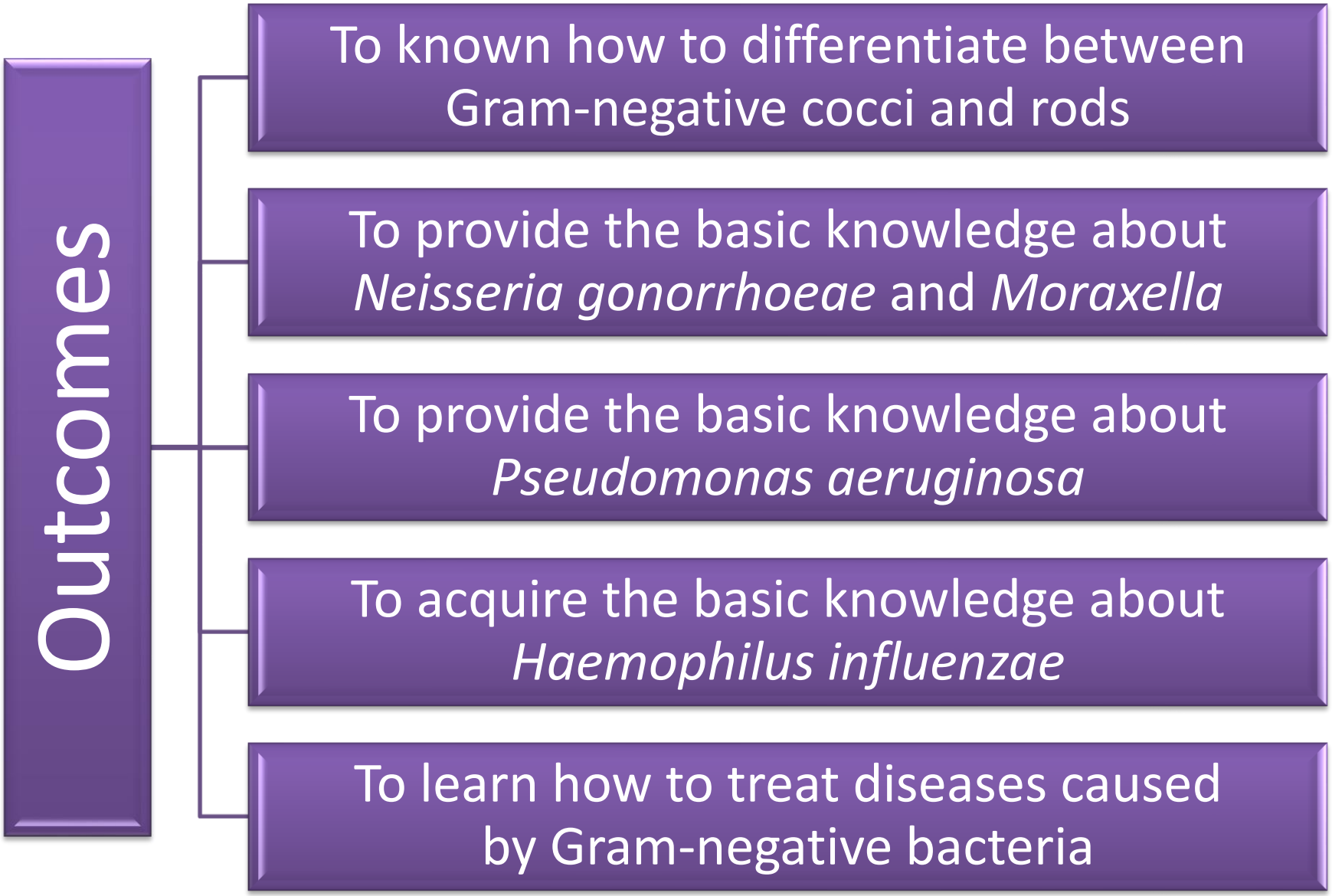
Gram-Negative Bacteria

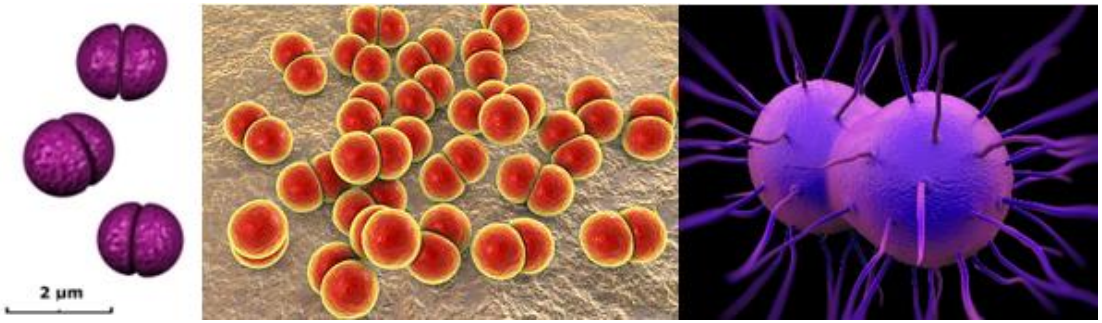
Lecture Five

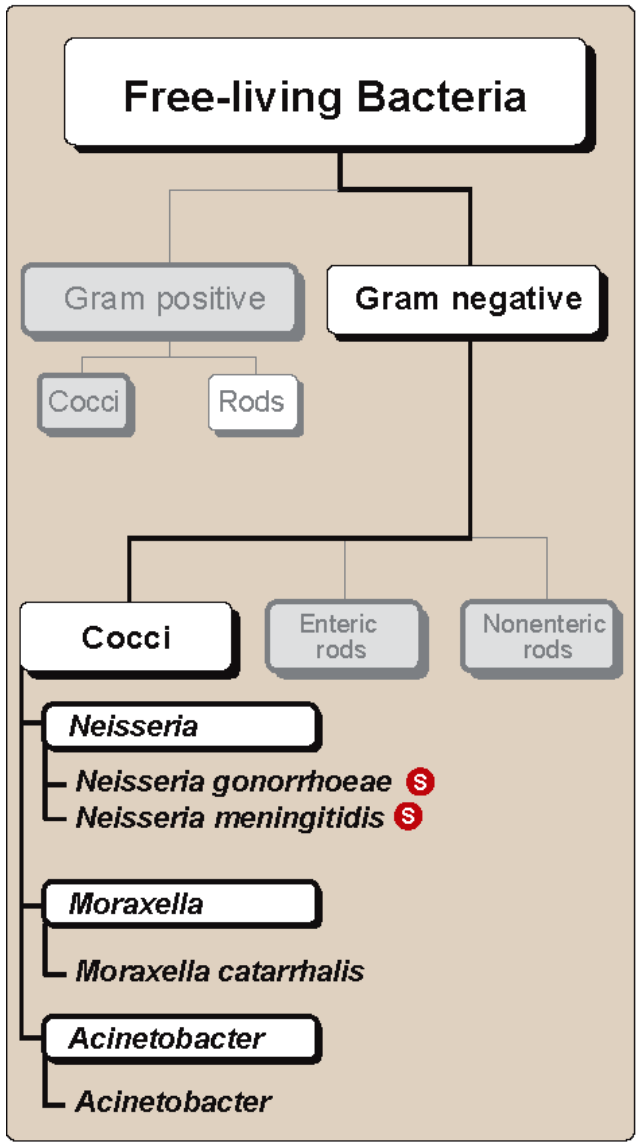
Learning Outcomes



Gram Negative Cocci

- The genus *Neisseria* consists of Gram-negative, aerobic cocci.
- *Neisseria gonorrhoeae* is a Gram-negative diplococcus that causes gonorrhea infectious disease.





Neisseria gonorrhoeae

- *Neisseria gonorrhoeae* does not produce any exotoxins but has various virulence factors that help infections to take place.
- Pili
- It enhance attachment of the organism to the host epithelial cell surface.
- Lipooligosaccharide (LOS)
- It causes endotoxic shock.
- Outer membrane proteins
- Contribute the virulent effect of bacteria.

Neisseria gonorrhoeae

- Porin Proteins
