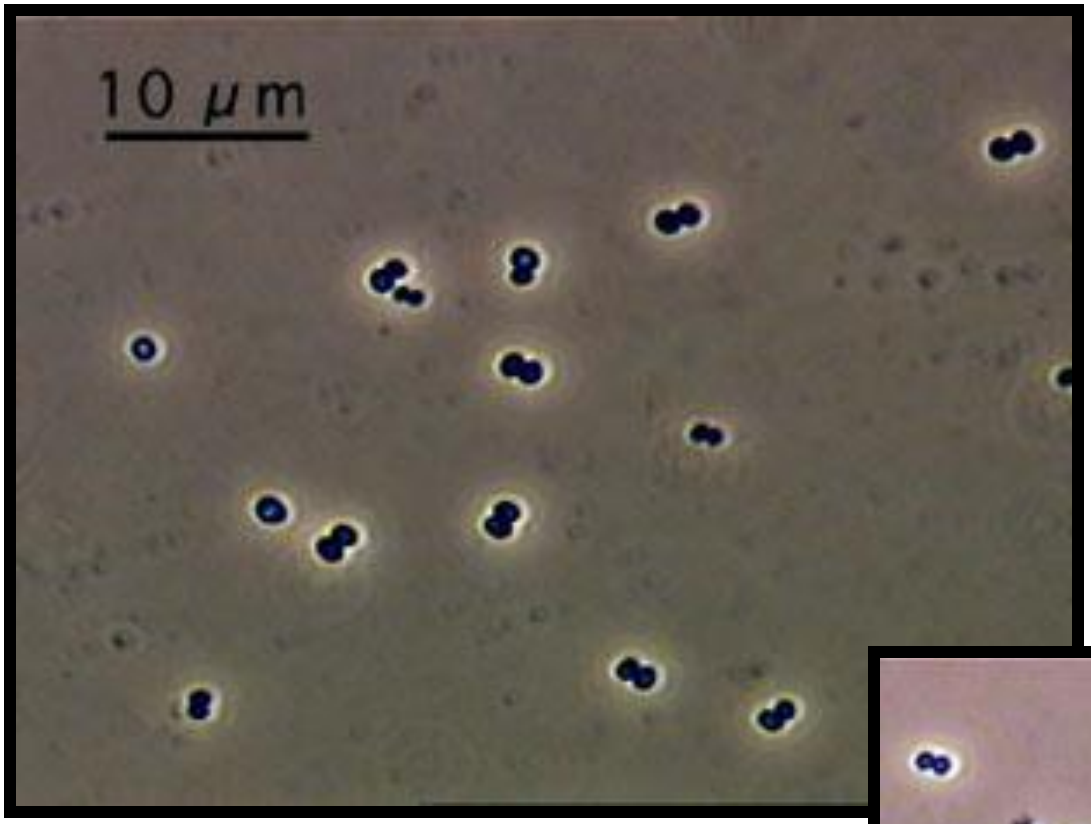
Streptococcus pneumoniae

Commonly referred to as **pneumococcus**

- Formerly *Diplococcus pneumoniae*
- Pneumonia
- Meningitis
- Bacteraemia

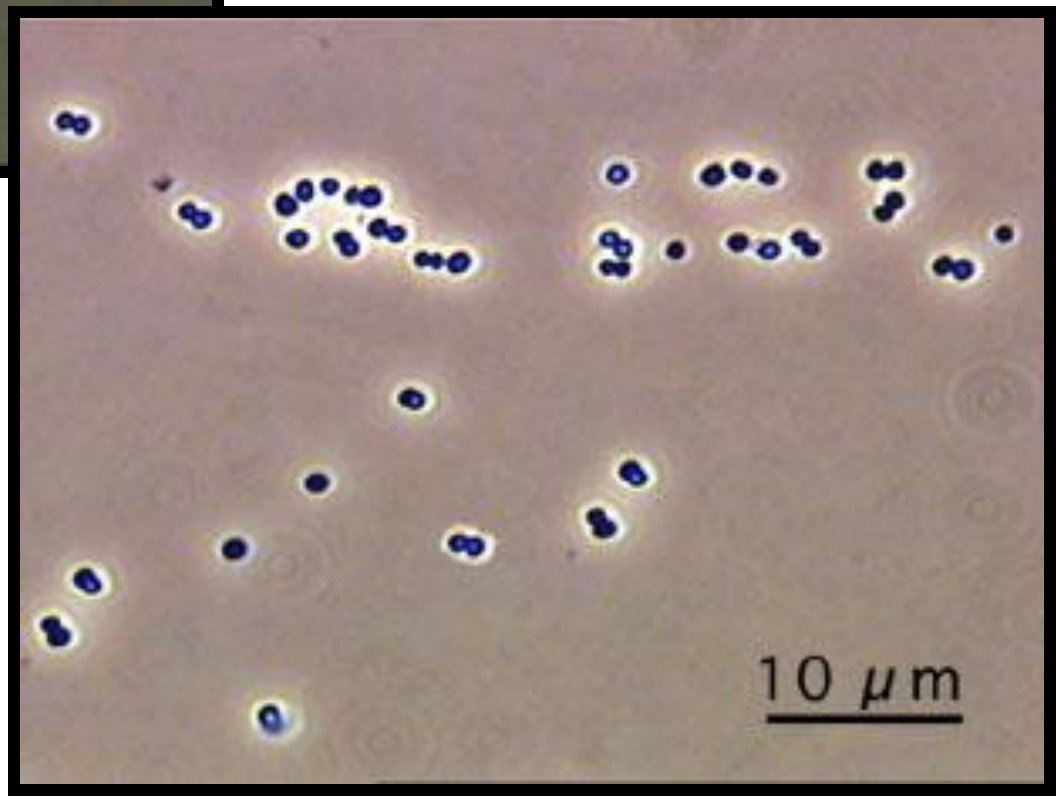
Streptococcus pneumoniae

- Gram-positive diplococci (in pairs)
- Encapsulated ovoid or lanceolate coccus
- Non-motile
- Fastidious (enriched media)
  - Blood or chocolate agar
  - 5-10 % CO_2
- Alpha haemolysis + draughtsman appearance
- Some strains are mucoid
- Soluble in bile
- Optochin sensitive

