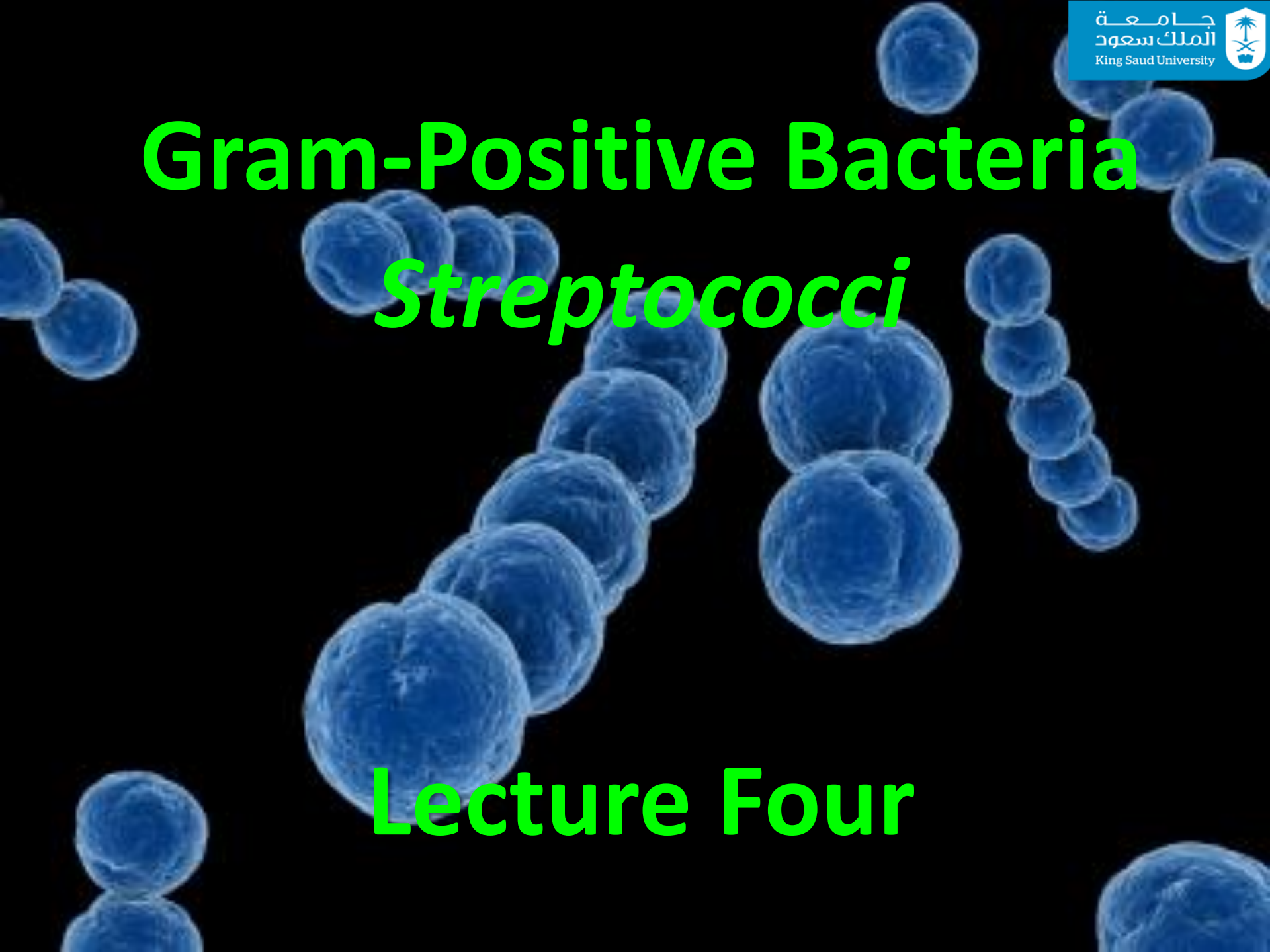
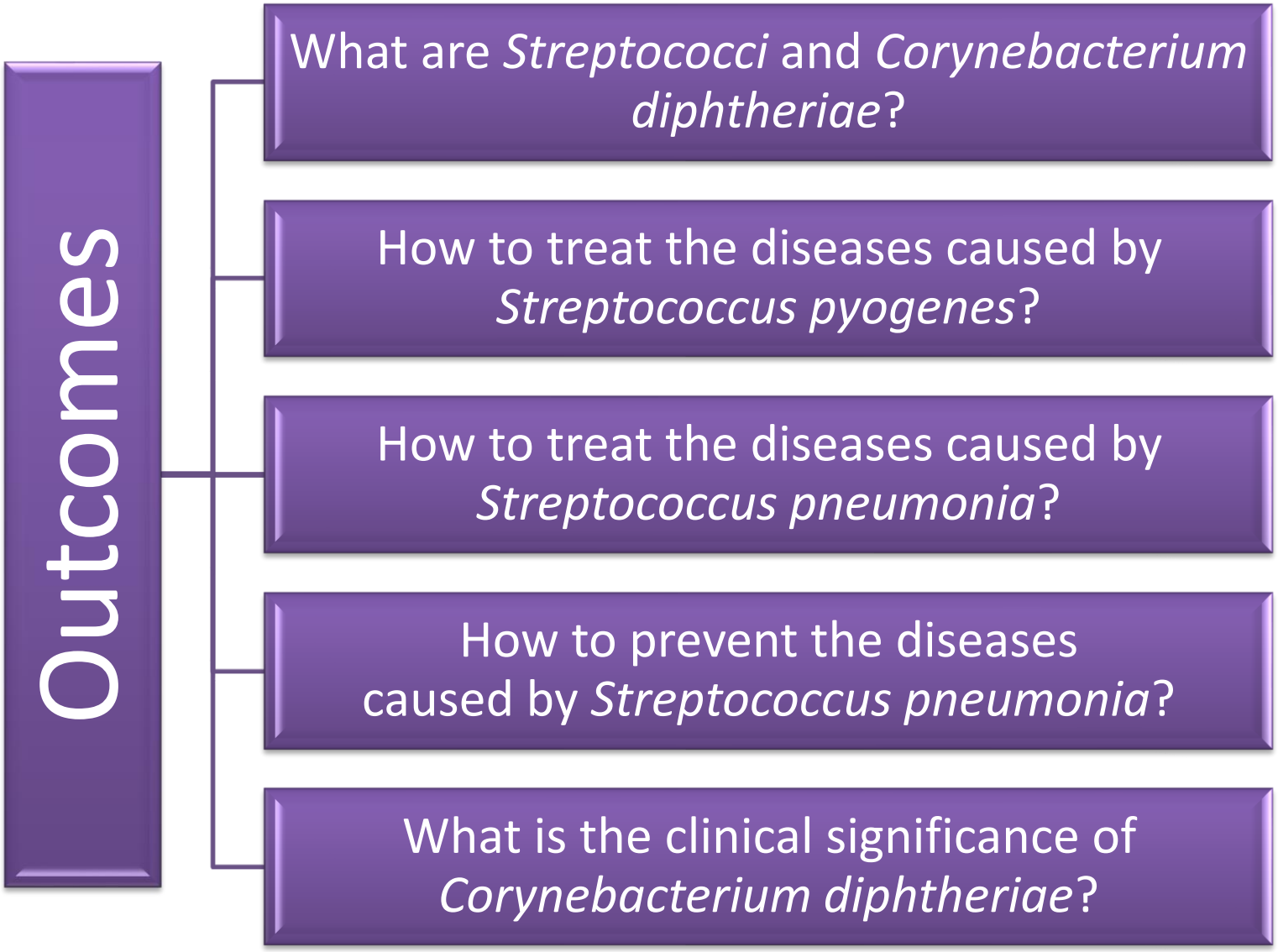
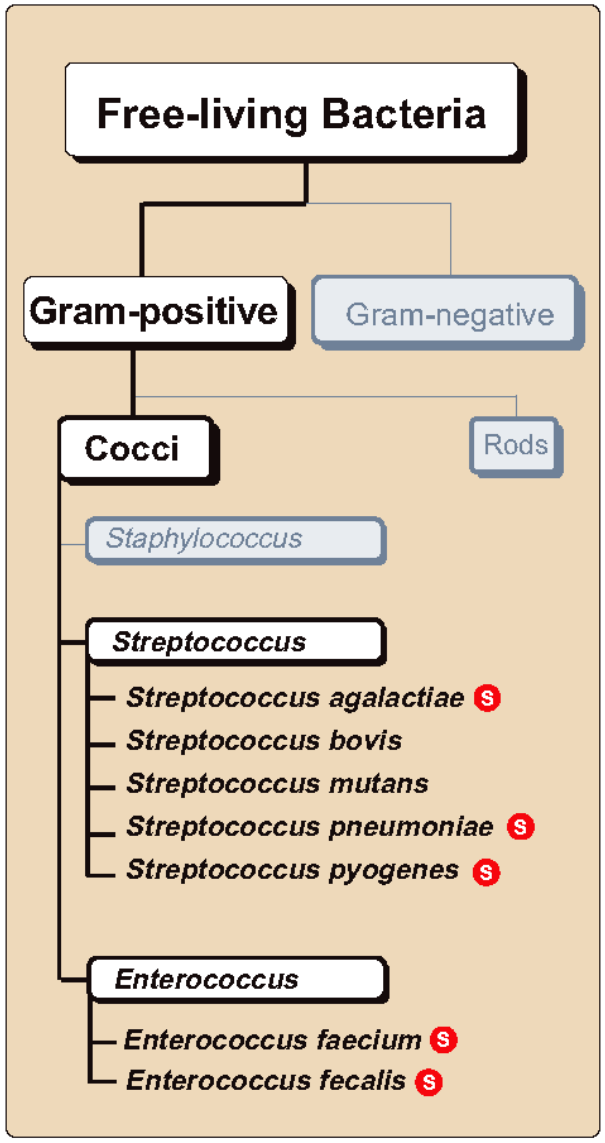