- The gonococcus expresses a single porin type, known as PorB.
- The protein tight binding and invasion of the epithelial cells.
- Also, protein from one bacterium binds to the LOS of an adjacent bacterium, which allows for the construction of a small colony.
- IgA Protease
- It degrades IgA (antibody) coating and leads to the invasion of host cell.

Neisseria gonorrhoeae

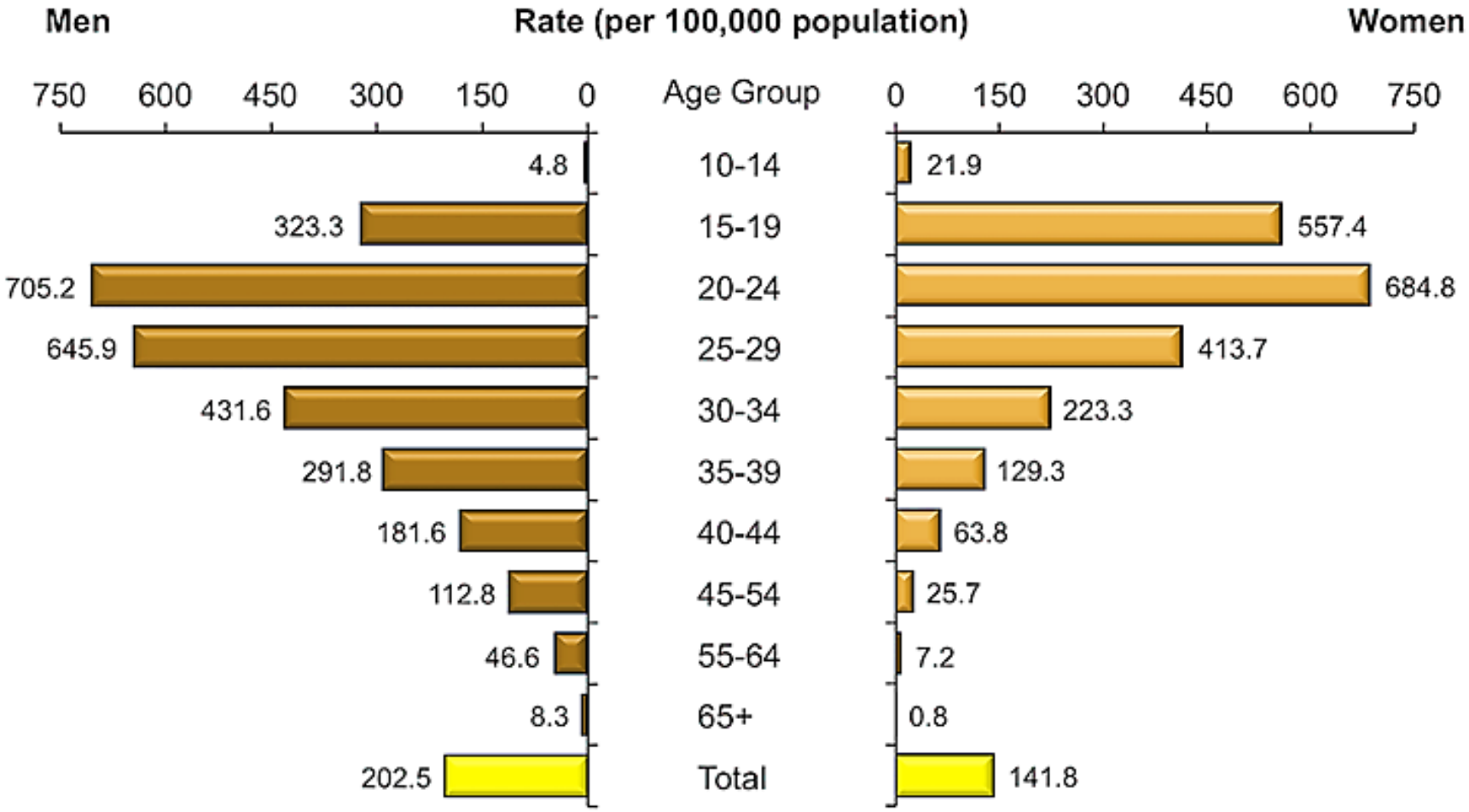
- Pathogenesis of *Neisseria gonorrhoeae*
- Pili and Opa proteins help adhesion of the gonococcus to the host epithelial cells.
- They make colonization possible.
- Both gonococci and meningococci produce an IgA protease that cleaves IgA1, helping the pathogen to evade immunoglobulins of this subclass.
- The gonococcus requires iron for growth and survival *in vivo*.

