STREPTOCOCCUS PNEUMONIAE (PNEUMOCOCCUS)

- Gram-positive, nonmotile, encapsulated cocci. They are lancet shaped, and their tendency to occur in pairs accounts for their earlier designation as *Diplococcus pneumoniae*.
- Pneumococcal cell wall structure is similar to other streptococci.
- Most common cause of community-acquired pneumonia and adult bacterial meningitis and is an important cause of otitis media, and sinusitis. The risk of disease is highest among young children, older adults, smokers, and persons with certain chronic illnesses.
- Like other streptococci, *S. pneumonia* is fastidious (has complex nutritional requirements) and routinely cultured on blood agar. It releases an α hemolysin that damages red cell membranes, causing colonies to be α hemolytic.
- *S. pneumoniae*is an obligate parasite of humans and can be found in the nasopharynxof many healthy individuals. This organism is **extremely sensitive to environmental agents**.

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Pathogenesis

- Pneumococcal infections can be either endogenous or exogenous: **Endogenous** : involves the spread of *S. pneumonia* residing in the nasopharynx of a carrier who develops impaired resistance to the organism. Susceptibility to the infection may result from, for example, general debilitation such as that caused by malnutrition or alcoholism, respiratory damage following a prior viral infection, or from a depressed immune system.
  Exogenous : by droplets from the nose of a carrier

- Pneumococcal infection started with adherence to nasopharyngeal cells. Aspiration of respiratory secretions containing pneumococci is the initial event leading to pneumonia.
- Normally, aspirated organisms are cleared rapidly by the defense mechanisms of the lower respiratory tract, including the cough and epiglottic reflexes; the mucociliary “blanket;” and phagocytosis by alveolar macrophages. Host factors that impair the combined efficiency of these defenses can allow pneumococci to reach the alveoli and multiply there. These include chronic pulmonary diseases; damage to bronchial epithelium from smoking or air pollution.
- Clinically, pneumococcal pneumonia begins abruptly with a shaking chill and high fever. Cough with production of sputum pink to rusty in color (indicating the presence of RBCs) and pleuritic chest pain are common.

Virulence factors:

1. Capsule: The polysaccharide capsule is both antiphagocytic and antigenic. Antiphagocytic properties of the capsule protect the bacteria from polymorphonuclear leukocyte attack, facilitating growth of the bacteria prior to the appearance of anti -capsular antibodies. There are approximately 85 distinct capsular serotypes.

2. Pili: Pili enable the attachment of encapsulated pneumococci to the epithelial cells of the upper respiratory tract. Not all pneumococci are piliated, but those clinical isolates that express pili are more virulent.

3. Choline-binding protein A: Choline binding protein A is a major adhesion allowing the pneumococcus to attach to carbohydrates on epithelial cells of the human nasopharynx.

4. Autolysins: Autolysins are enzymes that hydrolyze the components of a biological cell in which it is produced. Autolysin are peptidoglycan-hydrolyzing enzymes that are present in the bacterial cell wall and are normally inactive. However, these enzymes are readily activated (for example, by surface-active agents, β-lactam antibiotics, or stationary phase), resulting in cell lysis.

Autolysin is thus responsible for the release of intracellular virulence factors (notably, pneumolysin).

5. Pneumolysin: Although retained within the cytosol of intact pneumococci, pneumolysinis thought to be an important virulence factor by virtue of its ability to **attack mammalian cell membranes**, causing lysis once it is released by autolysin from the interior of the bacterium.

Pneumolysin binds to cholesterol and therefore interacts indiscriminately with all cell types. This toxin **stimulates production of proinflammatorycytokines**, **inhibits the activity of polymorphonuclear leukocytes and activates complement**.

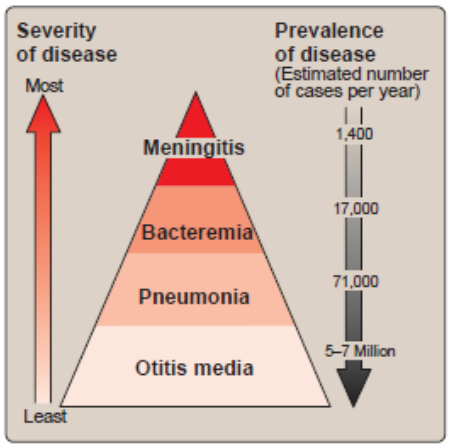
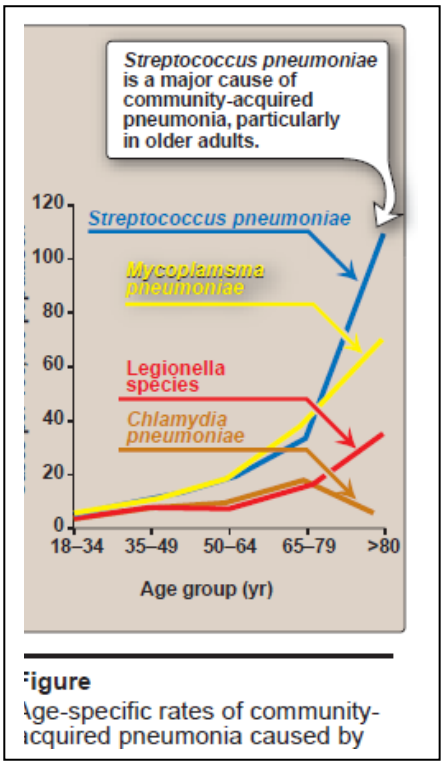


Figure
Comparison of severity and prevalence of some pneumococcal infections in children in the United States.



