THE GENUS STREPTOCOCCUS
The genus *Streptococcus* obtains Gram-positive cocci, nonmotile, nonsporeforming, arranged mostly in chains or in pairs. Most species are facultative anaerobes. Some of streptococci are encapsulated.

- The single scheme for differentiation of streptococci is used in practise:
  - streptococci with complete (β) hemolysis
  - streptococci with incomplete (α) hemolysis (s.c. viridans streptococci)
  - streptococci without hemolysis
Streptococci

- facultative anaerobe
- Gram-positive
- chains or pairs
- catalase negative
• Streptococci are widely distributed in nature.

• Some are members of the normal human microflora, other are associated with important human diseases attributable in part to infection by streptococci, in part to sensitization to them.

• Streptococci produce a variety of extracellular substances and enzymes.
The differentiation of streptococci according to serological properties (Lancefield groups A to V).

- Streptococci, classified into different groups, possess group-specific antigens which are either cell wall carbohydrates (s.c. C polysaccharides) or teichoic acid.

Other possibilities of differentiation of streptococci – according to biochemical properties or clinical presentations.
Chemical structure and antigens

- Cell wall polysaccharide C
- Peptidoglycan
- Lipoteichoic acid
- M-protein
- T substance and R protein
- Capsule
- F protein
This substance is major virulence factor of *S. pyogenes*.

When M protein is present, the streptococci are virulent, and in the absence of M type–specific antibodies, they are able to resist phagocytosis by polymorphonuclear leukocytes.

M protein also promotes adherence to host epithelial cells.

*S. pyogenes* strains that lack M protein are not virulent.
T substance

- This antigen has no relationship to virulence of streptococci.

- Unlike M protein, T substance is acid-labile and heat-labile.

- It is obtained from streptococci by proteolytic digestion.

- T substance permits differentiation of certain types of streptococci by agglutination with specific antisera.

- Another surface antigen has been called R protein.
Extracellular products

- Erythrogenic toxin (pyrogenic toxin)
- Streptolysin O
- Streptolysin S
- Hyaluronidase (spreading factor)
- Streptokinase
- Streptodornase
  (streptococcal deoxyribonuclease)
- other
Erythrogenic toxin (pyrogenic toxin)

- This toxin is soluble and it is destroyed by boiling for 1 hour.
- It causes the rash that occurs in scarlet fever. Only *S. pyogenes* strains elaborating this toxin can cause scarlet fever.
- A non-toxigenic strain, after lysogenic conversion will produce erythrogenic toxin.
- Erythrogenic toxin is antigenic.
- Superantigen.
Streptolysin O

- Streptolysin O is a protein that is hemolytically active in the reduced state, but rapidly inactivated in the presence of oxygen.

- ASLO – appear in human following infection with any streptococci that produce streptolysin O.
Streptolysin S

- Streptolysin S is the agent responsible for the hemolytic zones around streptococcal colonies growing on the surface of blood agar.

- It is not antigenic.
Hyaluronidase

- Hyaluronidase splits hyaluronic acid, an important component of the ground substance of connective tissues.

- Thus, hyaluronidase aids in spreading of infecting microorganisms (spreading factor).

- Hyaluronidases are antigenic and specific for each bacterial or tissue source.
Streptodornase
(streptococcal deoxyribonuclease)

- Streptococcal deoxyribonuclease depolymerizes DNA.

- The enzymatic activity can be measured by the decrease in viscosity of known DNA solutions.
Streptokinase (fibrinolysin)

- Streptokinase is produced by many strains of group A beta-hemolytic streptococci.
- It transforms the plasminogen of human plasma into plasmin, an active proteolytic enzyme that digests fibrin and other proteins.
- Streptokinase has been given intravenously for treatment of pulmonary and of coronary artery and venous thromboses.
Classification of streptococci of particular medical interest

- *Streptococcus pyogenes*
- *Streptococcus agalactiae*
- Beta-hemolytic streptococci C, F, G
- *Streptococcus pneumoniae*
- *Streptococcus anginosus*
- Viridans streptococci
- *Peptostreptococcus* species
The species *Streptococcus pyogenes*

- Gram-positive spherical cocci, 1.0 micrometer in diameter arranged in chains (especially in liquid media and pathological specimens).

- *S. pyogenes* likely as other streptococci does not produce catalase (in contrast to staphylococci).

- This species does not split ribose (in contrast to other streptococci).

- It grows in white regular colonies about 1 mm in diameter, with a large zone of β-hemolysis on blood agar after 24 hours of incubation.
The species *Streptococcus pyogenes*

- The metabolism of *S. pyogenes* is fermentative; the organism is a catalase-negative aerotolerant anaerobe (facultative anaerobe), and requires enriched medium containing blood in order to grow.

