

Orientation to Gram Positive Bacteria of Medical Importance

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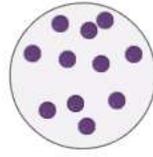
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- **Response Time:** 24-48 hours (usually much faster)
- **No phone contact**
- **Avoid social media**

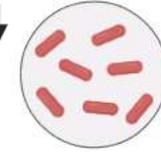


Gram-positive

Cocci



Rods



Clostridium
Corynebacterium
Listeria
Bacillus
Mycobacterium

Catalase test



Streptococci



Staphylococci

Growth on sheep's blood agar



γ -hemolytic

Enterococcus



β -hemolytic

Group A

S. pyogenes

Group B

S. agalactiae



α -hemolytic

Capsule

S. pneumoniae

No Capsule

Viridans streptococci

Coagulase test



S. saprophyticus
S. epidermidis



S. aureus

Diplococci



Pneumococci





<https://www.youtube.com/watch?v=krHgynVe6-g>



Coagulase converts fibrinogen to an insoluble fibrin capsule that surrounds the microorganism and limits access by immune cells.

Coagulase Test



<https://www.youtube.com/watch?v=NBcMypWZo18>



Shapes of Bacteria



Coccus



Coccobacillus



Bacillus



Vibrio



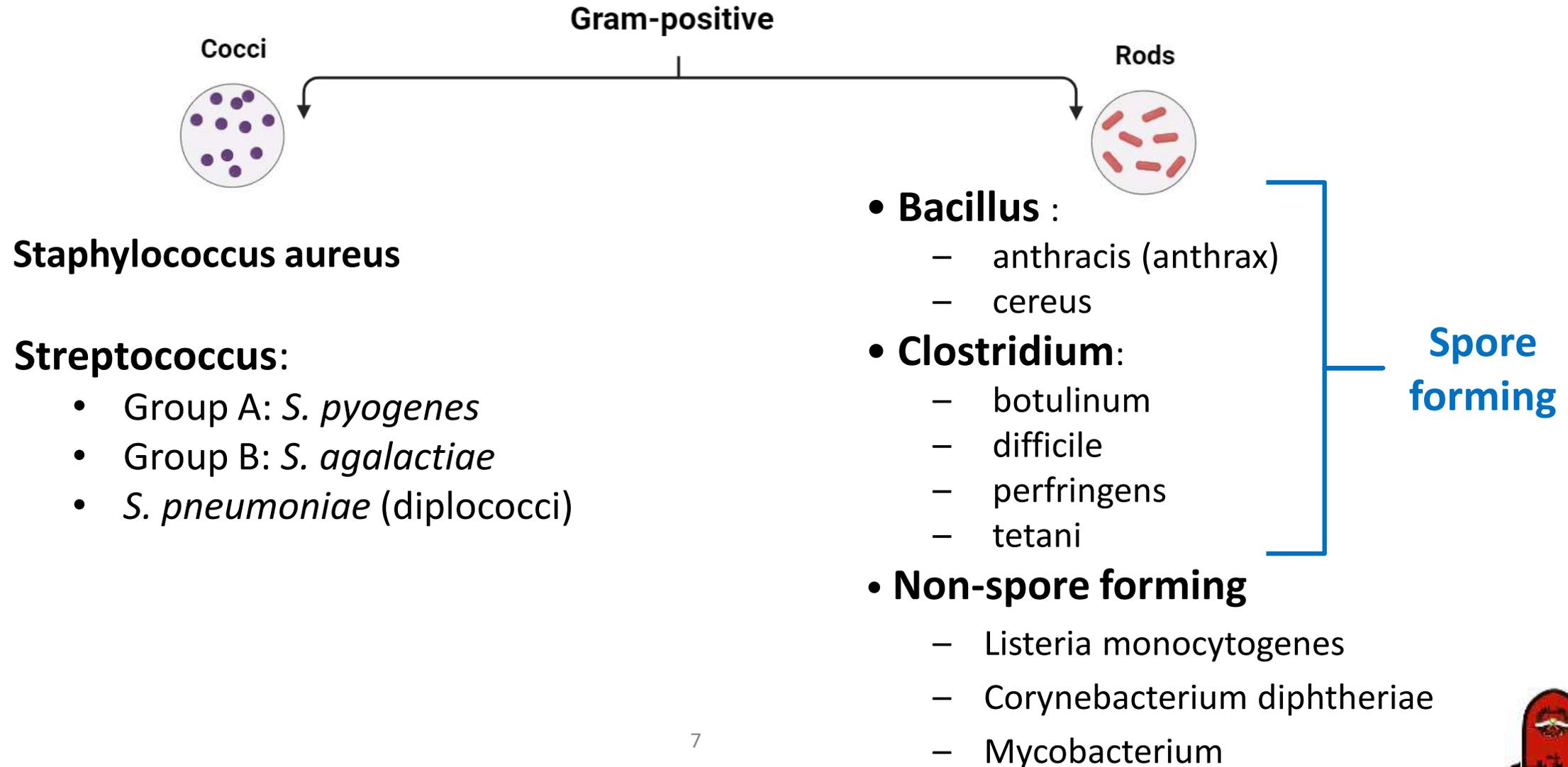
Spirillum



Spirochete



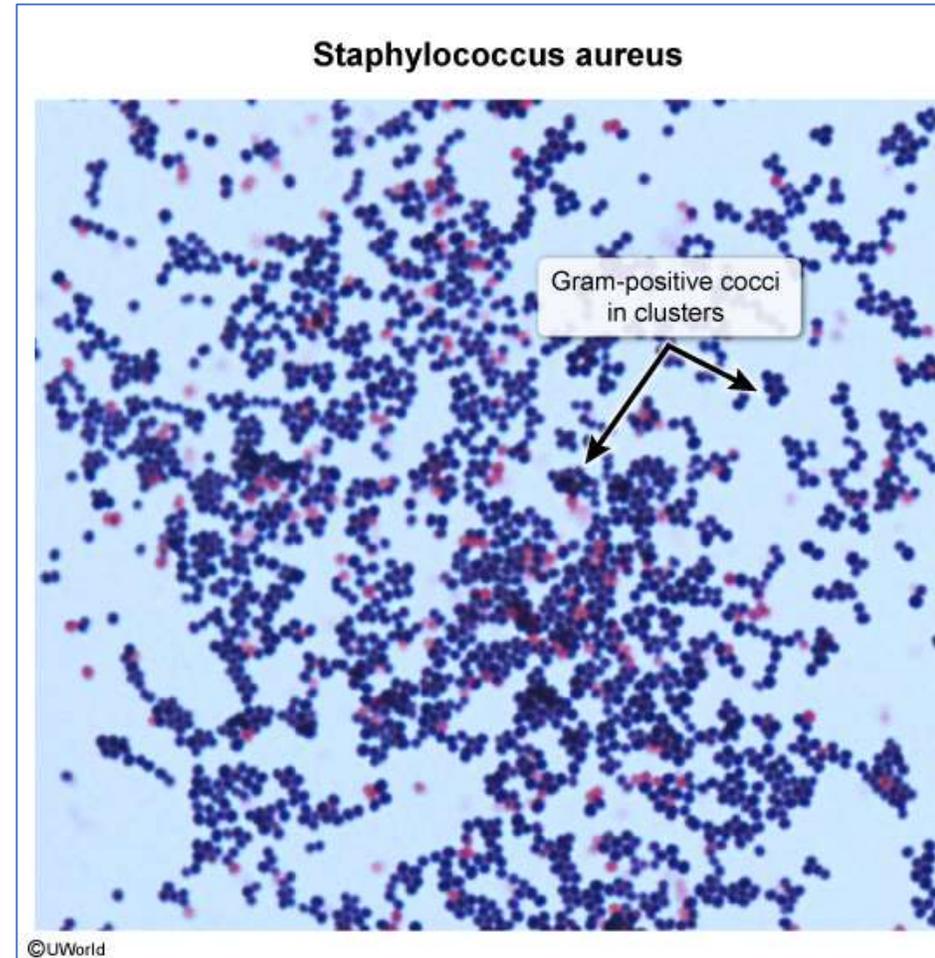
Medically Important Gram-Positive Cocci



Medically Important Gram-Positive Cocci

Staphylococci General Characteristics

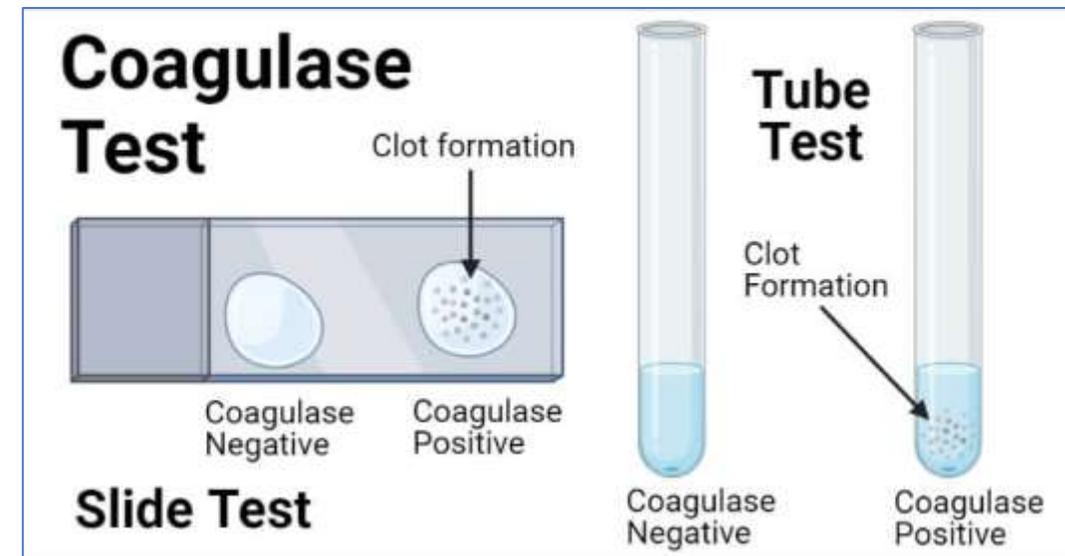
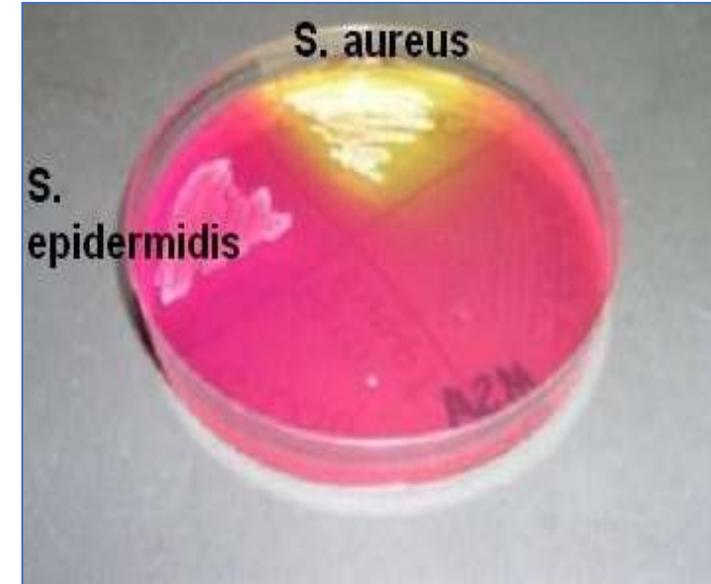
- Common inhabitant of the skin and mucous membranes.
- Spherical cells arranged in irregular clusters (grape-like clusters).
- Produces many virulence factors