جامعة
الملك سعود
King Saud University
Gram-Positive Bacteria
Streptococci
Lecture Four

Learning Outcomes

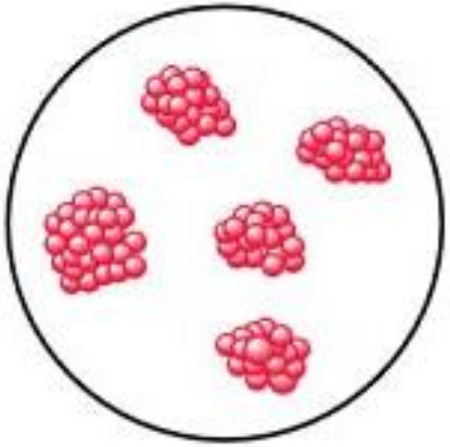


Streptococci

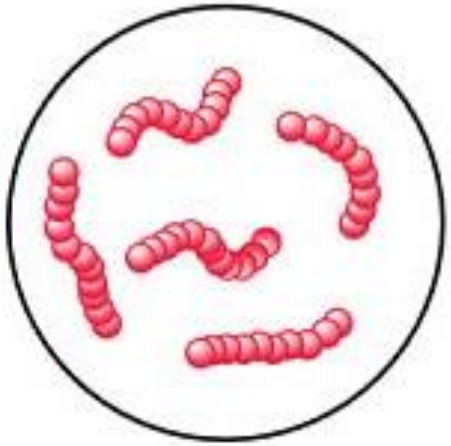
- *Streptococci* are Gram positive, non-motile and catalase negative bacteria.
- Clinically important genera include *Streptococcus* and *Enterococcus*.
- *Streptococci* can be classified by several ways (*e.g.* hemolytic properties of organism).



Streptococci

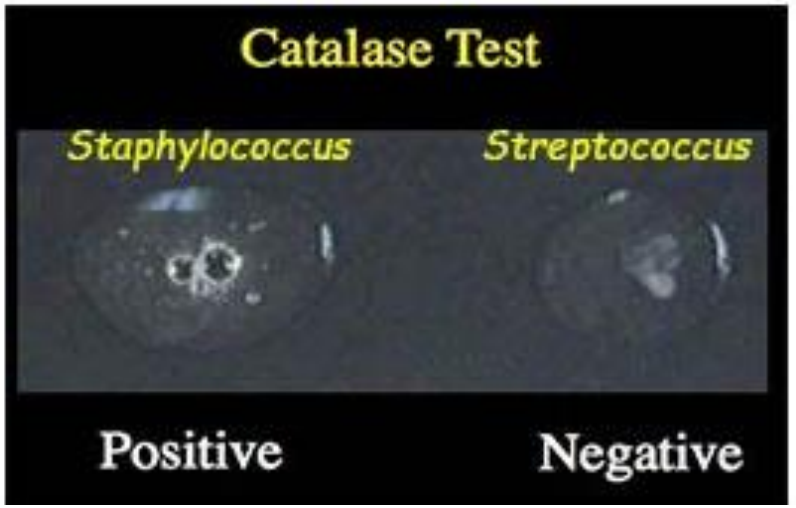


Staphylococcus



Streptococcus

Staphylococcus Vs Streptococcus



Streptococci

Rebecca Lancefield (1895–1981)

Streptococcus

α-hemolytic
green,
partial hemolysis

- **pneumoniae**
  optochin sensitive,
  bile soluble,
  capsule => quellung +
- **Viridans**
  mutans, sanguis
  optochin resistant,
  not bile soluble,
  no capsule

β-hemolytic
clear,
complete hemolysis

- **pyogenes**
  Group A,
  bacitracin sensitive
- **agalactiae**
  Group B,
  bacitracin resistant