- Group A streptococci typically have a capsule composed of hyaluronic acid and exhibit beta (clear) hemolysis on blood agar.
Group A streptococci are parasites of humans, and *Streptococcus pyogenes* is one of the most frequent pathogens of humans.

It is estimated that between 5-15% of normal individuals harbor *Streptococcus pyogenes*, usually in the respiratory tract, without signs of disease.

When the host defenses are compromised, or when the microorganism is able to exert its virulence, or when it is introduced to vulnerable tissues or hosts, an acute infection occurs.
**Streptococcus pyogenes** owes its major success as a pathogen to its ability to colonize and rapidly multiply and spread in its host while evading phagocytosis and confusing the immune system.

**Acute diseases** associated with *Streptococcus pyogenes* occur chiefly in the respiratory tract, bloodstream, or the skin. Streptococcal disease is most often a respiratory infection (pharyngitis or tonsillitis) or a skin infection (pyoderma). *S. pyogenes* is the leading cause of uncomplicated bacterial pharyngitis and tonsillitis.
- *S. pyogenes* infections can also result in sinusitis, otitis, mastoiditis, pneumonia, joint or bone infections, necrotizing fasciitis and myositis, meningitis or endocarditis.

- *S. pyogenes* also infects the skin. Infections of the skin can be superficial (impetigo) or deep (cellulitis).

- Scarlet fever and streptococcal toxic shock syndrome are systemic responses to circulating bacterial toxins.

- Two post streptococcal sequelae (rheumatic fever following respiratory infection and glomerulonephritis following respiratory or skin infection), occur in 1-3% of untreated infections.
The most frequent etiologic agents of bacterial tonsillitis and tonsillopharyngitis are *Streptococcus pyogenes* strains (80-90%).
Initial antibiotic therapy of bacterial tonsillitis and tonsillopharyngitis

- Antibiotics of I. choice
  - penicillin (3-4 x daily)
  - macrolides (in patients with allergy to penicillins)
Etiology and treatment of peritonsillar and tonsillar abscess

**Etiology:**
- *Streptococcus pyogenes*
- Anaerobic microbes
  - (Peptostreptococcus sp.)

**ATB of 1. choice:**
- Penicillin

**Alternative ATB:**
- Clindamycin
Diagnostic methods

- microscopy
- cultivation
- biochemical tests
- serological examination
- others
**Streptococcus pneumoniae**

- Pneumococci are alfa-hemolytic.
- Their growth is inhibited by optochin.
- The pneumococci are Gram-positive diplococci, often lancet-shaped or arranged in chains, possessing a capsule of polysaccharide that permits typing with specific antisera.
Streptococcus pneumoniae is very important etiologic agent of pneumonia

- Pneumonia
  - typical pathogens
  - atypical pathogens

- Pneumonia
  - community-acquired
  - hospital-acquired (nosocomial)
Etiology of pneumonia
CAP

typical pathogens

- *Streptococcus pneumoniae*
- *Haemophilus influenzae*
- *Moraxella (Branhamella) catarrhalis*
- *Staphylococcus aureus*
- *Klebsiella pneumoniae*
- other
Etiology of pneumonia CAP

atypical pathogens

- *Chlamydophila pneumoniae*
- *Chlamydophila psittaci*
- *Mycoplasma pneumoniae*
- *Legionella pneumophila*
- others
Etiology of pneumonia in Olomouc region (CAP)

- Unknown etiology: 42%
- Typical bacteria: 34%
- Chlamydia: 12%
- Mycoplasma: 6%
- Mixed infections: 6%
Initial antibiotic therapy of community-acquired pneumonia

- Drug of I. choice
  - amoxicillin

- Alternative antibiotics
  - macrolides (e.g. clarithromycin, azithromycin)
  - doxycycline (in adults and children older than 12 years)
Etiology and treatment of otitis media acuta

- **Etiology:**
  - *Streptococcus pneumoniae*
  - *Haemophilus influenzae*
  - *Moraxella (B) catarrhalis*

- **Antibiotic of I. choice:**
  - amoxicillin

- **Alternative antibiotic:**
  - amoxicillin/clavulanic acid
  - ampicillin/sulbactam
  - cephalosporins II. gen. (cefuroxime, cefprozil)
  - in patients with allergy to penicilllins - macrolides
Bacterial etiology of acute otitis media in Olomouc region

- **Streptococcus pneumoniae** - 49%
- **Moraxella (B) catarrhalis** - 14%
- **Haemophilus influenzae** - 21%
- Others - 16%
Etiology and treatment of sinusitis acuta