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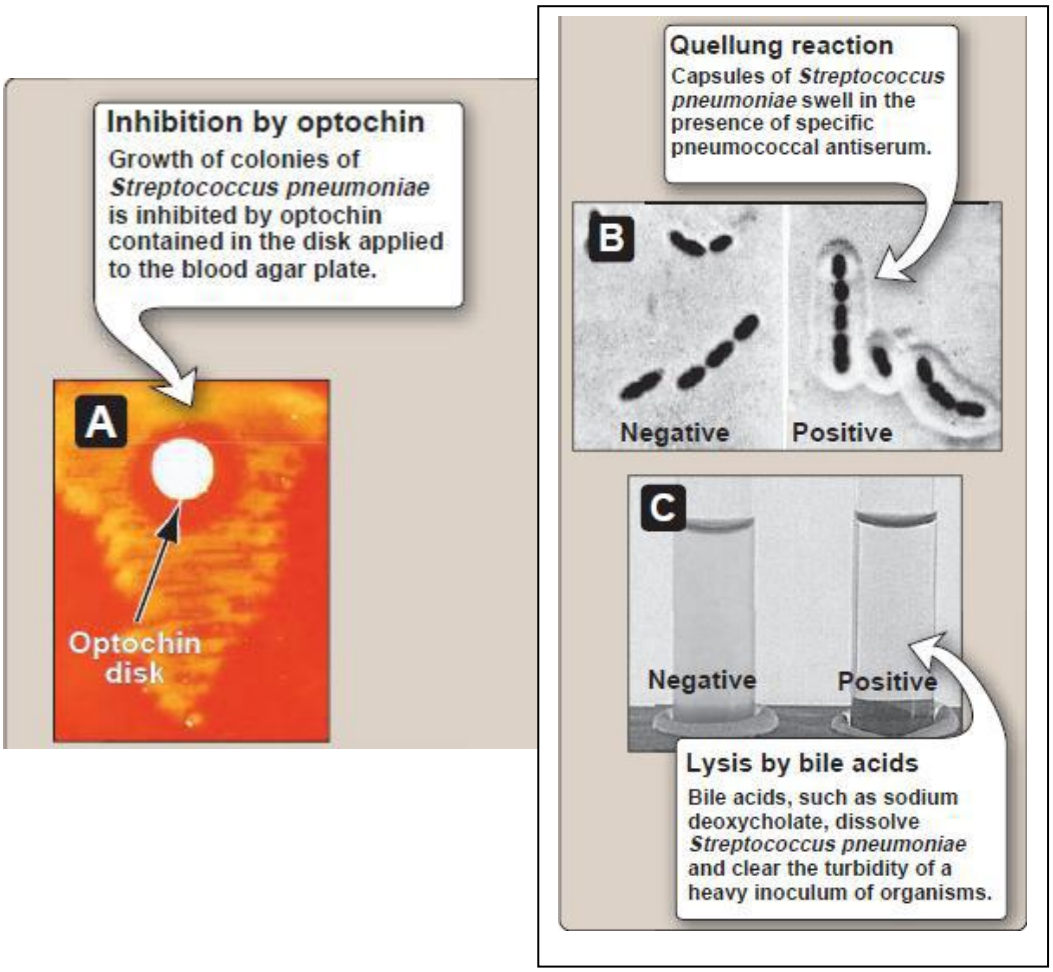
ge-specific rates of community-cquired pneumonia caused by

Laboratory identification

Specimens : naso-pharyngeal swab, blood, pus, sputum, or spinal fluid. Sputum collection may be difficult, however, and specimens contaminated with respiratory flora are useless for diagnosis. Other types of lower respiratory specimens may be needed for diagnosis.

- Lancet-shaped, gram positive diplococciare observed on a Gram stain of the sample.
- α-Hemolytic colonies appear when S. pneumonia is grown on blood agar overnight under aerobic conditions at 37^{o}C. colonies are translucent or mucoid, 1–2 mm in diameter. In young cultures the colonies are raised but later become flattened with raised edges, giving them a ringed appearance ('**draughtsmen**'). Note: When cultured anaerobically on blood agar, some strains of S. pneumoniae show beta haemolysis.
- Growth of these bacteria is inhibited by low concentrations of the surfactant optochin, and the cells are lysed by bile acids.
- **Bile solubility test** There are several ways of testing pneumococci for bile solubility, tube technique, the results of which are easy to read. Some workers, however, prefer to test suspect *alpha*-haemolytic colonies directly on a culture plate by touching a colony with a loopful of 2% sodium deoxycholate reagent (pH.7.0), incubating the plate at 35–37 ºC for 30 minutes, and examining for lysis (disappearance of the colony, indicating *S. pneumoniae*).
- Capsular swelling is observed when the pneumococci are treated with type-specific antisera (the Quelling reaction).