Neisseria gonorrhoeae

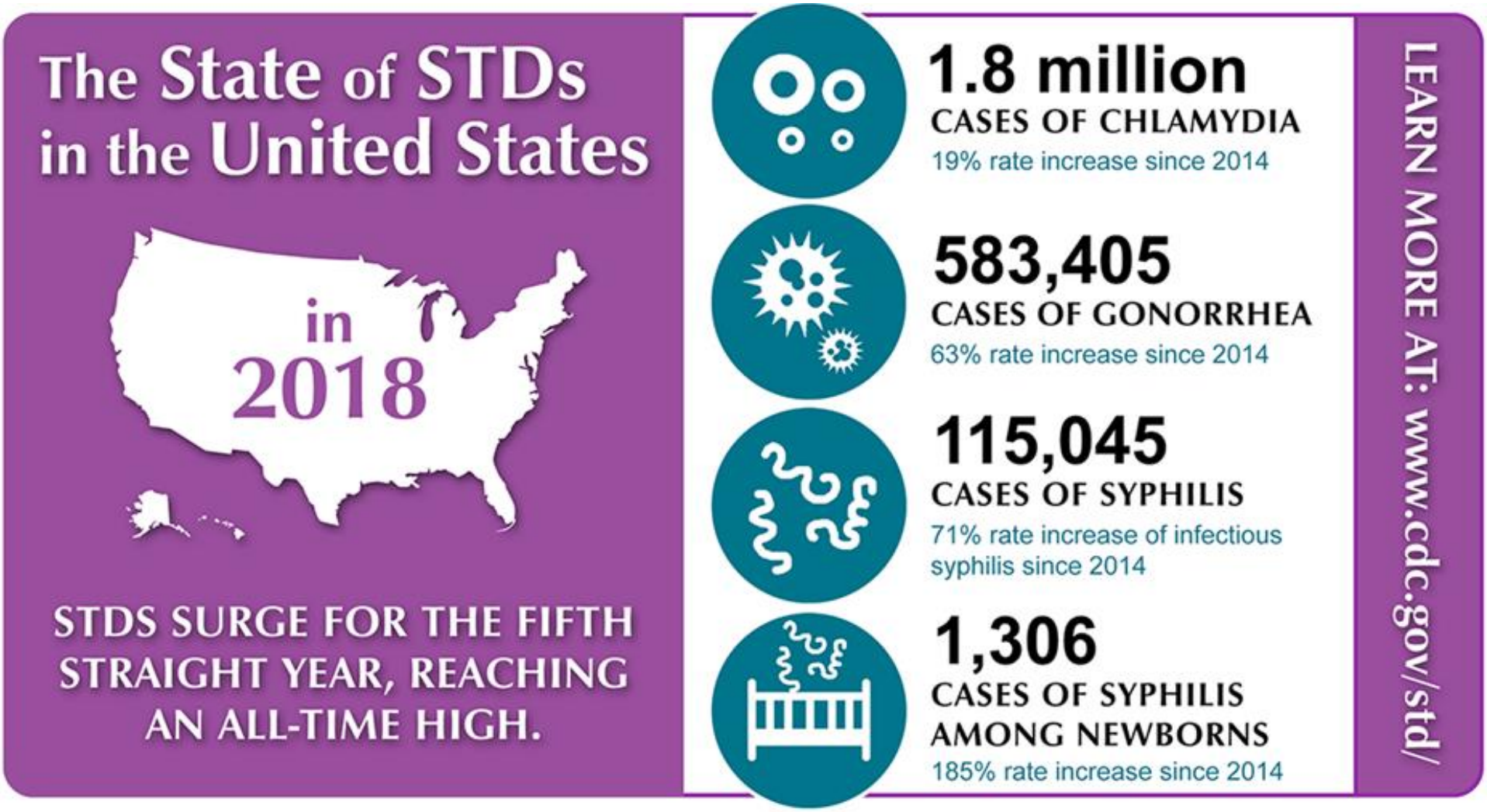
- Clinical Significance of *N. gonorrhoeae*
- Gonococci often colonize the mucous membrane of genitourinary tract.
- It may cause a localized infection with the production of pus.
- It may lead to tissue invasion, chronic inflammation and fibrosis.
- Higher proportion of female than male are generally asymptomatic, and can transmit gonococcal infections.

Neisseria gonorrhoeae

Gonorrhea in the United States in 2017



Neisseria gonorrhoeae



Neisseria gonorrhoeae

- Treatment and Prevention
- More than 20% of *N. gonorrhoeae* isolates are resistant to penicillin, tetracycline, cefoxitin and/or spectinomycin.
- Doxycycline is often used as a part of the treatment regimen for gonorrhea.
- Prevention of gonorrhea involves sexual contacts management of the patients.
- The use of barrier method is also a preventive measure against gonorrhea.

Neisseria gonorrhoeae

- Eye infections caused by *N. gonorrhoeae*
- Conjunctivitis (ophthalmia neonatorum) is common in newborns.
- Neonatal gonorrheal conjunctivitis is contracted when the infant is exposed to *N. gonorrhoeae* in the birth canal.
- It can lead to corneal scarring resulting in blindness in newborns.
- Silver nitrate or antibiotics are often applied to eyes to prevent gonorrhoea.