- **Etiology:**
  - *Streptococcus pneumoniae*
  - *Haemophilus influenzae*
  - *Moraxella (B) catarrhalis*

- **Antibiotic of I. choice:**
  - amoxicillin

- **Alternative antibiotic:**
  - amoxicillin/clavulanic acid
  - ampicillin/sulbactam
  - cephalosporins II. gen.
    - (cefuroxime, cefprozil)
  - in patients with allergy to penicillllins - macrolides
Bacterial etiology of acute sinusitis in Olomouc region

- **Streptococcus pneumoniae** - 61%
- **Moraxella (B) catarrhalis** - 5%
- **Haemophilus influenzae** - 22%
- **Others** - 12%
- **Streptococcus pneumoniae** - 61%
**Streptococcus agalactiae**

- These are the group B streptococci.

- They are members of the normal flora of the female genital tract and an important cause of neonatal sepsis and meningitis.

- They typically are beta-hemolytic.

- They have positive CAMP test.
Basing on results obtained in Neonatal department of Teaching Hospital in Olomouc, the most frequent bacterial pathogens of neonatal sepsis are *Escherichia coli*, *Klebsiella pneumoniae*, *Streptococcus agalactiae*, *Enterococcus* spp. and *Staphylococcus aureus*.

Based on their resistance to antibiotics it can be concluded that ampicillin in combination with gentamicin/netilmicin is first choice regimen.

In case of persisting signs of infection, it is necessary to consider the etiological role of chlamydia, mycoplasma and ureoplasma and the therapy is to be changed by adding of macrolide.

After the identification of bacterial pathogens and the resistance to antibiotics the therapy should be focused on the aimed (causal) one.
## Etiology of neonatal infections in Teaching Hospital in Olomouc

<table>
<thead>
<tr>
<th>Gram-negative bacteria</th>
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</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em></td>
<td>19 %</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td>16 %</td>
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<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>7 %</td>
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<tr>
<td><em>Enterobacter cloacae</em></td>
<td>6 %</td>
</tr>
<tr>
<td><em>Acinetobacter baumannii</em></td>
<td>5 %</td>
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</tbody>
</table>

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</tr>
</thead>
<tbody>
<tr>
<td><em>Streptococcus agalactiae</em></td>
<td>15 %</td>
</tr>
<tr>
<td><em>Enterococcus sp.</em></td>
<td>13 % (84 % is <em>E. faecalis</em>)</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>9 %</td>
</tr>
<tr>
<td><em>Staphylococcus sp.</em> (coagulase-negative)</td>
<td>6 %</td>
</tr>
<tr>
<td><em>Candida sp.</em> (87 % is <em>C. albicans</em>)</td>
<td>4 %</td>
</tr>
</tbody>
</table>
Etiology of community-acquired urinary tract infections

- *Escherichia coli*
- *Proteus mirabilis*
- *Enterococcus faecalis*
- *Streptococcus agalactiae*
- others
Bacterial etiology of community-acquired urinary tract infections in Olomouc region

- **E. coli**: 68%
- **P. mirabilis**: 11%
- **S. agalactiae**: 8%
- **E. faecalis**: 9%
- **Others**: 4%
Initial antibiotic therapy of community-acquired urinary tract infections

**Drug of I. choice**
- nitrofurantoin, cotrimoxazol, trimethoprim

**Alternative antibiotics**
- amoxicillin/clavulanic acid
- ampicillin/sulbactam
- cephalosporins II. gen. (cefuroxime, cefprozil)
Streptococcus milleri group

- *S. anginosus*
- *S. intermedius*
- *S. constellatus*

These streptococci are part of the normal flora (oral cavity and gastrointestinal tract) with the ability to cause abscesses and systemic infections.

They may be beta, alpha or non-hemolytic.
Viridans streptococci

- Viridans streptococci include *S. mitis*, *S. mutans*, *S. salivarius*, *S. sanquis* and other.

- Typically they are alpha-hemolytic, but they may be non-hemolytic.

- The viridans streptococci are the most prevalent members of normal microflora of the upper respiratory tract and are important for healthy state of mucous membranes there.

- They may reach the bloodstream as a result of trauma and are a principal cause of endocarditis on abnormal heart valves.
**Peptostreptococcus species**

- These streptococci grow only under anaerobic conditions and variably produce hemolysins.

- They are part of the normal microflora of the mouth, upper respiratory tract, bowel, and female genital tract.

- They often participate with many other bacterial species in mixed anaerobic infections in the abdomen, pelvis, lung, or brain.