

Streptococci—continued

Lec.5

Group B Streptococci:

Represented by the pathogen *S. agalactiae*, gram-positive, catalase-negative organisms. *S. agalactiae* is found in the vaginocervical tract of female carriers, and the urethral mucous membranes of male carriers as well as in the gastrointestinal (GI) tract.

S. agalactiae can be transmitted sexually among adults and from an infected mother to her infant at birth.

Group B streptococci are a leading cause of **meningitis and septicemia in neonates**, with a high mortality rate.

They are also an occasional cause of infections in postpartum women (endometritis) and individuals with impaired immune systems, in whom the organism may cause septicemia or pneumonia.

Pathogenesis

Capsule is the major organism factor. The sialic acid moiety of the capsule has been shown to bind serum factor H, which in turn accelerates degradation of C3b before it can be effectively deposited on the surface of the organism.

This makes alternate pathway-mediated mechanisms of opsonophagocytosis relatively ineffective. Thus, complement-mediated phagocyte recognition requires specific antibody and the classical pathway.

Newborns will have this antibody only if they receive it from their mother as transplacental IgG.

GBS have also been shown to produce a peptidase that inactivates C5a, the major chemoattractant of PMNs.

Dx:

Sample: blood, cervical swabs, sputum, or spinal fluid can be obtained for culture on blood agar.

Latex agglutination tests can also demonstrate the presence of group B antigen in these samples.

Group B streptococci are β hemolytic, with larger colonies and less hemolysis than group A.

Most isolates remain sensitive to penicillin G and ampicillin, which are still the antibiotics of choice. In life-threatening infections, an aminoglycoside can be added to the regimen.

STREPTOCOCCUS PNEUMONIAE (PNEUMOCOCCUS)

S. pneumoniae are gram-positive, nonmotile, encapsulated cocci. They are lancet shaped, and their tendency to occur in pairs accounts for their earlier designation as *Diplococcus pneumoniae*. *S. pneumoniae* is the 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. pneumoniae* 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 nasopharynx of many healthy individuals.

This organism is **extremely sensitive to environmental agents**.

Pneumococcal infections can be either endogenous or exogenous:

Endogenous : involves the spread of *S. pneumoniae* 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.

Pathogenesis

1. Capsule: The *S. pneumoniae* 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, some of which endow strains with greater virulence than others (about 20 serotypes account for the vast majority of pneumococcal infections).

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.

The genes required for regulation and assembly of the pilus are not present in all pneumococcal strains, but they can be horizontally transferred between strains on a pathogenicity “islet”, which is small pathogenicity island. The chromosomal region responsible for production of the pneumococcal pilus is called the *rlrA* islet, named for the regulatory gene (*rlrA*) that is required for expression.