Neisseria gonorrhoeae

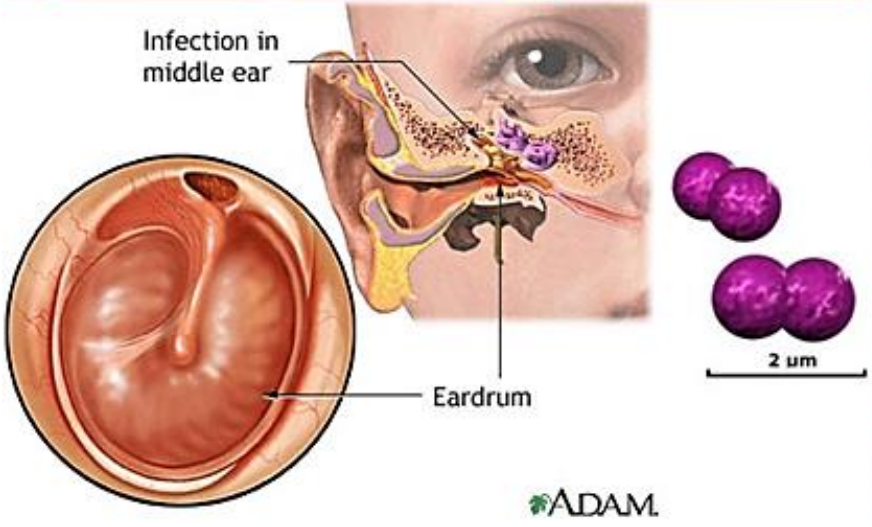
Moraxella

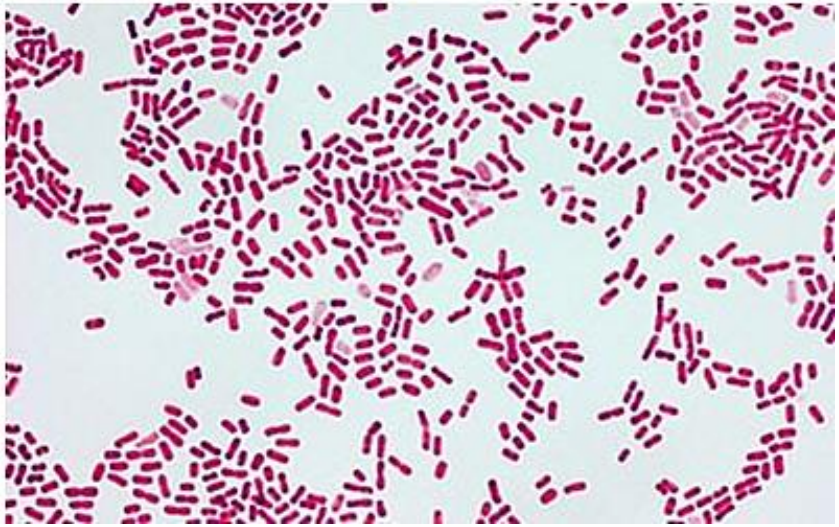
- *Moraxella* are non-motile, Gram-negative diplococci that are generally found in pairs.
- *Moraxella* are aerobic, fastidious organisms that do not ferment carbohydrates.
- It can cause infections of the respiratory system, middle ear, eye, CNS and joints.
- *Moraxella bovis* causes bovine keratoconjunctivitis (new forest eye; in cattle only).
- *Moraxella* can be treated by the use of subconjunctival injection of tetracycline as the antibiotic.

Moraxella


Moraxella

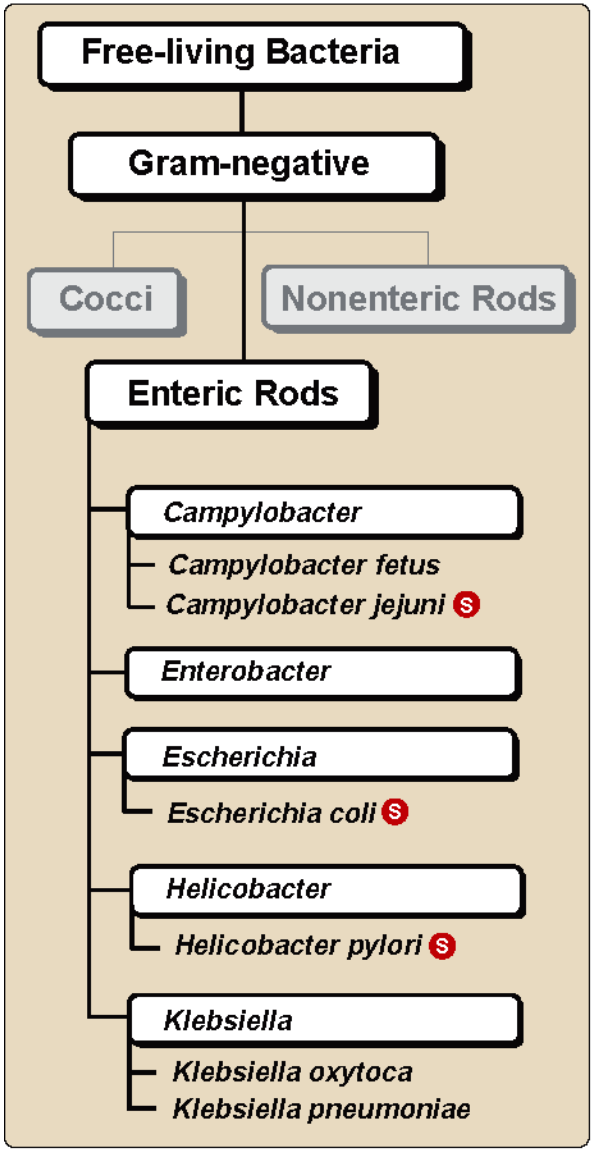

New Forest Eye


Infection in middle ear
Eardrum
2 µm
ADAM.