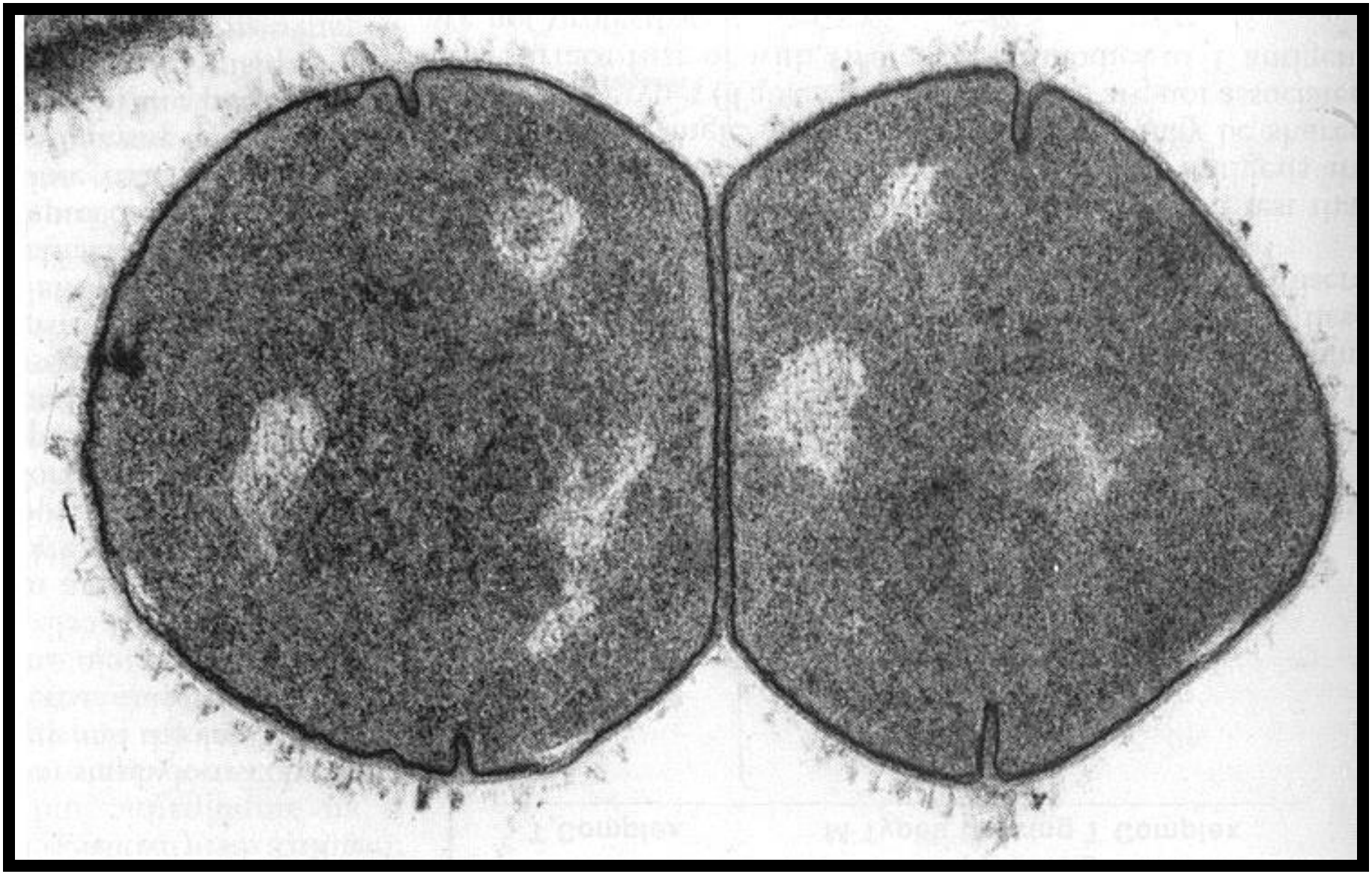


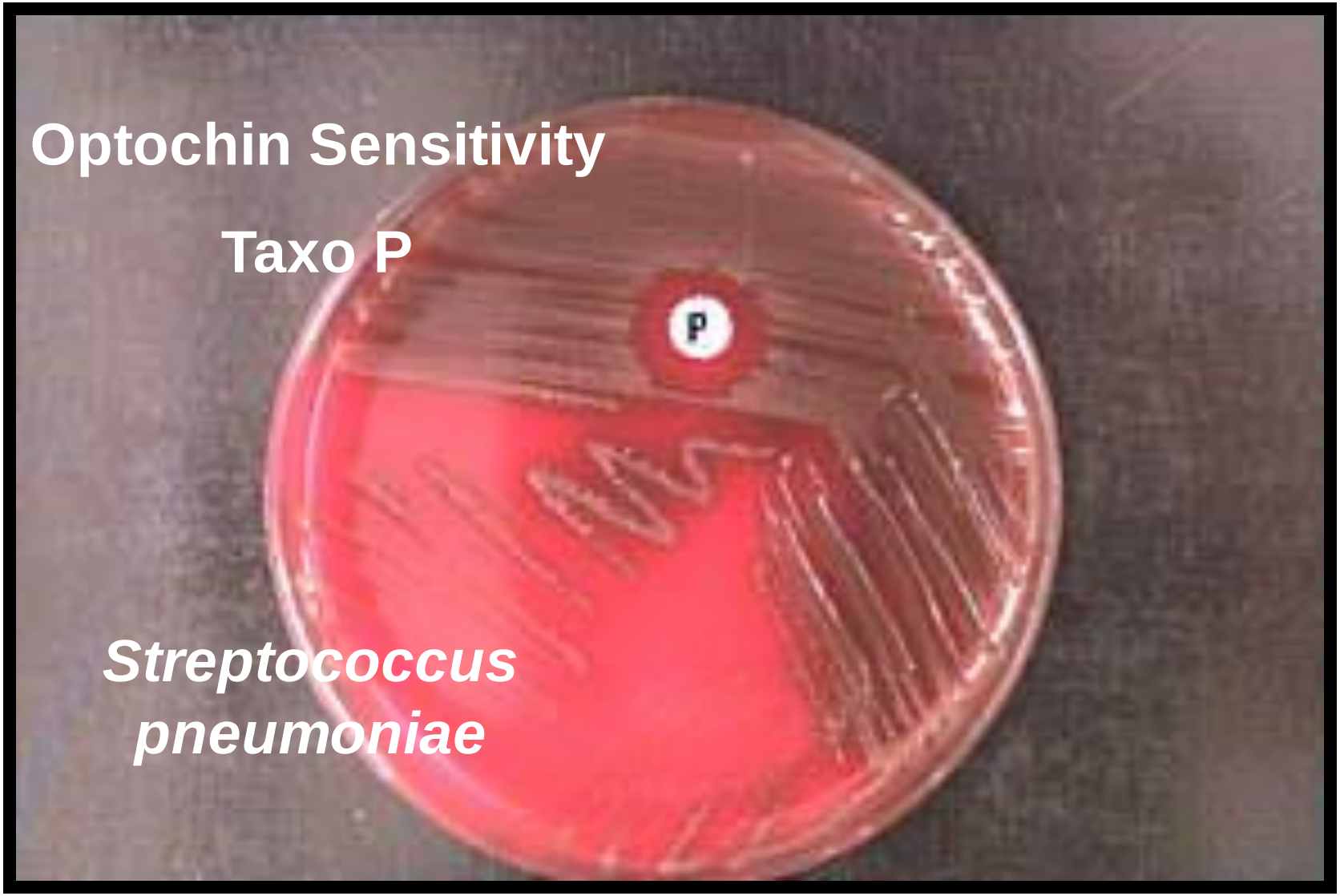
S. pneumoniae

- Diplococcus



S. pneumoniae: lancet-shaped diplococcus




Optochin Sensitivity
Taxo P
P
Streptococcus pneumoniae

Streptococcus pneumoniae-Pathogenesis

- Virulence factors
  - Capsular polysaccharide
    - The major factor
    - 84 serotypes
    - Both antigenic and type specific
    - Antiphagocytic
    - Serotype 3 , 7 are most virulent
    - 90% of cases of bacteraemic pneumococcal pneumonia and meningitis are caused by 23 serotypes
    - Quellung reaction , india ink
  - Pneumolysin
    - Membrane damaging toxin

Streptococcus pneumoniae-Pathogenesis

- Carrier rate
  - Oropharyngeal flora of 5 – 70% of the population
  - Significance in respiratory infection

Streptococcus pneumoniae-Disease

- Respiratory tract infections
  - Lobar pneumonia (commonest cause of CAP)
  - Empyema
  - Otitis media (6 months – 3 yrs)
  - Mastoiditis
  - Sinusitis
  - Acute exacerbation of chronic bronchitis
- Meningitis