Prevention

There are two types of pneumococcal vaccine:

1. Pneumococcal polysaccharide vaccine (PPV): Immunizes against 23 serotypes of *S. pneumonia* and is indicated for the protection of high-risk individuals **older than age 2 years**.

2. Pneumococcal conjugate vaccine 13: The polyvalent PCV 13, is effective in infants and toddlers (ages 6 weeks to 5 years). It is made up of 13 pneumococcal antigens conjugated to CRM197, a mutant nontoxic diphtheria toxin.

VIRIDANS STREPTOCOCCI

The viridians group of streptococci includes many gram-positive, catalase-negative, α− or γ−hemolytic species that constitute the main facultative oral flora. The viridians streptococci are relatively avirulent, but *Streptococcus mutans* and other members of the viridians group cause dental caries.

In patients with abnormal or damaged heart valves, they can also infect these valves during a bacteremia, causing endocarditis. Therefore, at-risk

patients with rheumatic, congenital, or sclerotic valvular disease should receive prophylactic penicillin before undergoing dental procedures.
The following are the main features which differentiate *S. pneumoniae* from viridans streptococci:

Features	*S. pneumoniae*	*Viridans streptococci*
Haemolysis	*Alpha*	*Alpha, beta,* non-haemolytic
Optochin	Sensitive	Resistant
Bile Solubility	Positive	Negative

ENTEROCOCCI

- Enterococci contain a C-substance that reacts with group D anti sera. Therefore, in the past, they were considered group D streptococci.
- DNA analysis and other properties have placed them in their own genus, Enterococcus.
- The term enterococcus derives from their presence in the intestinal tract and the many biochemical and cultural features that reflect that habitat. These include the ability to grow in the presence of high concentrations of bile salts and sodium chloride.
- The clinically most important species are *E. faecalis* and *E. faecium*. causing about 95% of enterococcal infections including infections of the urinary tract, biliary tract, ulcers (e.g. bed sores), wounds (particularly abdominal) and occasionally endocarditis or meningitis.
- Enterococci can be α-, β-, or nonhemolytic.
- Enterococci are not very virulent, but they have become prominent as a cause of nosocomial infections as a result of their multiple antibiotic resistance.

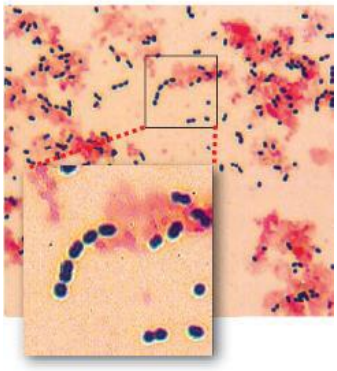


Figure
Enterococcus fecalis showing chain formation characteristic of *Streptococcus*.

Laboratory identification

Enterococciare distinguished from the non–group D streptococci by their ability to survive in the presence of **bile**, and to hydrolyze the polysaccharide **esculin**, producing black colonies on esculin-containing plates.
Unlike nonenterococcal group D streptococci, enterococci grow in **6.5% NaCl**, and yield a positive pyrazinamidase**(PYR) test**.
E. faecalis can be distinguished from *E. faecium* by their fermentation patterns, which are commonly evaluated in clinical laboratories

NONENTEROCOCCAL GROUP D STREPTOCOCCI

Streptococcus bovis is the most clinically important of the nonenterococcus group D streptococci. Part of normal fecal flora, they are either α− or nonhemolytic. *S. bovis* occasionally causes urinary tract infections and endocarditis, the latter especially in association with colon cancer.
The organism is bile and esculin positive, but is PYR-negative, and does not grow in 6.5 percent salt (unlike the enterococci). It tends to be sensitive to penicillin and other antibiotics.

Further Readings:
***SHERRIS MEDICAL MICROBIOLOGY:* AN INTRODUCTION TO INFECTIOUS DISEASES**, 4TH EDITION *by KENNETH J. RYAN, MD C. GEORGE RAY, MD*

Lippincott's Illustrated Reviews: Microbiology, Third Edition, Copyright © 2013 Lippincott Williams & Wilkins, a Wolters Kluwer business.

District Laboratory Practice in Tropical Countries, Part 2, Second Edition by Monica Cheesbrough, Cambridge University Press

CASES IN MEDICAL MICROBIOLOGY AND INFECTIOUS DISEASES, FOURTH EDITION, ASM Press Washington, DC, by Peter H. Gilligan, Ph.D. Daniel S. Shapiro, M.D. and Melissa B. Miller, Ph.D.