Gram Negative Rods

- Enteric Bacteria
- Enteric bacteria are Gram-negative rods.
- They are bacteria of the intestines that are associated with gastrointestinal flora (Gut flora) or disease.
- The taxonomic family is Enterobacteriaceae.
- *e.g. Escherichia coli*



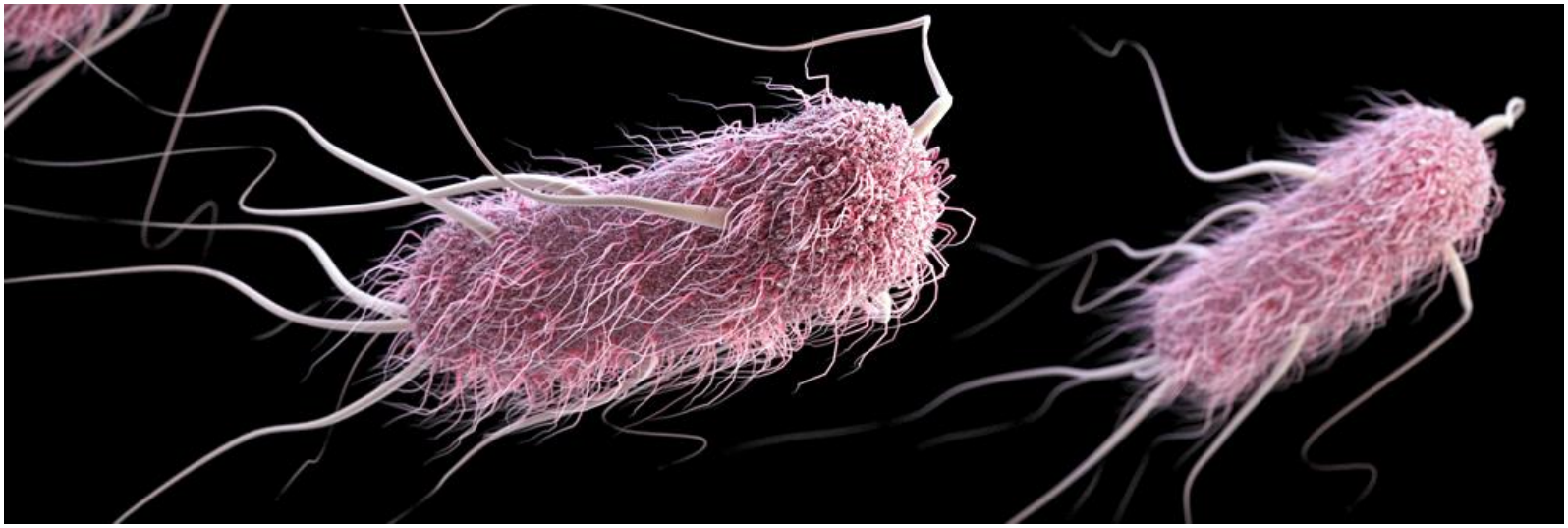
Gram Negative Rods

- They are found in the gastrointestinal (GI) tract of humans or other animals.
- They are sensitive to drying and all grow in the presence or absence of oxygen (facultative anaerobes).
- They contain lipopolysaccharide (LPS), which is both antigenic and an important virulence factor (endotoxin).
- Fecal contamination is commonly important in the transmission of those organisms that cause GI tract diseases.

Escherichia coli

- *Escherichia coli* is part of the normal flora of the colon in humans and animals.
- It can be pathogenic both within and outside of the GI tract.
- *Escherichia coli* has pili that are important for adherence to host mucosal surfaces.
- It may be motile or non-motile.
- Most *Escherichia coli* strains can ferment lactose and produce acid and gas.
- *E. coli* may cause ophthalmia neonatorum.

Escherichia coli



- Most *Escherichia coli* strains are harmless, but some serotypes can cause serious food poisoning in their hosts.
- *Escherichia coli* can get into meat, raw milk or dairy products during processing.
- *E. coli* spread from one person to another.

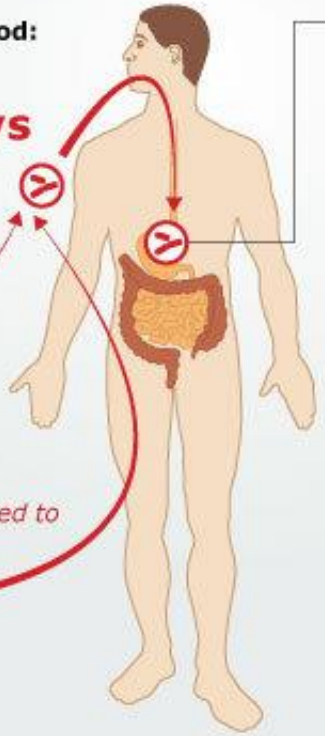
Escherichia coli

Enterohemorrhagic bacteria Escherichia coli (EHEC)

Most Escherichia coli (E.coli) strains are harmless.

But some, like enterohemorrhagic **E. coli (EHEC)**, are a hazard to human health and life.

Incubation period:
three to eight days



E. coli (EHEC), once in the human stomach, begins producing toxins that cause serious illnesses

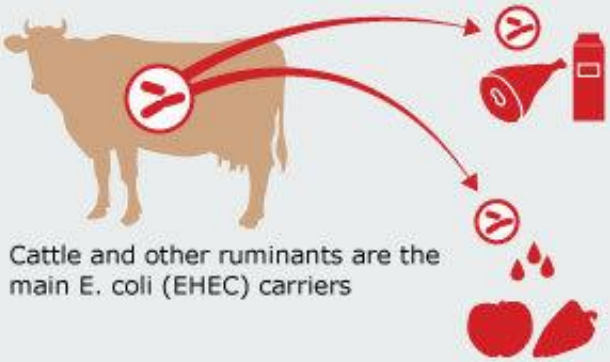
Symptoms caused by E. coli (EHEC)

- Stomach muscle spasms
- Diarrhea (sometimes bloody diarrhea)
- Fever
- Vomiting

Complications:
hemolytic uremic syndrome (HUS)

Death rate: 3-5 %

INFECTION SOURCES



Cattle and other ruminants are the main E. coli (EHEC) carriers

Uncooked meat and raw milk

The bacteria die when food is exposed to heat (70°C and higher)

Fruit and vegetables (droppings of sick animals find their way into water bodies that in turn feed the soil)