Medically Important Gram-Positive Cocci

Staphylococcus aureus

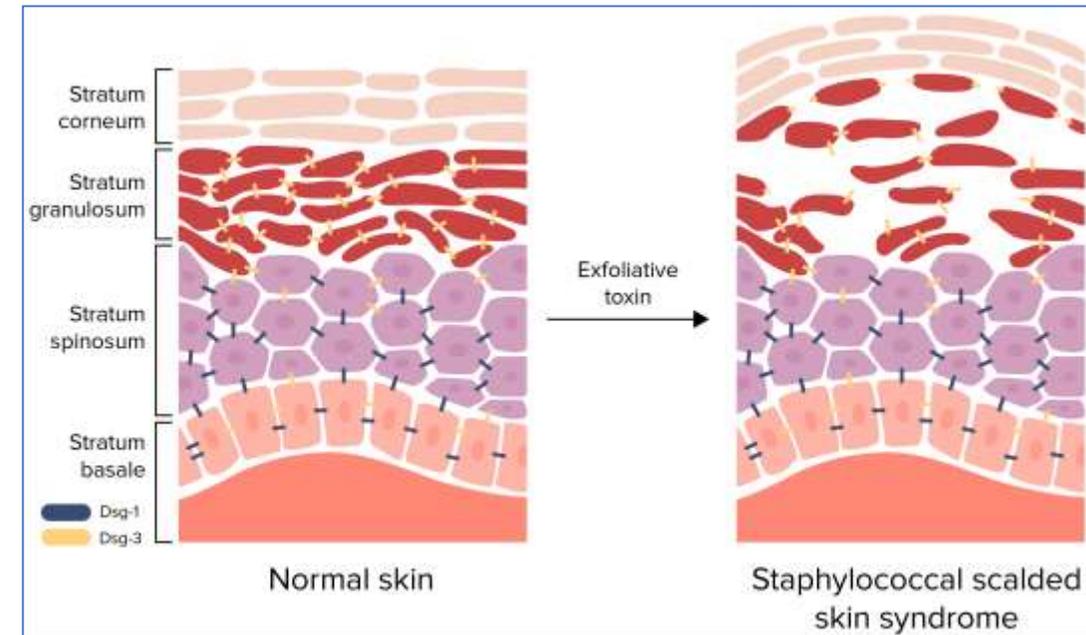
- Diseases:
 - Food poisoning.
 - Enterotoxin. Enterotoxin is heat resistant (stable at 100°C for 1 hour) and causes rapid-onset food poisoning. Symptoms arise within 1-6 hours of ingesting contaminated food and predominantly include nausea and vomiting; watery diarrhea may also occur.
 - Localized infections (Abscess formation).
 - Spreading infections.
 - Necrotizing infections.
 - Systemic infections (ex. Osteomyelitis).



Medically Important Gram-Positive Cocci

Staphylococcus aureus

- **Exfoliatin.** Exfoliatin is a proteolytic exotoxin that cleaves the desmosomes, causing a blister just below the stratum corneum of the epidermal skin. This exotoxin plays a role in the pathogenesis of bullous impetigo and staphylococcal scalded-skin syndrome



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Staphylococcus aureus - staphylococcal scalded-skin syndrome



Staphylococcal scalded skin syndrome in a newborn: This image shows diffuse erythema, bullae formation, and skin peeling.



Cutaneous manifestations of SSSS:
Erythema, skin peeling, and crusting on the face



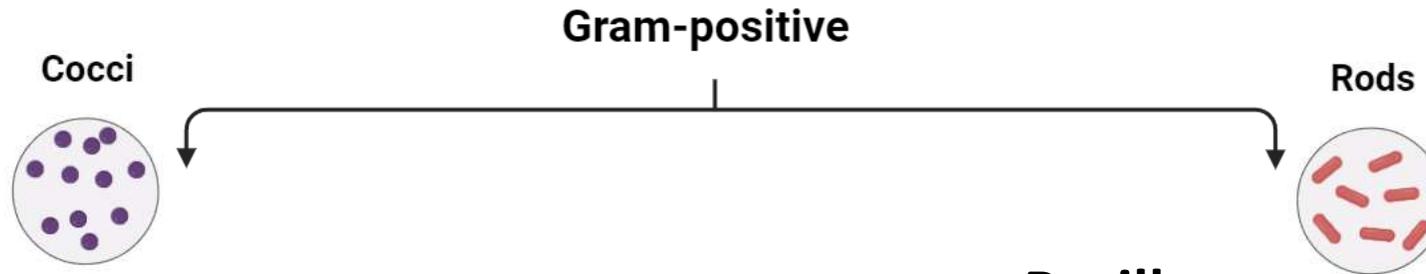
Medically Important Gram-Positive Cocci

Coagulase-negative staphylococcus

- Frequently involved in nosocomial and opportunistic infections.
- *S. epidermidis* – lives on skin and mucous membranes; endocarditis, bacteremia, UTI.
- *S. saprophyticus* – infrequently lives on skin, intestine, vagina; UTI.