γ-hemolytic
no hemolysis

- **Enterococcus**
  E. faecalis,
  E. faecium

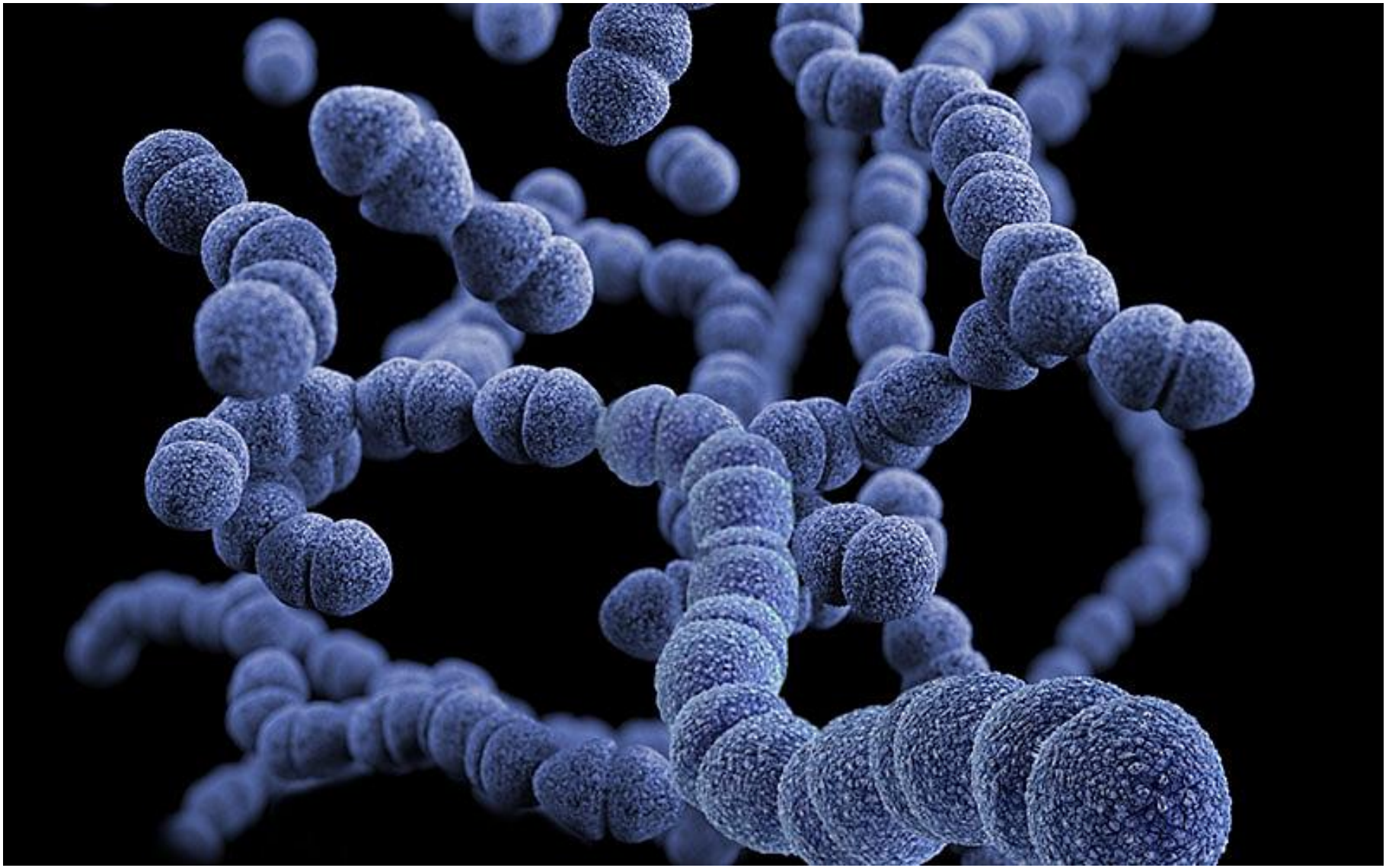
Streptococci

- Hemolytic Properties on Blood Agar
- α-Hemolytic *Streptococci* cause a chemical change in hemoglobin of red cells in blood agar.
- A green pigment that forms a ring around the colony appeared.
- β-Hemolytic *Streptococci* cause complete lysis (yellow) of red cells in the media around and under the colonies.
- γ-Hemolytic *Streptococci* cause no color change or lysis of red blood cells.

Streptococcus pneumoniae

- *Streptococcus pneumoniae* (α-Hemolytic) are Gram-positive, non-motile, encapsulated cocci.
- *Streptococcus pneumoniae* is the most common cause of community-acquired pneumonia and adult bacterial meningitis.
- The risk of disease is highest among young children, older adults, smokers, and persons with certain chronic illnesses.
- They are usually found in pairs (diplococci) and do not form spores.

Streptococcus pneumoniae



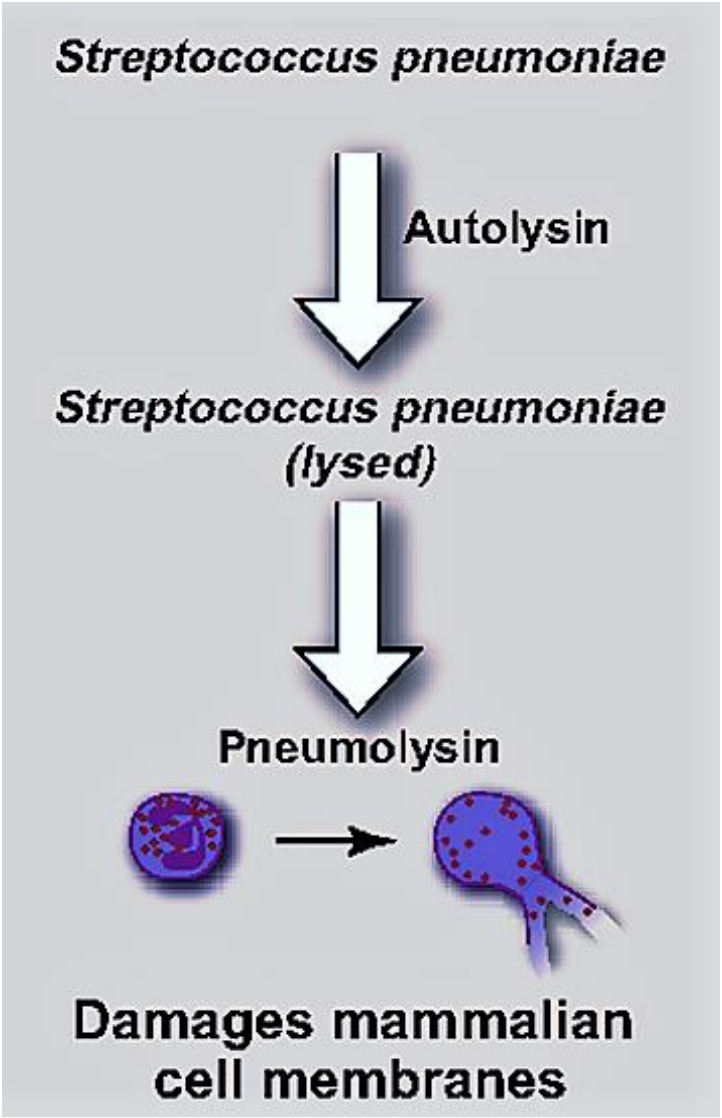
Streptococcus pneumoniae

- Epidemiology of *Streptococcus pneumoniae*
- It is extremely sensitive to environmental agents.
- Pneumococcal infections can be either endogenous or exogenous.
- Endogenous infection involves the spread of *Streptococcus pneumoniae* residing in the nasopharynx of a carrier who develops impaired resistance to the organism.
- Infection can also be exogenous by droplets from the nose of a carrier.

Streptococcus pneumoniae

- Pathogenesis of *Streptococcus pneumoniae*
- The bacterial capsule of *Streptococcus pneumoniae* is the most important virulence factor.
- The cell-associated enzymes pneumolysin and autolysin contribute to *Streptococcus pneumoniae* pathogenicity.
- Pili enables the attachment of the encapsulated pneumococci of the epithelial cells of the upper respiratory tract.