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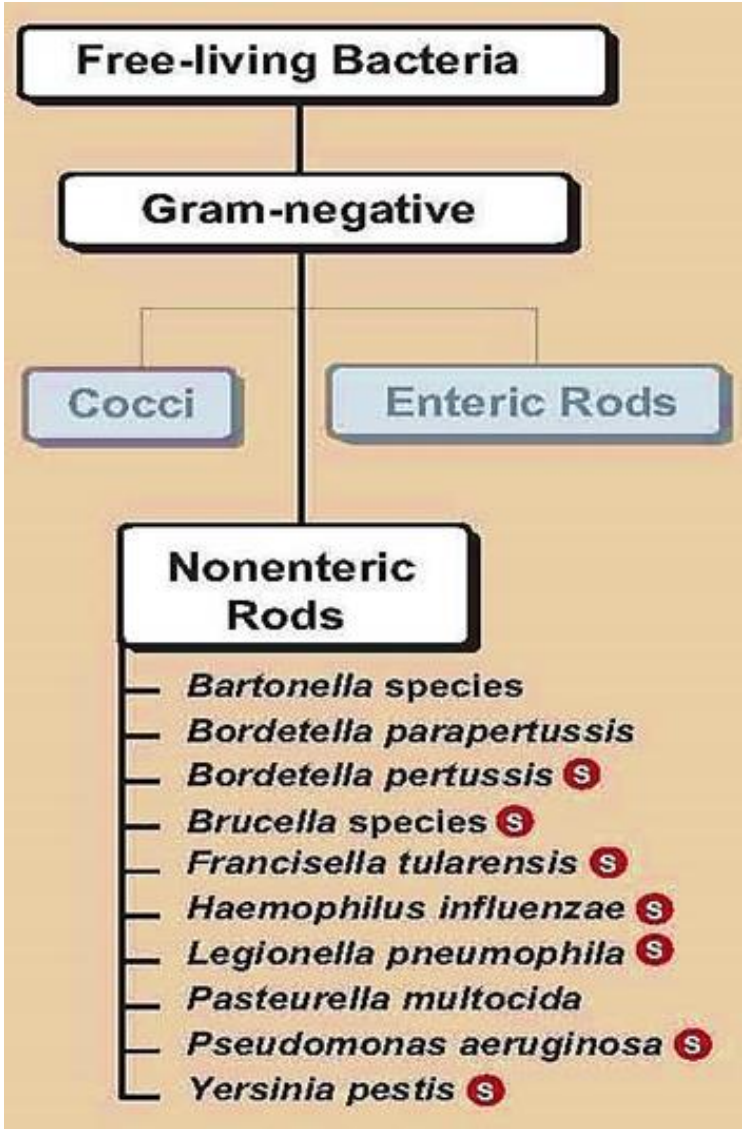
Gram Negative Rods

- Nonenteric Bacteria
- Gram-negative bacilli.
- Do not ferment sugars.
- They resist antibiotics.
- Can be cultured in lab.
- *e.g. Pseudomonas aeruginosa*.



Pseudomonas aeruginosa

- *Pseudomonas aeruginosa* is the primary human pathogen in the genus *Pseudomonas*.
- It is found in soil, water, plants and animals.
- It may colonize healthy humans without causing disease.
- It is an opportunistic pathogen and a major cause of nosocomial infections.
- It can grow in laboratory water baths, hot tubs and other water-containing vessels.
- This explains why it is responsible for so many nosocomial infections.

Pseudomonas aeruginosa

- Pathogenesis of *Pseudomonas aeruginosa*
- *Pseudomonas aeruginosa* disease begins with the attachment of bacteria to the host cells followed by the colonization.
- Pili on the bacteria mediate adherence.
- The damage of the host tissue facilitates the adherence and colonization.
- *Pseudomonas aeruginosa* produces numerous types of toxins that can promote local invasion and the spread of the microorganism.

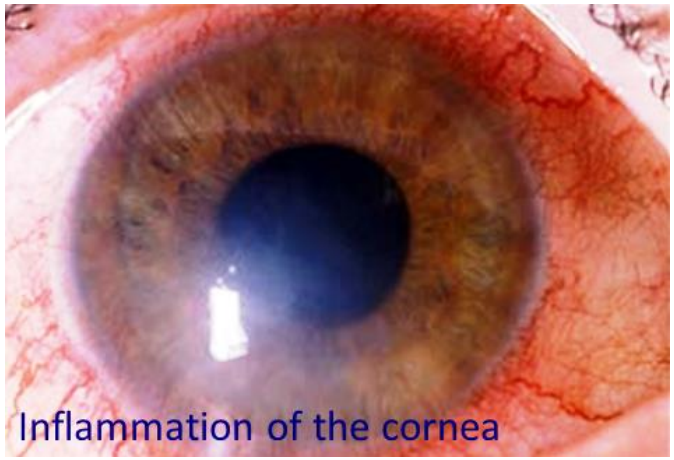
Pseudomonas aeruginosa

- Clinical Significance of *P. aeruginosa*
- *Pseudomonas aeruginosa* causes both localized and systemic illness.
- Localized infection may occur in the eye causing keratitis (inflammation of the cornea and endophthalmitis).
- The systemic infections may include infections to the bones, joints, skin and central nervous system.
- Individuals with impaired immune defences are at a high risk.

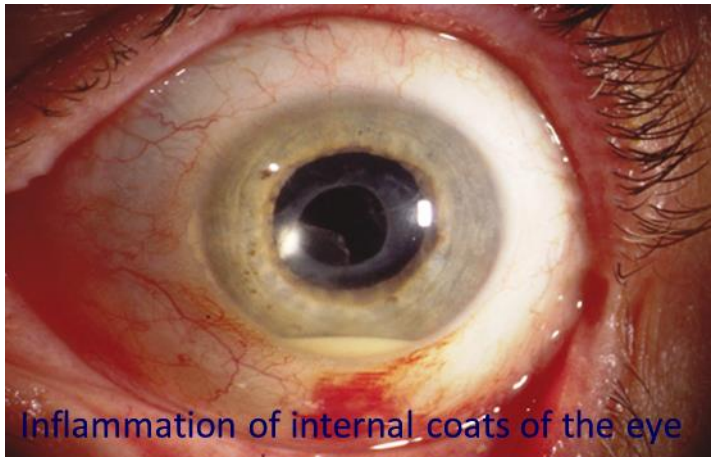
Pseudomonas aeruginosa

- Treatment and Prevention of *P. aeruginosa*
- It is difficult to find antibiotics that are effective against *P. aeruginosa* because of its rapid development of resistance mutations and its own innate mechanisms of antibiotic resistance.
- *Pseudomonas* infections typically occur in patients with impaired defenses.
- An aggressive antimicrobial therapy is required which includes the use of a combination of two antibiotics.