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Staphylococcus aureus

Streptococcus:

- Group A: *S. pyogenes*
- Group B: *S. agalactiae*
- *S. pneumoniae* (diplococci)

• Bacillus :

- anthracis (anthrax)
- cereus

• Clostridium:

- botulinum
- difficile
- perfringens
- tetani

• Non-spore forming

- *Listeria monocytogenes*
- *Corynebacterium diphtheriae*
- *Mycobacterium*

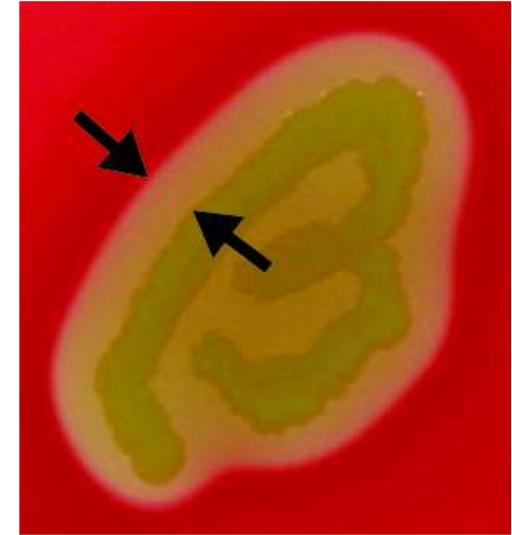
Spore forming



Medically Important Gram-Positive Cocci

Streptococci

- Gram-positive cocci arranged in chain
- Catalase & Coagulase negative
- Classification
 - **α -hemolytic:** partial hemolysis of RBCs
 - **β -hemolytic:** complete hemolysis of RBCs
 - **γ -hemolytic:** no hemolysis of RBCs

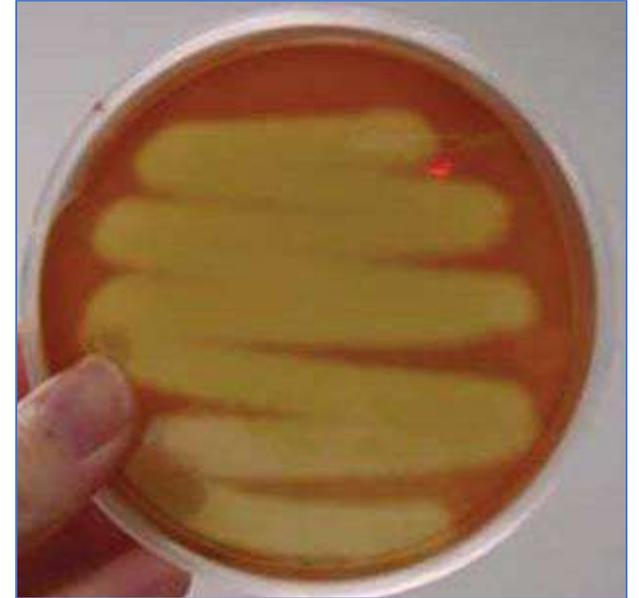


Medically Important Gram-Positive Cocci

Streptococci - *S. pyogenes*

***S. pyogenes* (Group A strept):**

- Group-A streptococci (GAS).
- β -hemolytic.
- Most serious streptococcal pathogen.
- Inhabits throat, nasopharynx, occasionally skin.
- Diseases:
 - Pharyngitis.
 - Skin infections.
 - Necrotizing infections.
 - Systemic infections