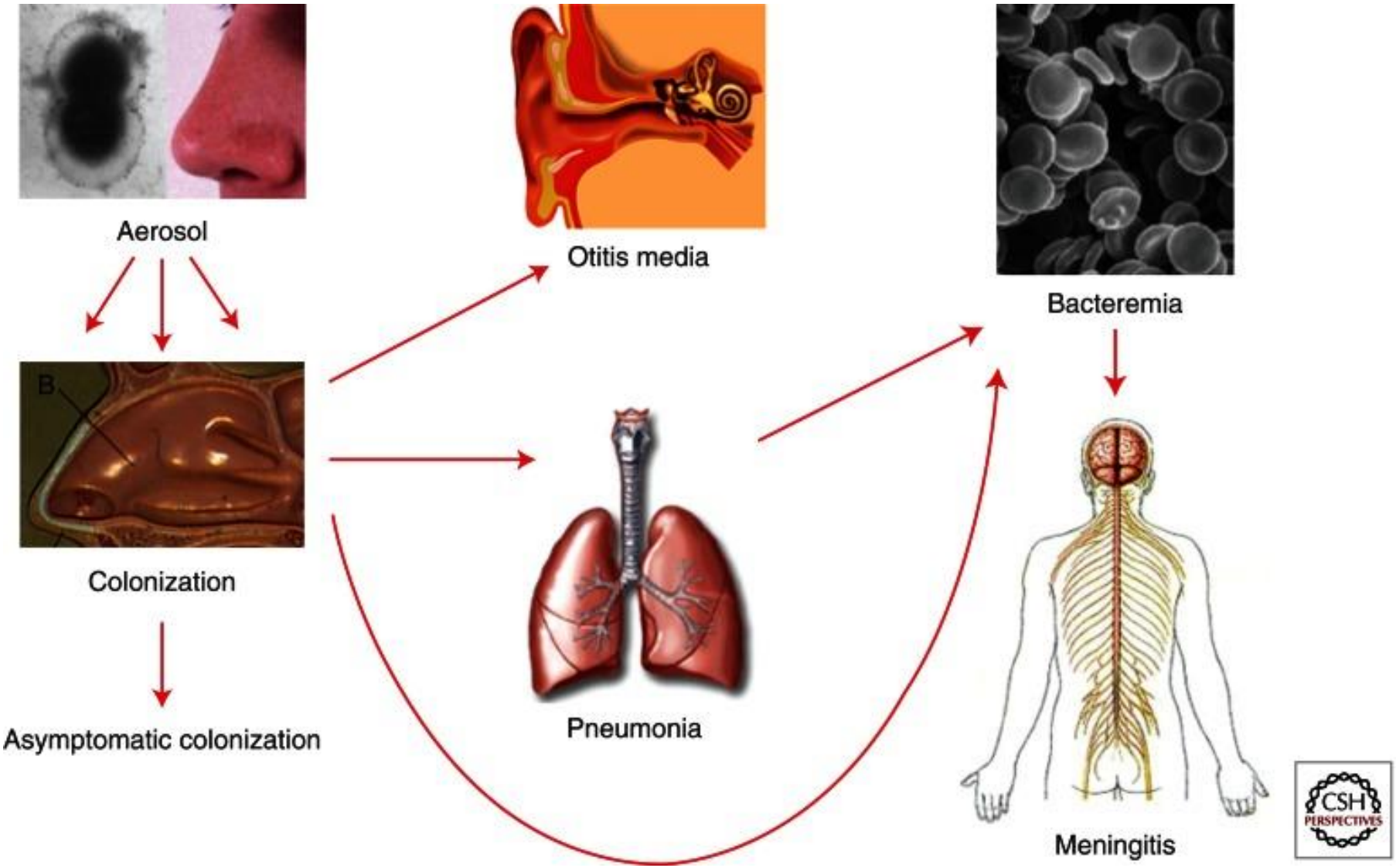
Streptococcus pneumoniae



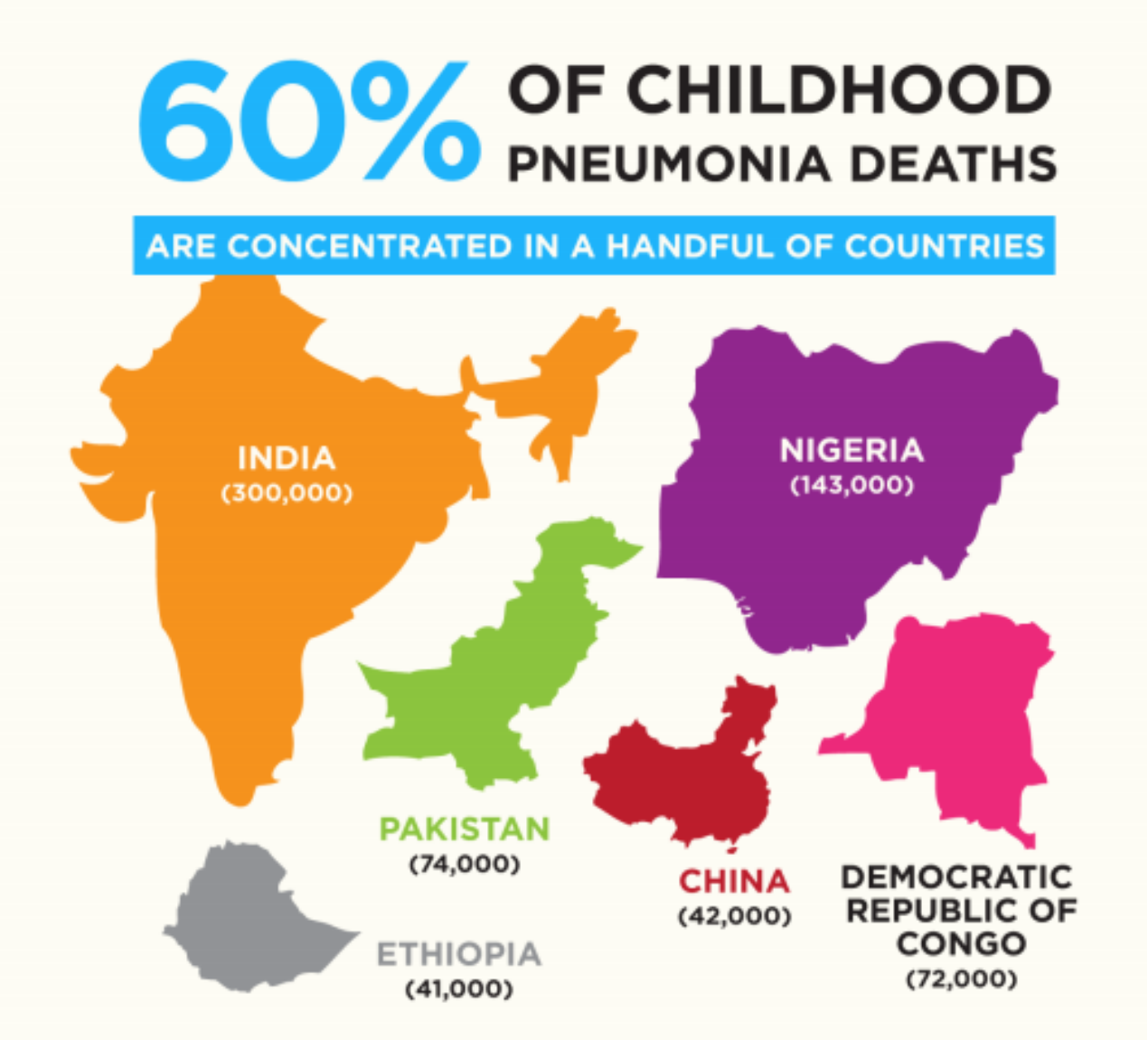
Streptococcus pneumoniae

- Clinical Significance of *Streptococcus pneumoniae*
- Acute bacterial pneumonia: A leading cause of death, especially in older adults.
- Otitis media: The most common bacterial infection of children.
- Bacteremia/sepsis: Commonly caused by pneumococcus, especially in individuals who are functionally or anatomically asplenic.
- Meningitis: *S. pneumoniae* is the most common cause of adult bacterial meningitis.

Streptococcus pneumoniae



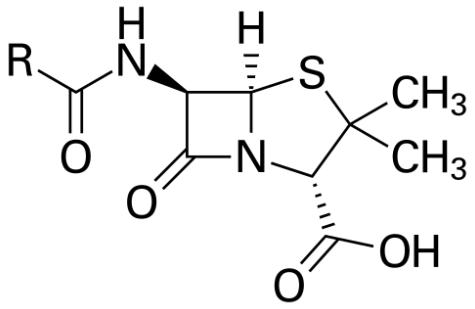
Streptococcus pneumoniae



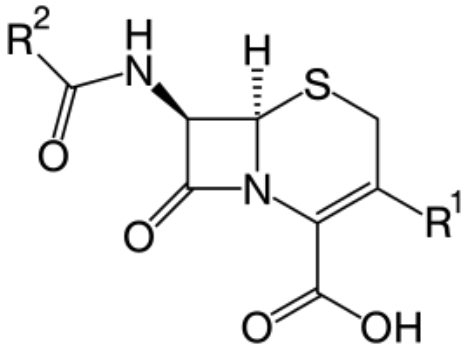
Streptococcus pneumoniae

- Treatment of *Streptococcus pneumoniae*
- *S. pneumoniae* are highly sensitive to penicillin until the late 1980s.
- The incidence of penicillin resistance has been increasing worldwide.
- The resistance is due to the bacterium's penicillin-binding proteins (PBPs) rather than the production of β-lactamase.
- Cephalosporins and vancomycin are the antibiotics to treat infections by penicillin-resistant strains of *S. pneumoniae*.