- Conjunctivitis
- Peritonitis (primary)
- Bacteraemia (15 % of pneumonia)
- septicaemia

Streptococcus pneumoniae-Clinical Feature

- Lobar pneumonia
  - Sudden onset
  - Fever
  - rigor
  - Cough , rusty sputum
  - Pleural pain
  - Signs of lobar consolidation
  - Polymorphonuclear leucocytosis
  - Empyema , pericarditis

Streptococcus pneumoniae-Laboratory Diagnosis

- Specimen
  - Sputum
  - CSF
  - Swabs
  - Pus
  - Blood culture
  - Aspirate

Streptococcus pneumoniae-Laboratory Diagnosis

- Microscopy
  - Gram stained smear
    - Gram-positive diplococci + pus cells
- culture
    - Blood agar , chocolate agar + 10 % CO2
- identification
    - Alph-haemolytic colonies
    - Optochin sensitive
    - Bile soluble

Streptococcus pneumoniae-Treatment

- Meningitis
  - Parenteral ceftriaxone + vancomycin

- pneumonia
  - Outpatients
    - Erythromycin
    - Amoxacillin – clavulanic acid
    - Cefuroxime or ceftriaxone (IV) + oral *b- lactam*
  - Inpatients
    - Parenteral cefuroxime or ceftriaxone