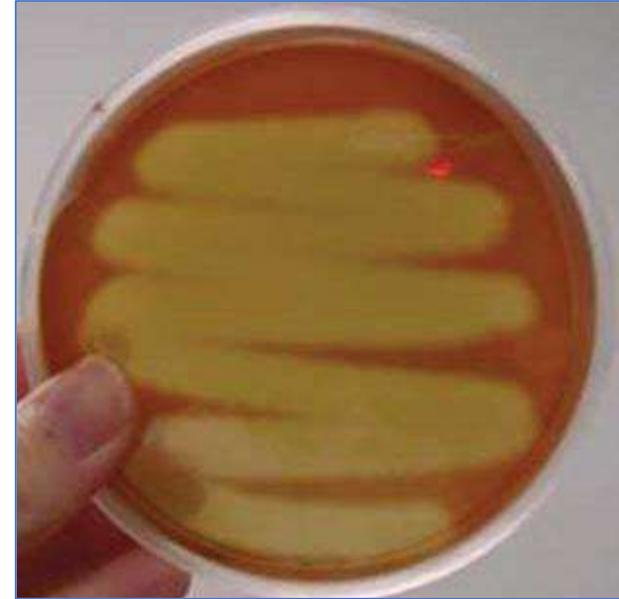


Medically Important Gram-Positive Cocci

Streptococci - *S. agalactiae*

***S. agalactiae* (Group B strept):**

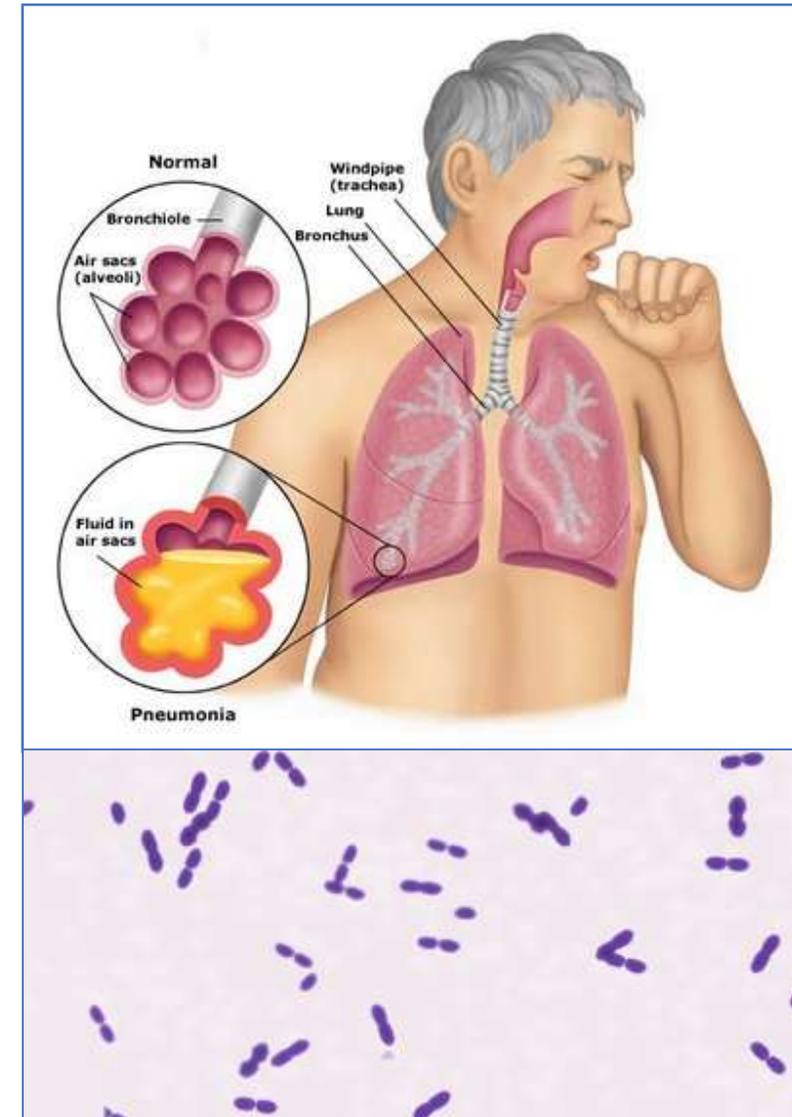
- Group-B streptococci (GBS).
- Frequently colonize genital (in 5%–30% of women) and GI tracts
- In older adults with chronic medical conditions:
 - Most common infection: cellulitis
 - Sepsis
 - Less common: cystitis, pyelonephritis, pneumonia, septic arthritis, endocarditis, meningitis
- In neonates:
 - Acquired in utero by ascending infection or during passage through vagina
 - Early (within 6 days) or late (up to 90 days) onset
 - Can present with:
 - Bacteremia, Sepsis, Meningitis, Pneumonia, Respiratory distress syndrome



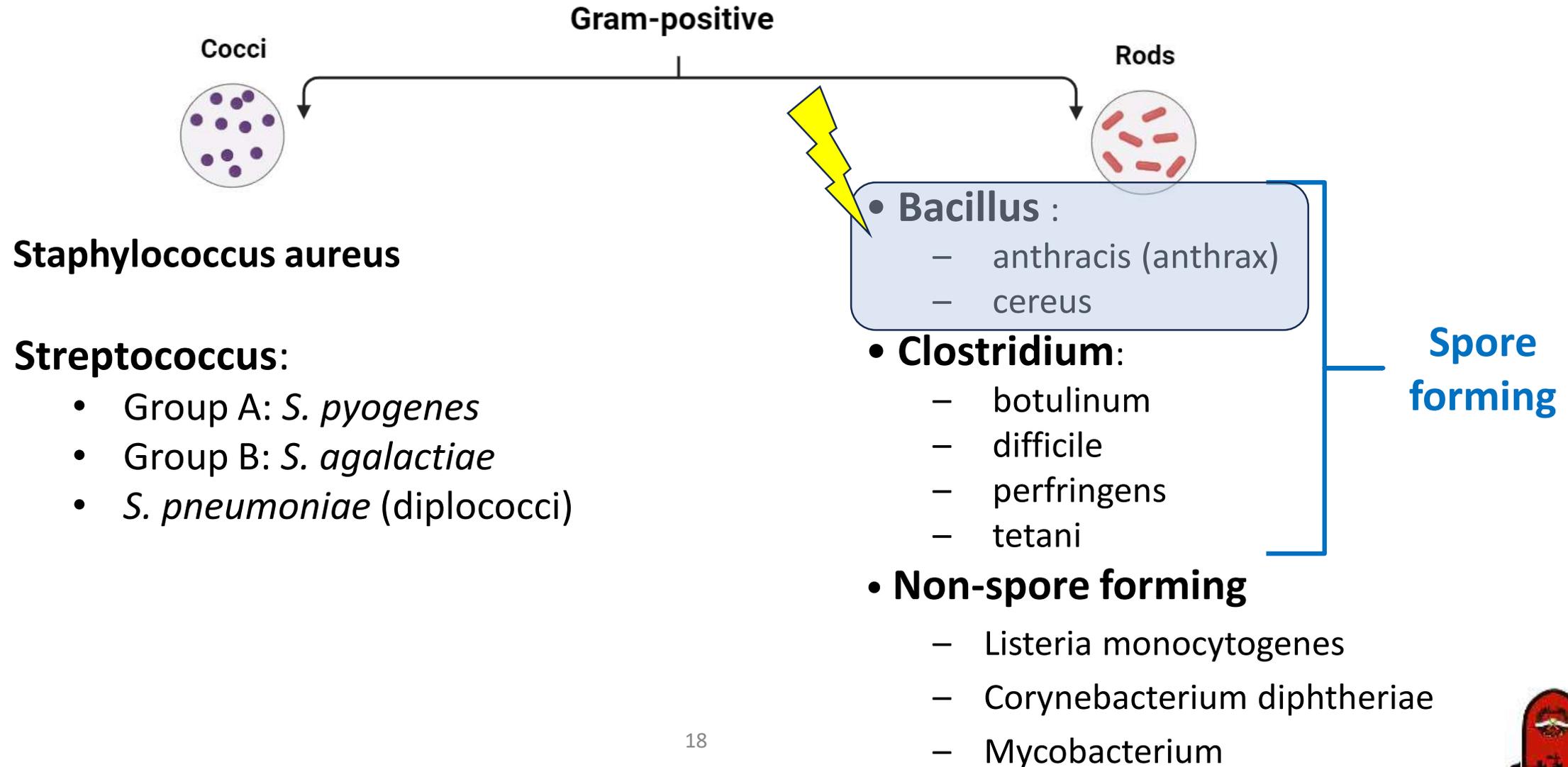
Medically Important Gram-Positive Cocci

Streptococci - *Streptococcus pneumoniae*

- α -Hemolytic
- Pneumonia-inflammatory condition of the lung.
- Inhabits nasopharynx of healthy people.
- May also infect brain: (pneumococcal meningitis) and blood stream (pneumococcus septicemia).
- Most common bacterial cause of community-acquired pneumonia
- Nasopharyngeal colonization is common (5%–40%).