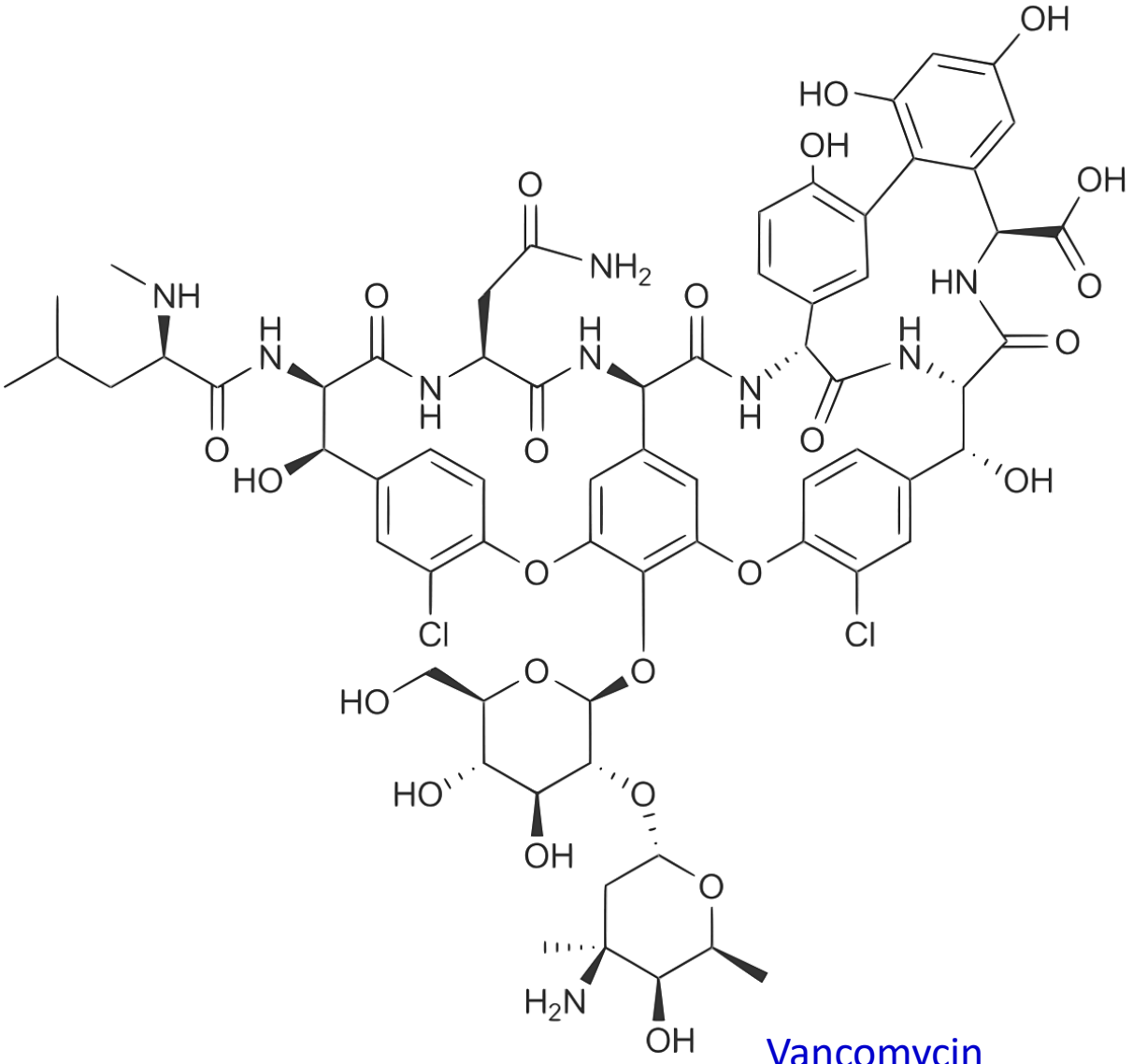
Streptococcus pneumoniae



Penicillins



Cephalosporins



Vancomycin

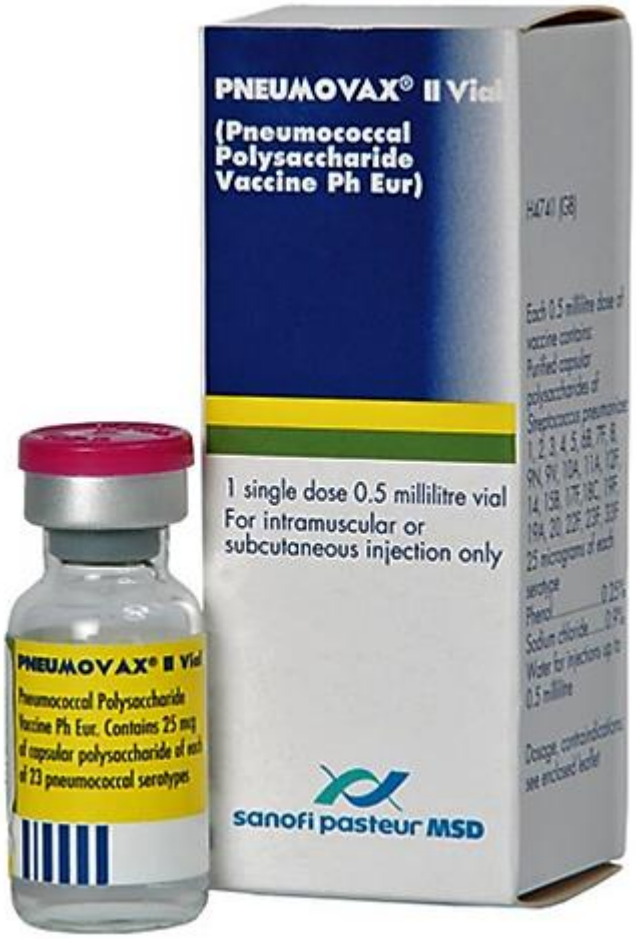
Streptococcus pneumoniae

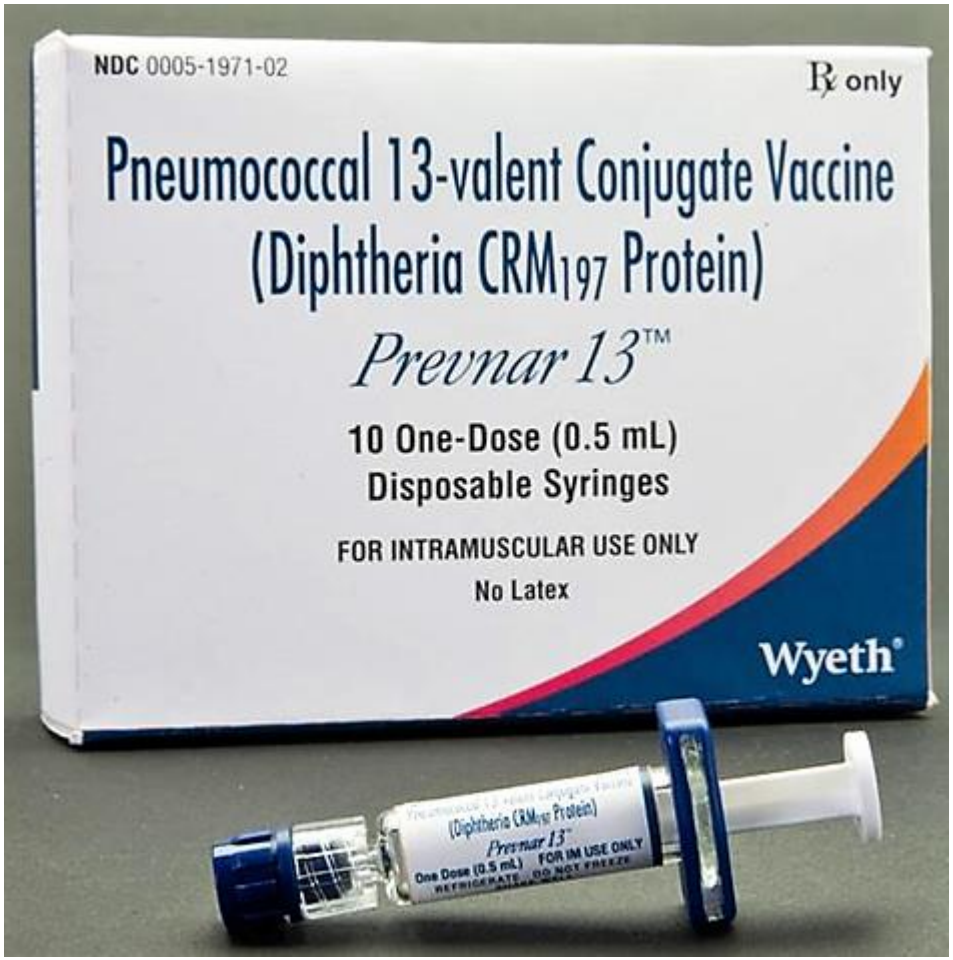
- Prevention and Vaccination
- Two types of pneumococcal vaccine are available.
- Pneumococcal Polysaccharide Vaccine (PPV)
- It has been introduced in the US in 1983.
- It immunizes against 23 serotypes of *S. pneumoniae* (> 2 years individuals).
- It protects against the pneumococcal strains responsible for 85 to 90% of infections, including penicillin-resistant strains.

Streptococcus pneumoniae

- Pneumococcal Conjugate Vaccine (PCV13)
- PCV13 was licensed in the US in 2010.
- It is effective in infants and toddlers (ages 6 weeks to 5 years).
- It is made up of 13 pneumococcal antigens.
- Significant declines in the incidence of invasive pneumococcal diseases occurred as a result of the introduction of the PCV13 in recent years.