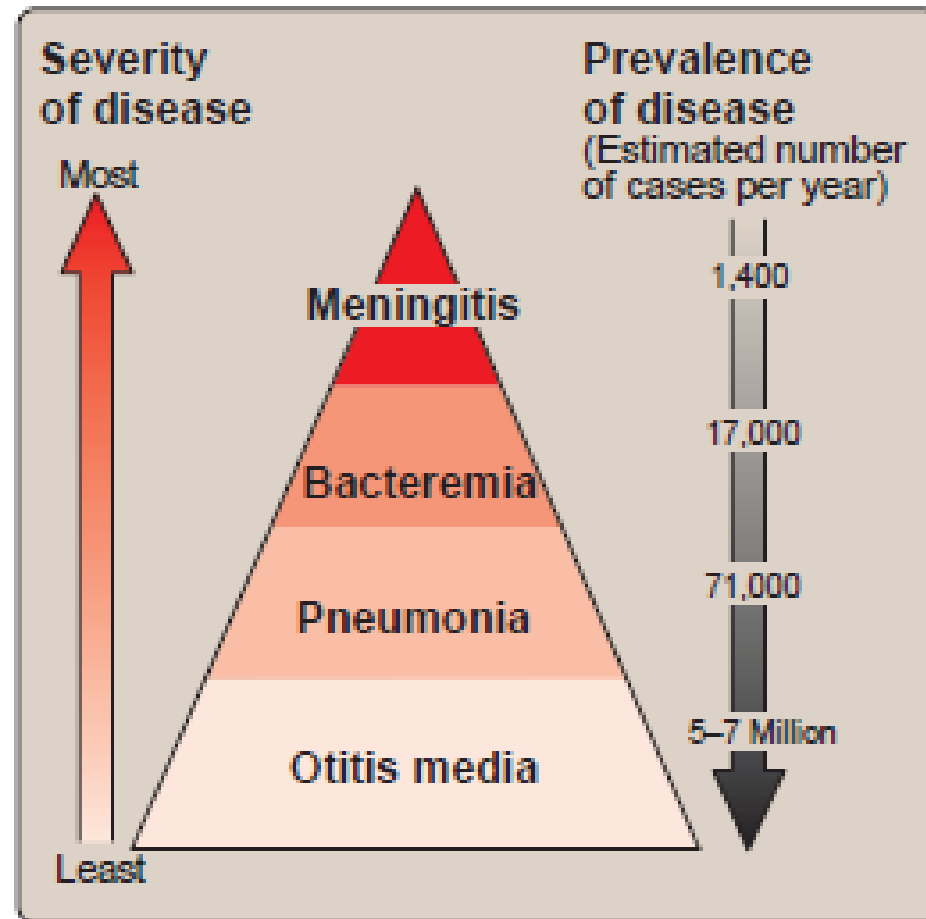
3. Choline-binding protein A: Choline binding protein A is a major adhesin allowing the pneumococcus to attach to carbohydrates on epithelial cells of the human nasopharynx.

4. Autolysins: Autolysins are enzymes that hydrolyze the components of a biological cell in which it is produced. LytA, B and C 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, pneumolysin is 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 proinflammatory cytokines, inhibits the activity of polymorphonuclear leukocytes and activates complement.

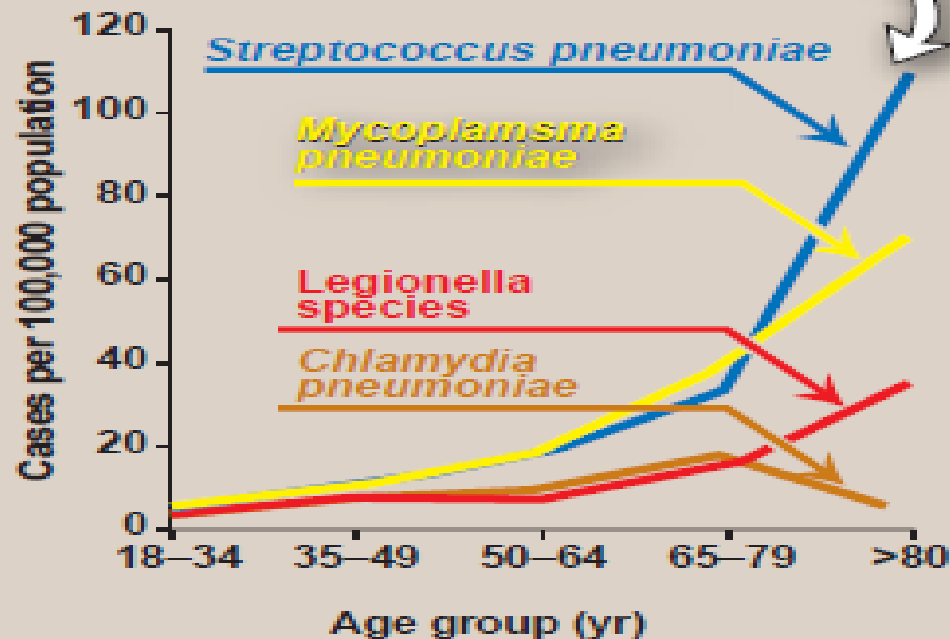
Diseases:



Figure

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

Streptococcus pneumoniae is a major cause of community-acquired pneumonia, particularly in older adults.