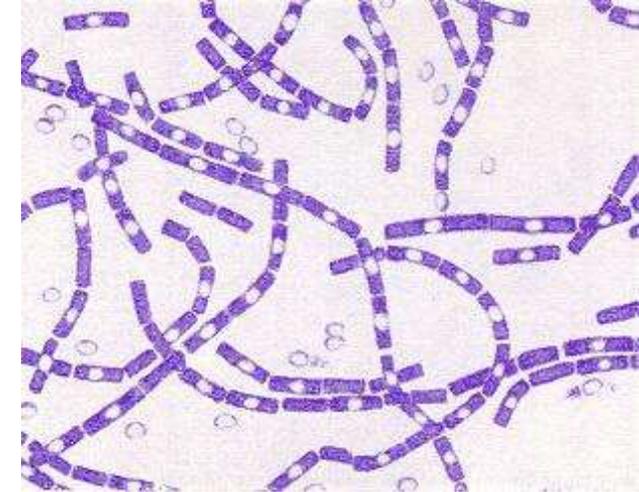
Medically Important Gram-Positive Bacilli



Medically Important Gram-Positive Bacilli

Bacillus - *Bacillus anthracis*

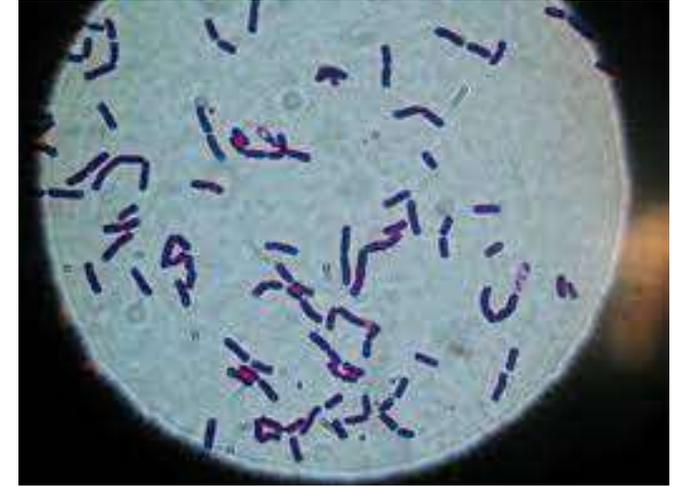
- Large, block-shaped rods
- Central spores
- Virulence factors – polypeptide capsule/exotoxins
- 3 types of anthrax:
 - Cutaneous – spores enter through skin, black sore; least dangerous.
 - Pulmonary – inhalation of spores.
 - Gastrointestinal – ingested spores.



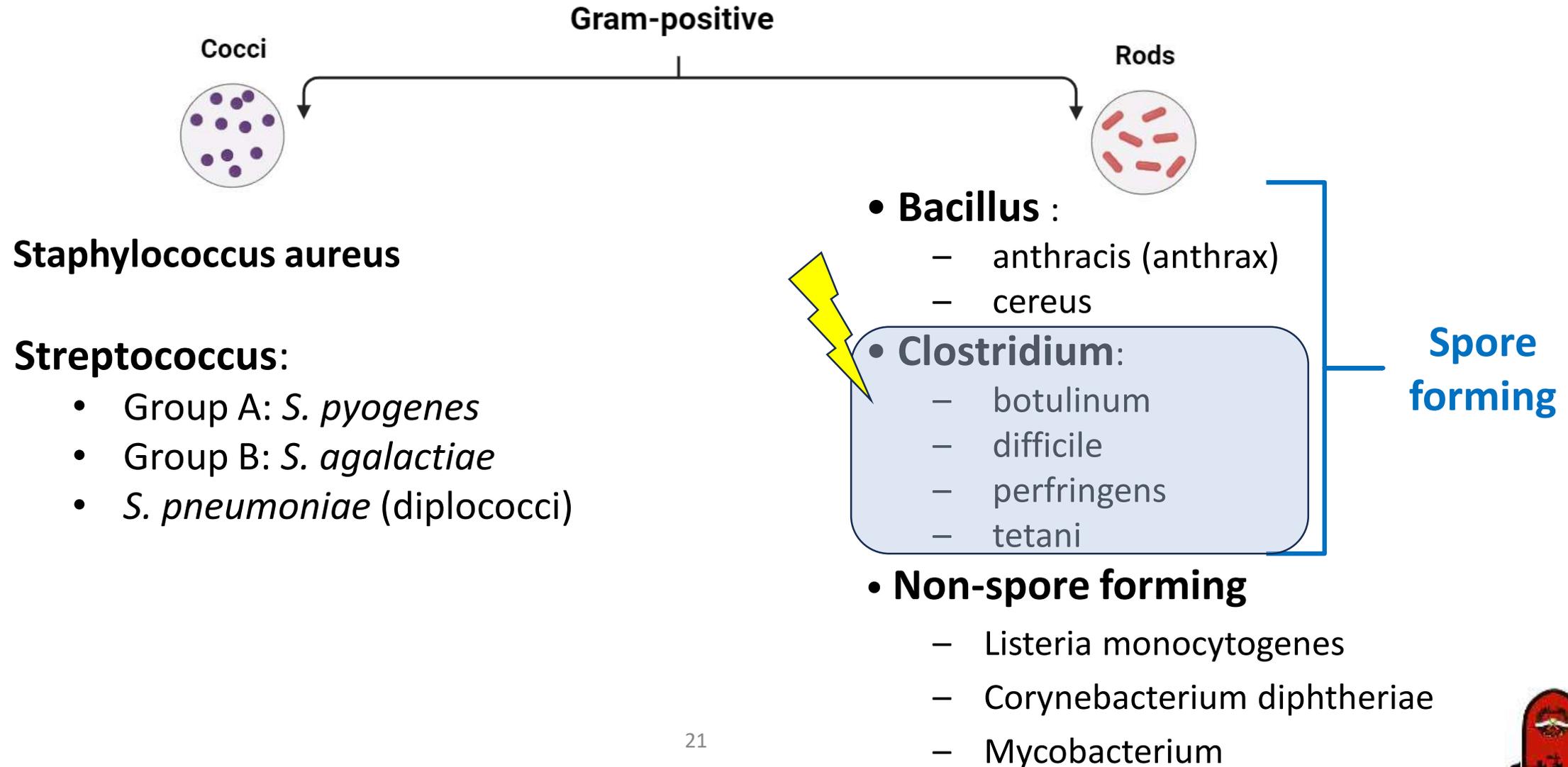
Medically Important Gram-Positive Bacilli