Streptococcus pneumoniae





β-hemolytic *Streptococci*

- Based on serologic (Lancefield) groupings, many *Streptococci* have a polysaccharide in their cell walls known as C-substance.
- The Lancefield scheme classifies primarily β-hemolytic *Streptococci* into groups based on their C-substance.
- The clinically most important groups of β-hemolytic *Streptococci* are types A and B.
- Commercial kits are now widely used for the identification of β-hemolytic *Streptococci*.

Streptococcus pyogenes

- Group A of β-Hemolytic *Streptococci*
- *Streptococcus pyogenes* is the most clinically important member of Gram-positive cocci.
- It is one of the most encountered bacterial pathogens of humans worldwide.
- It can invade intact skin or mucous membranes, causing some of the most rapidly progressive infections known.
- Some *S. pyogenes* strains cause rheumatic fever and acute glomerulonephritis.

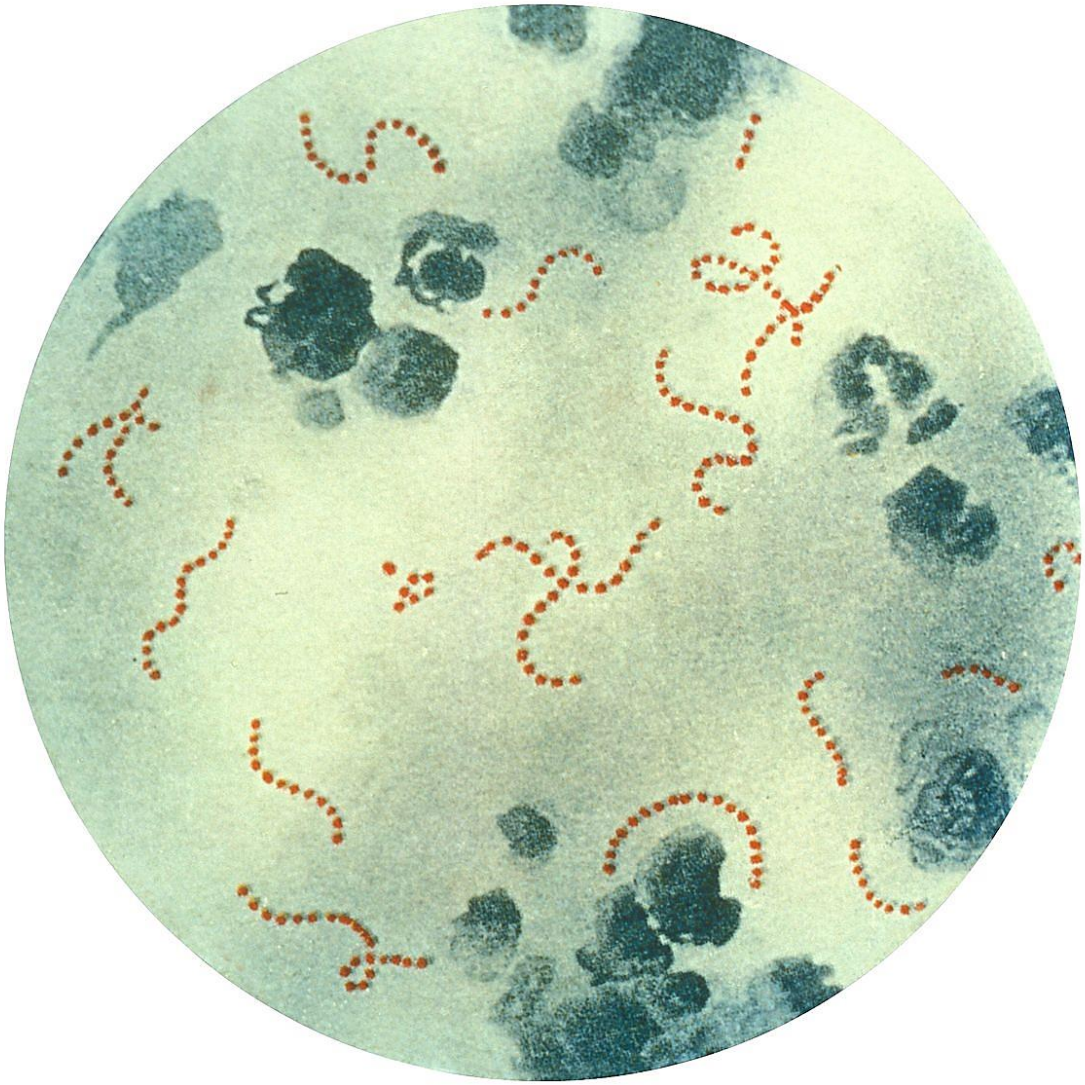
Streptococcus pyogenes

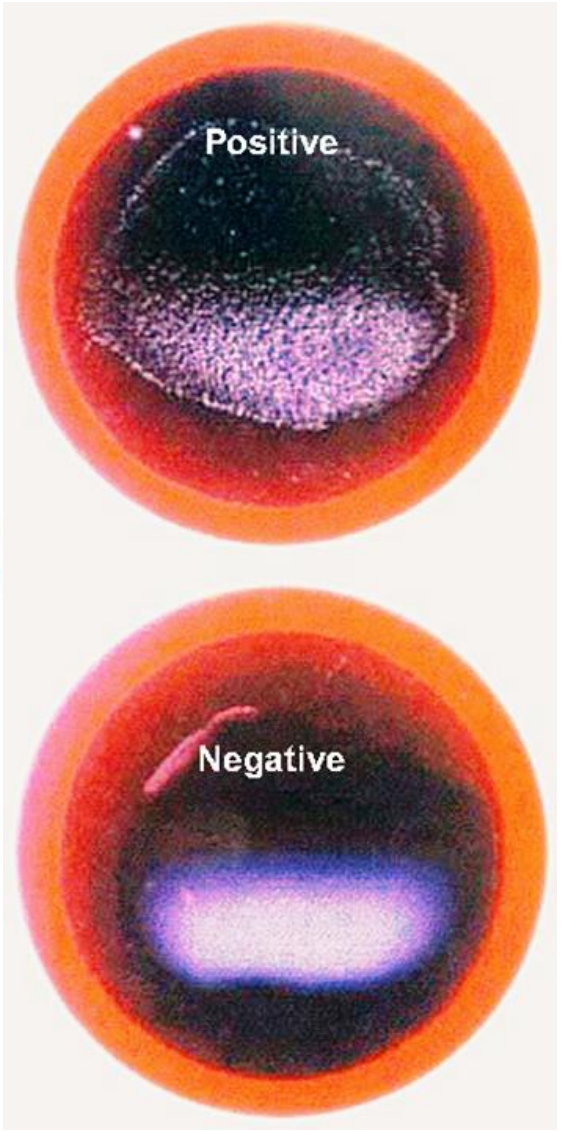
- Unlike staphylococcal species, *Streptococcus pyogenes* do not survive well in the environment.
- *Streptococcus pyogenes* is usually spread from person to person by skin contact and *via* the respiratory tract.
- *Streptococcus pyogenes* cells usually form long chains when recovered from liquid culture, but may appear as individual cocci, pairs, or clusters of cells from infected tissue.

Streptococcus pyogenes

- *S. pyogenes* secretes a range of exotoxins.
- 700 million infections occur a year.
- The overall mortality rate is 0.1% (around 700,000 cases a year).
- Rapid latex antigen kits for direct detection of group A *Streptococci* in patient samples are widely used.
- In a positive test, the latex particles clump together, whereas, in a negative test, they stay separate, giving the suspension a milky appearance.