Pseudomonas aeruginosa



Inflammation of the cornea



Inflammation of internal coats of the eye

Gram (–) rods

Pseudomonas species

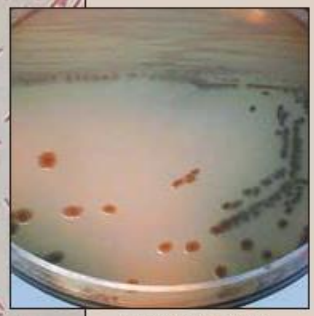
Pseudomonas aeruginosa

- Localized infections
- Systemic infections

1. Antipseudomonal β-lactams[1]
1. Ceftazidime
1. Tobramycin
1. Ciprofloxacin

[1]Piperacillin or ticarcillin.

Pseudomonas aeruginosa grown from sputum (Gram stain)



Pseudomonas aeruginosa on MacConkey agar

- Encapsulated, motile rods (polar flagella)
- Aerobic or facultative anaerobe
- Produces diffusible green and blue pigments
- Oxidase positive
- Oxidizes but does not ferment carbohydrates, such as lactose
- Culture on MacConkey agar

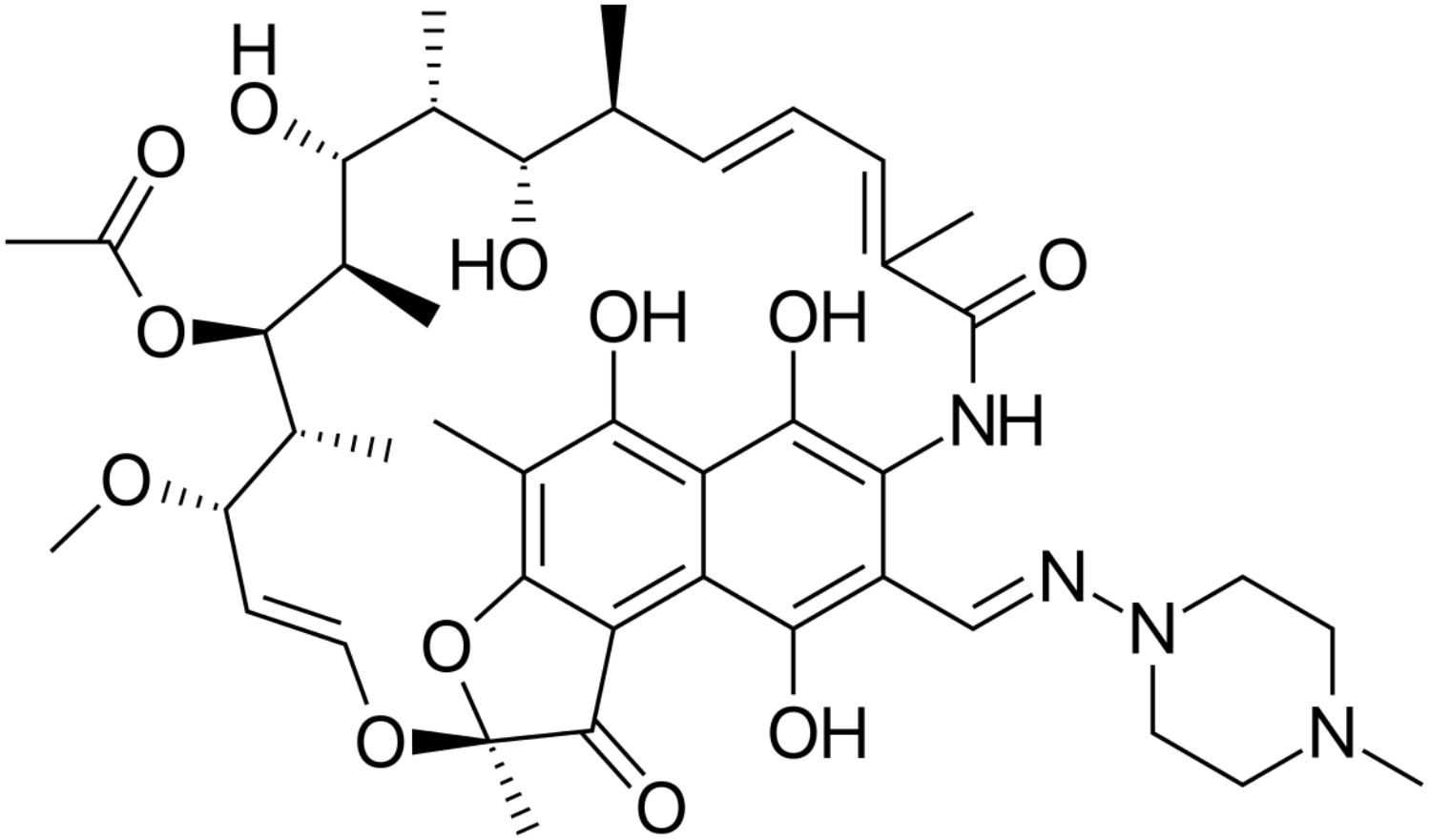
Haemophilus influenzae

- *Haemophilus influenzae* is a normal resident of the human upper respiratory tract.
- *Haemophilus influenzae* causes pneumonia in older adults and immunocompromised individuals.
- The transmission takes place by respiratory droplets.
- After attaching to and colonizing the respiratory mucosa, the infection can become systemic, with bacteria spreading through the blood to the CNS.