Bacillus - *Bacillus cereus*

- Grows in foods, spores survive cooking/ reheating (rice dishes).
- Ingestion of toxin-containing food causes nausea, vomiting, abdominal cramps, diarrhea
- No treatment.
- Increasingly reported in immunosuppressed.



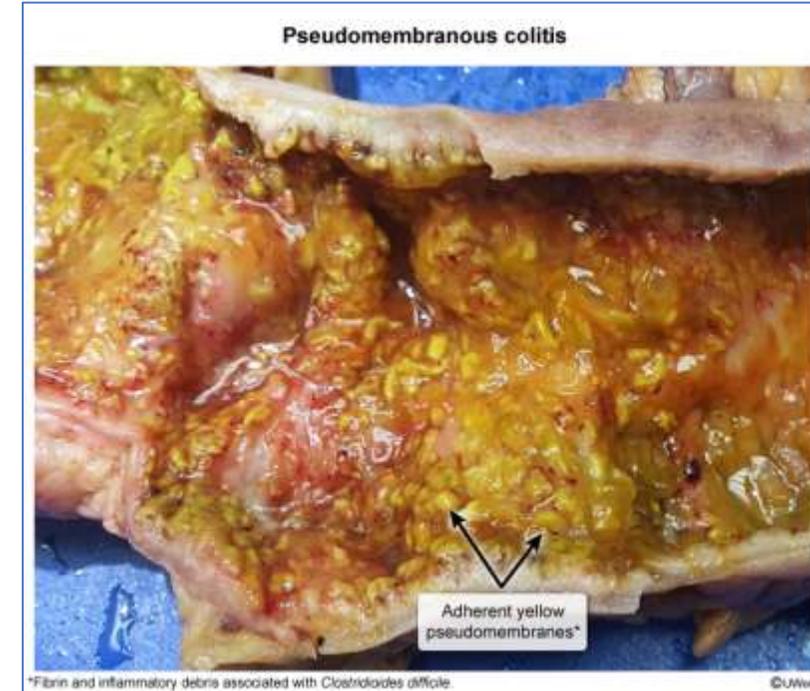
Medically Important Gram-Positive Cocci



Medically Important Gram-Positive Bacilli

Clostridium - *Clostridium difficile*

- Normal flora colon, in low numbers.
- Causes antibiotic associated colitis
- Due to treatment with broad-spectrum antibiotics that kills other bacteria: *C. difficile* overgrowth
- Enterotoxins that damage intestines.
- Major cause of diarrhea in hospitals.
- Treatment: stop antimicrobials/fluid electrolyte replacement.



Clostridioides difficile colitis

Risk factors	<ul style="list-style-type: none">• Recent antibiotic use• Hospitalization• Gastric acid suppression (eg, PPI)
Pathogenesis	<ul style="list-style-type: none">• Disruption of intestinal flora → <i>C difficile</i> overgrowth• Pseudomembrane formation
Clinical presentation	<ul style="list-style-type: none">• Profuse watery diarrhea (most common)• Leukocytosis (~15,000/mm³)• Fulminant colitis/toxic megacolon
Diagnosis	<ul style="list-style-type: none">• Stool PCR for <i>C difficile</i> genes*• Stool EIA for <i>C difficile</i> toxin
Treatment	<ul style="list-style-type: none">• Oral fidaxomicin or oral vancomycin• IV metronidazole added for fulminant disease

*Genes specific to toxigenic strains are assessed.

EIA = enzyme immunoassay; **IV** = intravenous; **PCR** = polymerase chain reaction; **PPI** = proton pump inhibitor.



Medically Important Gram-Positive Bacilli

Clostridium - *Clostridium perfringens* (Gas Gangrene)