Streptococcus pyogenes





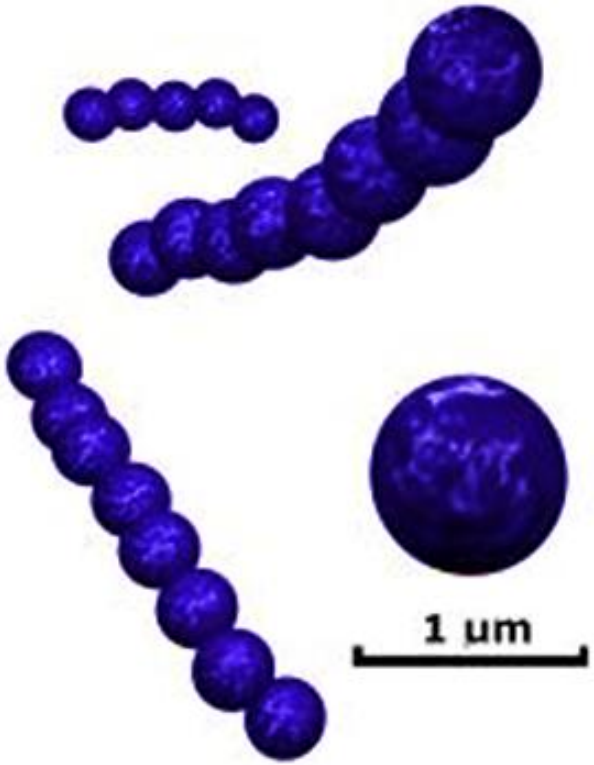
Streptococcus pyogenes

- Treatment of *Streptococcus pyogenes*
- Antibiotics are used for all group A streptococcal infections.
- *S. Pyogenes* has not acquired resistance to penicillin G, which remains the antibiotic of choice for acute streptococcal disease.
- Clindamycin is added to penicillin to inhibit protein synthesis so that toxin is not released abruptly from rapidly dying bacteria.
- Prevention: Rheumatic fever is prevented by rapid eradication of infecting organism.

Streptococcus agalactiae

- Group B of β-Hemolytic *Streptococci*
- Group B *Streptococci* have larger colonies and less hemolysis than group A.
- They are represented by the pathogen *Streptococcus agalactiae* which are Gram-positive and catalase-negative organisms.
- They are a leading cause of meningitis and septicemia in neonates.
- *S. agalactiae* can be transmitted sexually and from mother to her infant at birth.

Streptococcus agalactiae

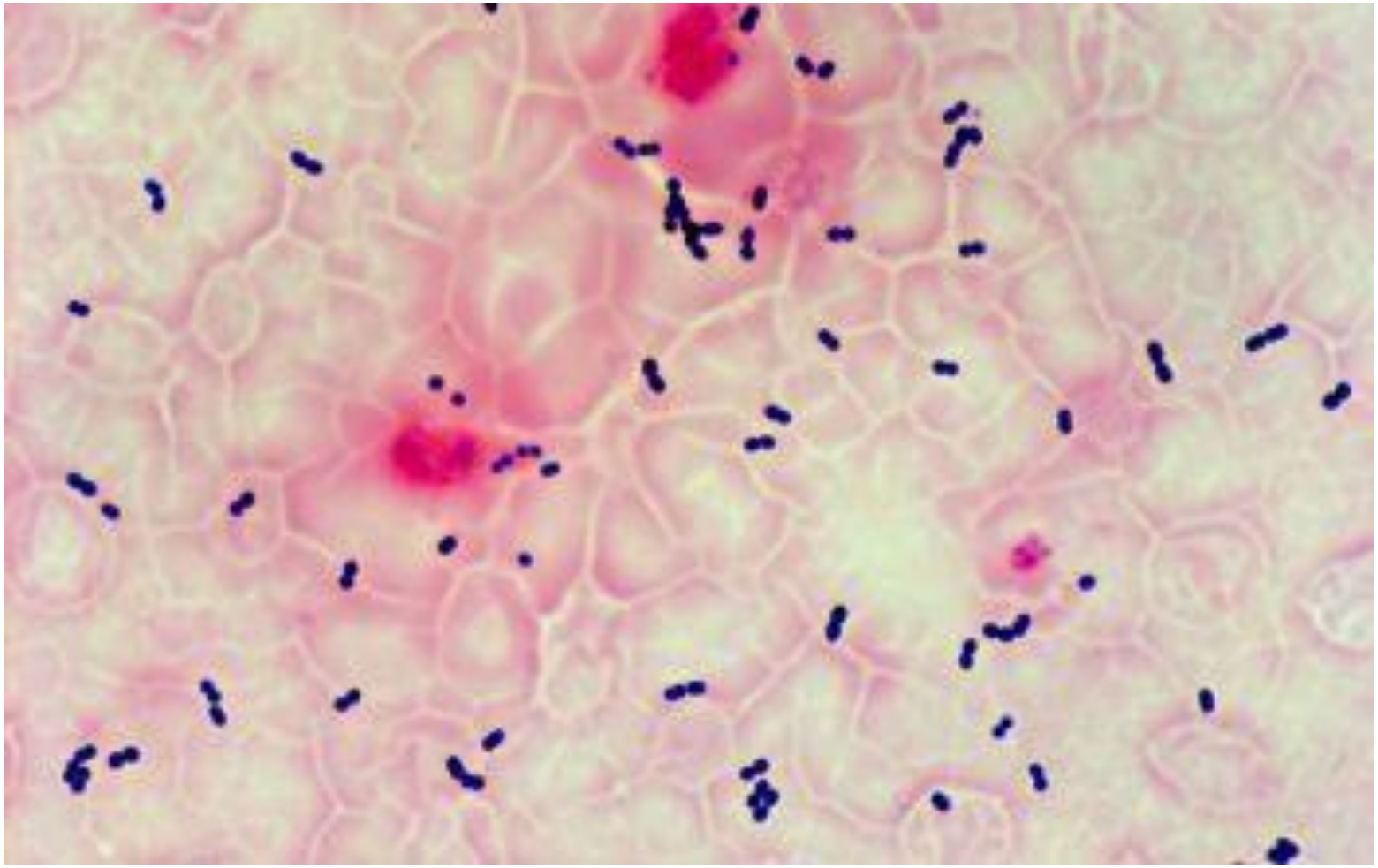


Streptococcus agalactiae

γ-Hemolytic *Streptococci*

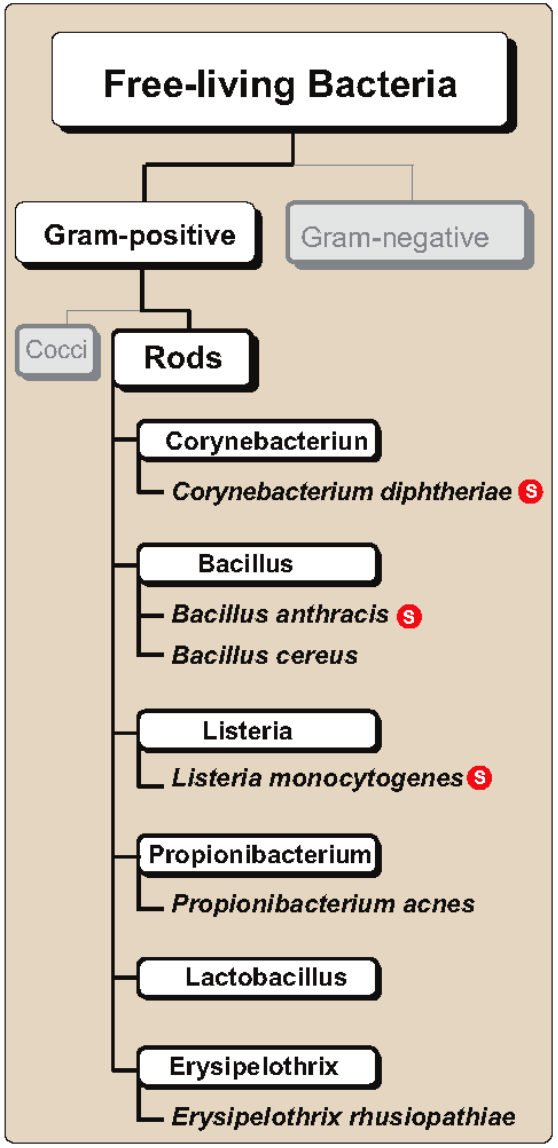
- *Enterococci* (γ-Hemolytic *Streptococci*) are Gram-positive cocci.
- Often occur in pairs (diplococci) or short chains.
- They are difficult to be distinguished from other *Streptococci* on physical characteristics.
- They are facultative anaerobic organisms.
- They are not capable of forming spores.
- They are tolerant to temperature (10–45°C), pH (4.5–10.0), and high salt concentration.