Haemophilus influenzae

- *Haemophilus influenzae* was a leading cause of bacterial meningitis, especially in infants and young children.
- Prevention of *Haemophilus influenzae*
- A conjugated vaccine against *H. influenzae* capsular polysaccharide type b is now administered to infants.
- The vaccine has dramatically lowered the number of meningitis infections.
- Rifampin is used to treat the bacterial infection and is given prophylactically.

Haemophilus influenzae



Rifampin

Haemophilus influenzae

- Brazilian purpuric fever (BPF) is an illness of children caused by the bacterium *Haemophilus influenzae* biotype aegyptius.
- BPF was first recognized in Brazil in 1984.
- At this time, young children between the ages of 3 months and 10 years were contracting a strange illness which was characterized by high fever.
- These cases were all fatal due to sepsis and thought to be due to meningitis.

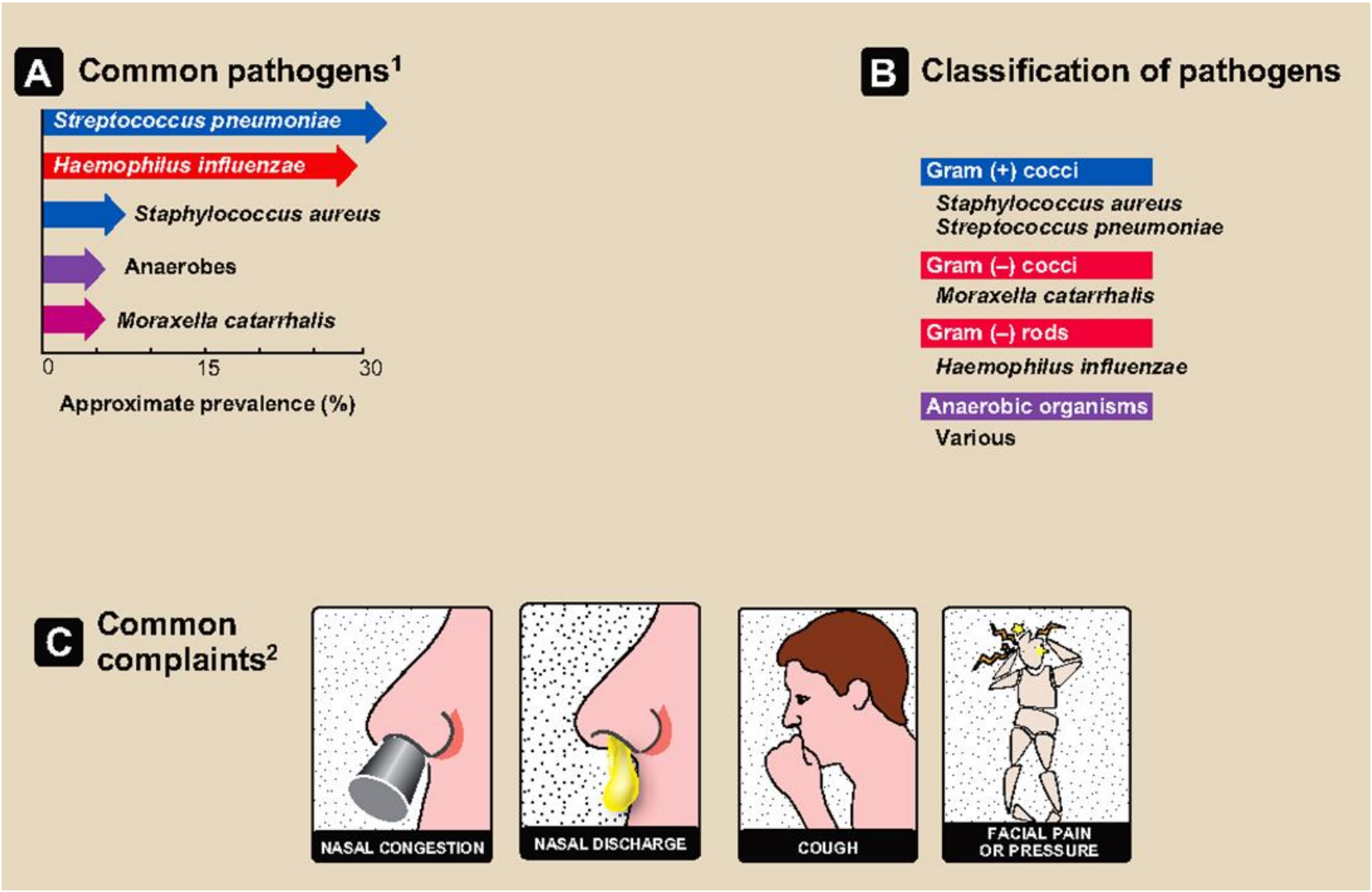
Haemophilus influenzae

- These deaths was confirmed to be due infection by *H. influenzae aegyptius*.
- Although BPF was thought to be confined to Brazil, other cases occurred in Australia and the US during 1984–1990.
- The basic method for control of the conjunctivitis includes proper hygiene and care for the affected eye.
- It is difficult to treat BPF because of the difficulty obtaining an early proper diagnosis.

Haemophilus influenzae

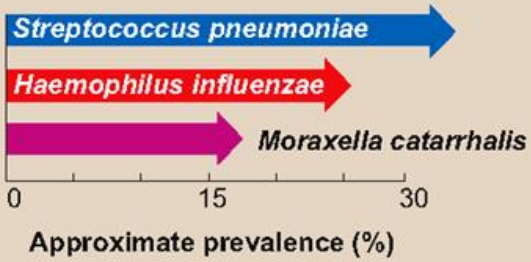
- Bacterial conjunctivitis is an inflammation of the bulbar and/or the palpebral conjunctivas due to bacteria.
- Complications developed with extremely pathogenic bacteria.
- Produces a thick and yellow-green eye discharge.
- It may be associated with a respiratory infection.
- It may be associated with a sore throat.

Haemophilus influenzae



Haemophilus influenzae

A Common pathogens[1]



B Classification of pathogens

Gram (+) cocci

Streptococcus pneumoniae

Gram (–) cocci

Moraxella catarrhalis

Gram (–) rods

Haemophilus influenzae

C Common complaints[2]