Figure

Age-specific rates of community-acquired pneumonia caused by specific pathogens.

1. Acute bacterial pneumonia: A leading cause of death, especially in older adults and those whose resistance is impaired, this disease is caused most frequently by *S. pneumoniae* which is frequently preceded by an upper or middle respiratory viral infection, which predisposes to *S. pneumoniae* infection of pulmonary parenchyma. Mechanisms by which virus infection predisposes an individual to streptococcal pneumonia include increased volume and viscosity of secretions that are more difficult to clear and secondary inhibition of the action of bronchial cilia by viral infection.

2. Otitis media: The most common bacterial infection of children, this disease (which is characterized by earache) is most frequently caused by pneumococcus, followed by *Haemophilus influenzae* and *Moraxella catarrhalis*. The traditional empiric treatment of pneumococcal otitis media with a β -lactam antibiotic (with or without a penicillinase-inhibitor) has been threatened by the spread of penicillin-resistant pneumococci.

3. Bacteremia/sepsis: In the absence of a focus of infection
bacteremia/ sepsis is commonly caused by pneumococcus, especially in individuals who are functionally or anatomically asplenic. This includes people with sickle cell disease who infarct their spleen and are functionally asplenic, although they still have a remnant of anatomical spleen.

4. Meningitis: H. influenzae was formerly the leading cause of bacterial meningitis in the United States. After a vaccine was developed against this organism, *S. pneumoniae* became the most common cause of adult bacterial meningitis. This disease has a high mortality rate, even when treated appropriately.

Laboratory identification

Specimens : naso -pharyngeal swab, blood, pus, sputum, or spinal fluid.

α -Hemolytic colonies appear when *S. pneumoniae* is grown on blood agar overnight under aerobic conditions at 37°C.

Lancet-shaped, gram positive diplococci are observed on a Gram stain of the sample.

Growth of these bacteria is inhibited by low concentrations of the surfactant optochin, and the cells are lysed by bile acids.

Capsular swelling is observed when the pneumococci are treated with type-specific antisera (the Quellung reaction).

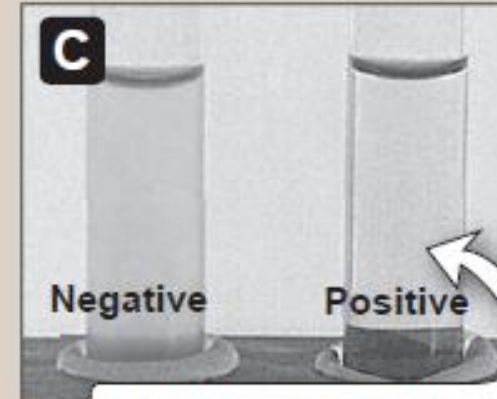
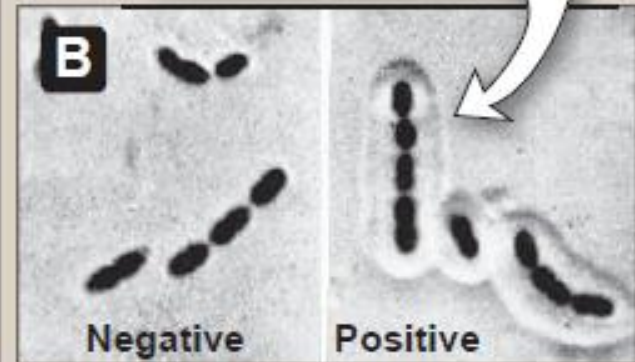
Inhibition by optochin

Growth of colonies of *Streptococcus pneumoniae* is inhibited by optochin contained in the disk applied to the blood agar plate.



Quellung reaction

Capsules of *Streptococcus pneumoniae* swell in the presence of specific pneumococcal antiserum.



Lysis by bile acids

Bile acids, such as sodium deoxycholate, dissolve *Streptococcus pneumoniae* and clear the turbidity of a heavy inoculum of organisms.