γ-Hemolytic *Streptococci*

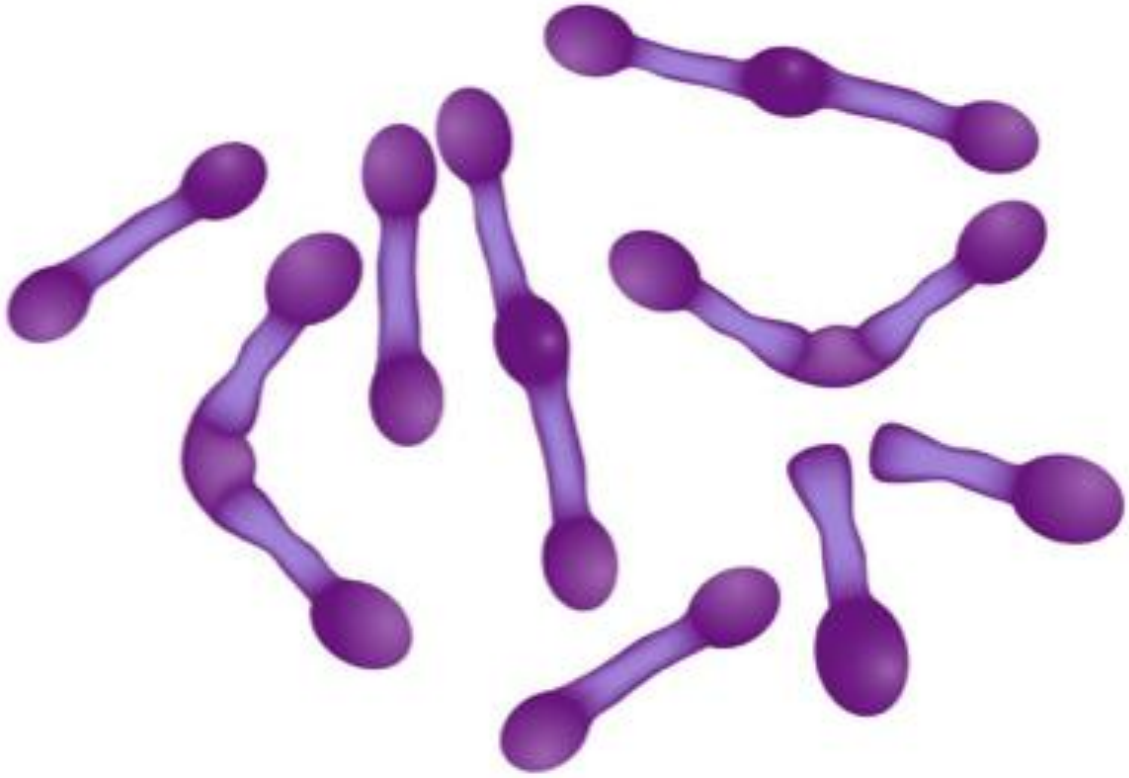


Corynebacterium diphtheriae

- *Corynebacterium diphtheriae*, Gram + rods, causes diphtheria.
- It is an acute respiratory or cutaneous disease and may be life-threatening.
- Diphtheria is a serious disease.
- The development of effective vaccines beginning in early childhood has made the disease rare in developed countries.



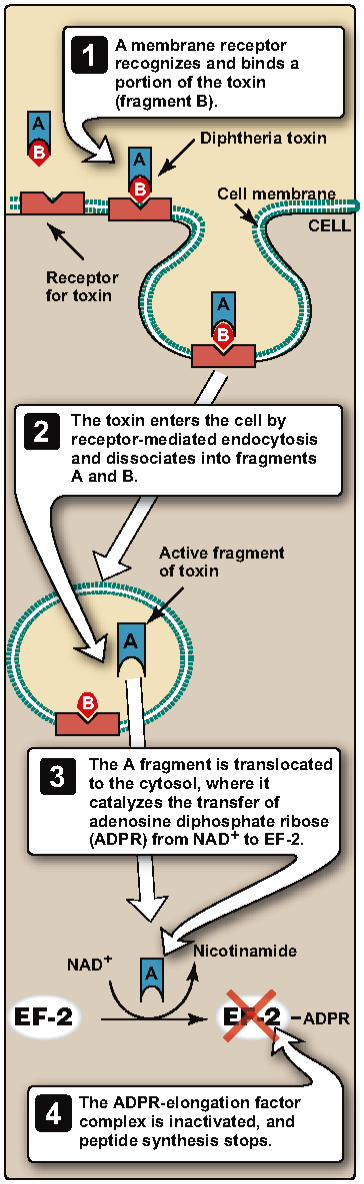
Corynebacterium diphtheriae



Corynebacterium diphtheriae

Corynebacterium diphtheriae

- Pathogenesis of *C. diphtheriae*
- Diphtheria is caused by the local and systemic effects of a single exotoxin that inhibits protein biosynthesis.
- The toxin molecule (composed of two fragments, A and B) is a heat-labile polypeptide.
- Fragment B binds to susceptible cell membranes and delivers fragment A to its target.



Corynebacterium diphtheriae

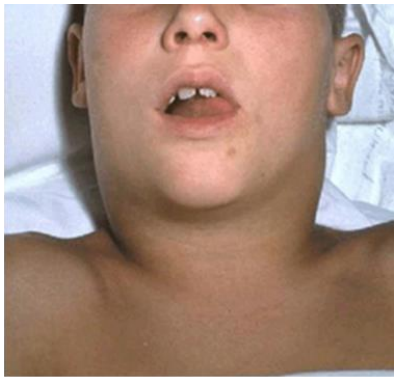
- Signs and Symptoms of *C. diphtheriae*
- In its early stages, diphtheria can be mistaken for a bad sore throat.
- A low-grade fever and swollen neck glands are the other early symptoms.
- As the infection progresses, someone may have one or more of the following symptoms.
- Difficult breathing or swallowing.
- Complain of double vision.
- Have slurred speech.

Corynebacterium diphtheriae

- Clinical Significance of *C. diphtheriae*
- Infection may result in respiratory or cutaneous clinical disease.
- Upper Respiratory Tract Infection: Diphtheria is a strictly localized infection of the throat.
- The infection produces a distinctive thick, grayish, adherent exudate that is composed of cell debris and inflammatory products.
- It coats the throat and may extend into the nasal passages or downward in the respiratory tract.

Corynebacterium diphtheriae

- Cutaneous Diphtheria: A puncture wound or cut in the skin can result in the introduction of *C. diphtheriae* into the subcutaneous tissue.
- This leads to a chronic, non-healing ulcer with a gray membrane.
- Rarely, exotoxin production leads to tissue degeneration and death.



Diphtheria with marked swelling of the lymph nodes in the neck

Corynebacterium diphtheriae

- Treatment of *Corynebacterium diphtheriae*
- Diphtheria treatment requires prompt neutralization of toxin, followed by eradication of the organism.
- A dose of horse serum antitoxin inactivates any circulating toxin, although it does not affect toxin already bound to a cell surface.
- Antibiotics (*e.g*. penicillin) kill the organism and prevent further toxin production.
- Suspected patients must be isolated since the disease is highly contagious.

Corynebacterium diphtheriae

- Prevention of *Corynebacterium diphtheriae*
- Diphtheria can be prevented through immunization with toxoid (*e.g*. DTaP triple vaccine) together with tetanus toxoid and pertussis antigens.
- The initial series of injections should be started in infancy.
- Booster injections of diphtheria toxoid (with tetanus toxoid) should be given at approximately 10-year intervals throughout life.

Corynebacterium diphtheriae

- Eye Infections by *C. diphtheriae*
- Diphtheritic conjunctivitis (membranous conjunctivitis) is one of the most destructive of all acute diseases.
- It is severe conjunctival inflammation caused by *Corynebacterium diphtheria*.
- It is characterized by an infiltrating membrane and leaves a raw surface.
- Diphtheritic conjunctivitis leads to necrosis of the infiltrated tissue.
- Early diagnosis is very important.

Diphtheroids

- Diphtheroids are other *Corynebacterium* species that morphologically resemble the type species, *Corynebacterium diphtheriae*.
- They cause an acute bacterial disease involving primarily the nose, throat, skin, urogenital tract, and conjunctiva.
- They are generally unable to produce exotoxin.
- Few cause diseases in rare circumstances such as in immunosuppressed individuals.