Prevention

There are two types of pneumococcal vaccine:

1. Pneumococcal polysaccharide vaccine (PPV): Introduced in the **United States** in 1983, PPV immunizes against 23 serotypes of *S. pneumoniae* and is indicated for the protection of high-risk individuals older than age 2 years.

2. Pneumococcal conjugate vaccine 13: The polyvalent PCV 13, licensed in the United States in 2010, 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.

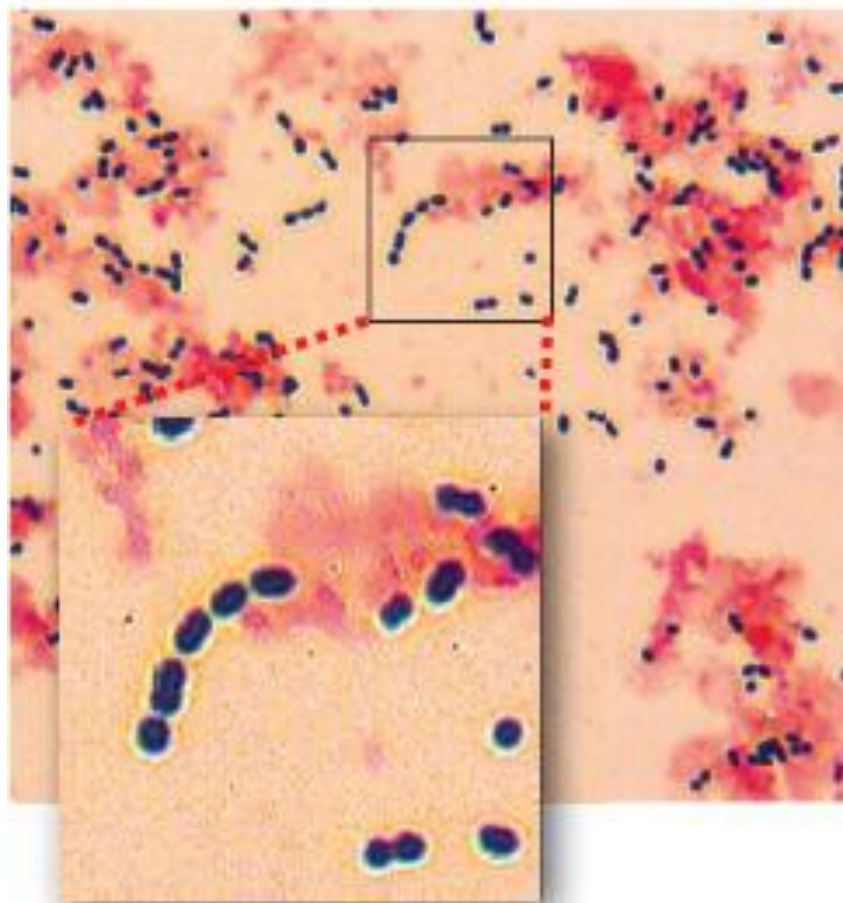
ENTEROCOCCI

Enterococci contain a C-substance that reacts with group D anti sera. Therefore, in the past, they were considered group D streptococci.

Today, DNA analysis and other properties have placed them in their own genus, *Enterococcus*.

The clinically most important species are *E. faecalis* and *E. faecium*. Enterococci can be α -, β -, or nonhemolytic.

As a rule, 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 faecalis showing chain formation characteristic of *Streptococcus*.

Epidemiology

Enterococci are part of the normal fecal flora. However, they can also colonize oral mucous membranes and skin, especially in hospital settings. These organisms are highly resistant to environmental and chemical agents.

B. Diseases

Enterococci seldom cause disease in normal, healthy individuals. However, under conditions in which host resistance is lowered or the integrity of the gastrointestinal or genitourinary tract has been disrupted (for example, by instrumentation), enterococci can spread to normally sterile sites, causing urinary tract infections, bacteremia/sepsis, endocarditis, biliary tract infection, or intra-abdominal abscesses.

C. Laboratory identification

Enterococci are 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 percent NaCl**, and yield a positive pyrazin amidase (**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.

VIRIDANS STREPTOCOCCI

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