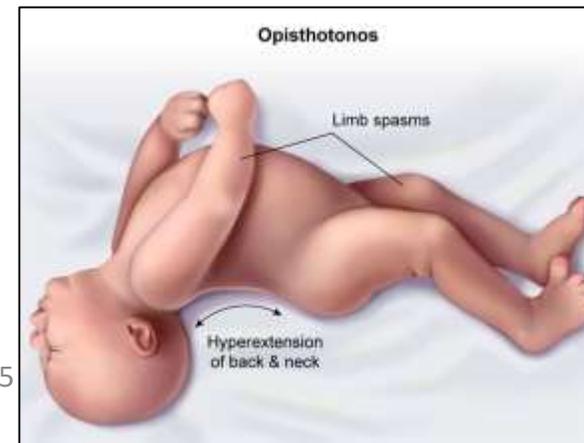
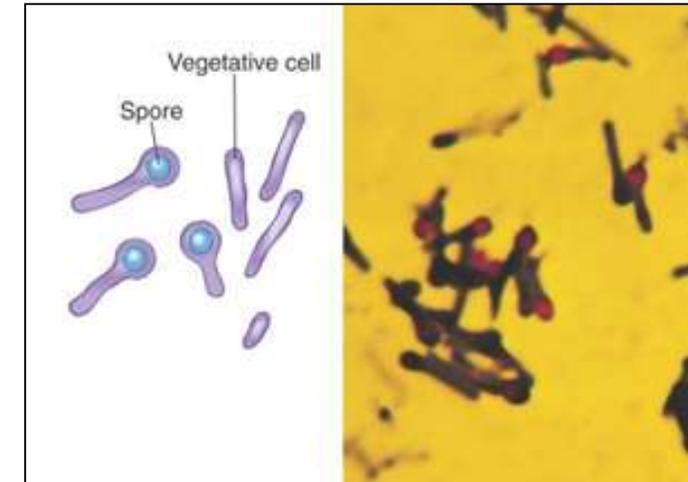
- Spores of *Clostridium perfringens*, a gram-positive bacillus responsible for ~95% of cases of gas gangrene (clostridial myonecrosis)
- Spores are abundant in soil and can inoculate penetrating injury sites.
- Soft tissue :wound infections: myonecrosis
- Virulence factors (lytic enzymes)
- Treatment: antibiotics/amputation



Medically Important Gram-Positive Bacilli

Clostridium - *Clostridium tetani* : Tetanus

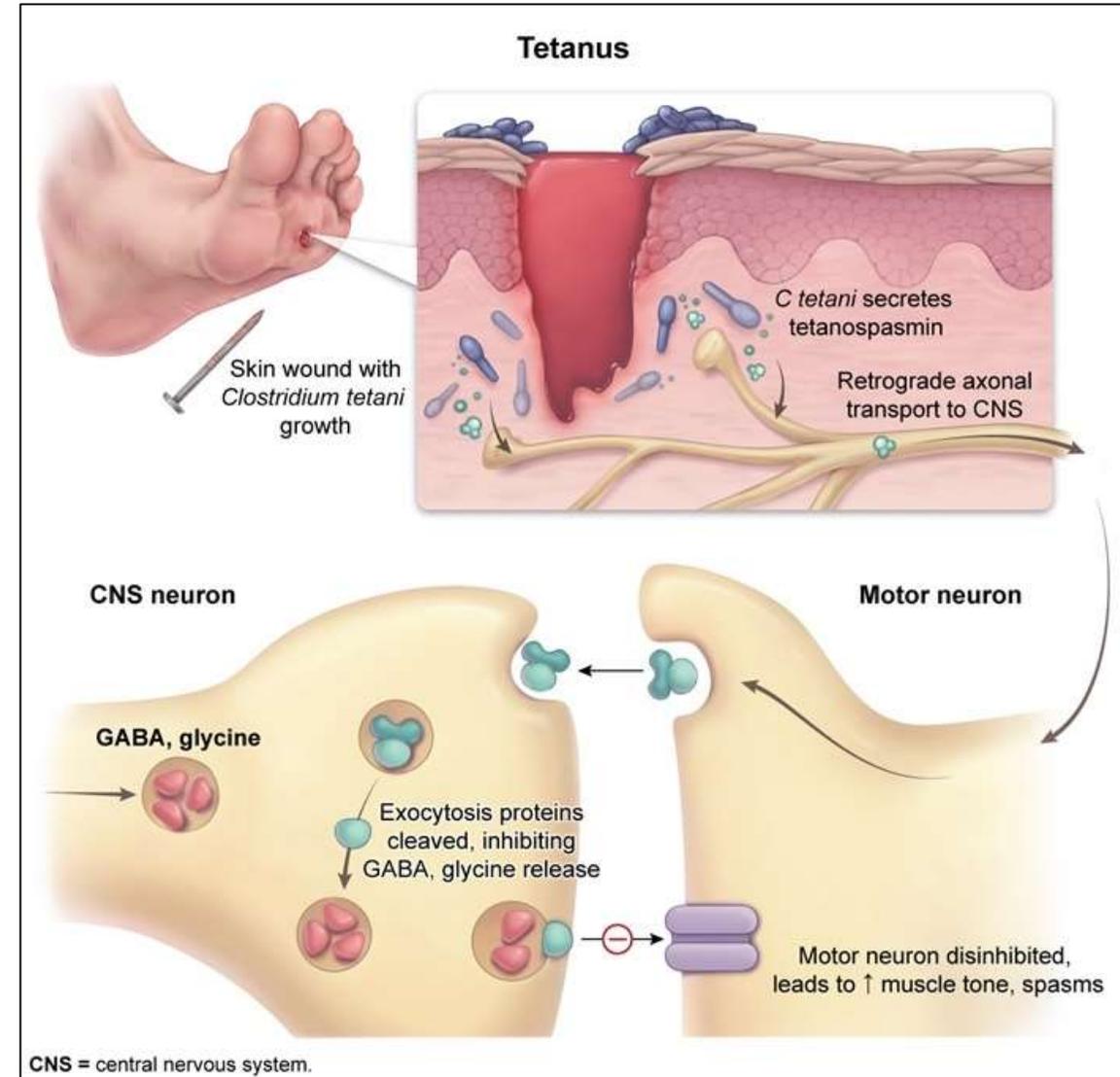
- Clostridium tetani is a thin, gram-positive rod with a round terminal spore ("tennis racket" appearance) that grows in strict anaerobic conditions.
- Common resident :of soil and GI tracts of animals.
- Causes tetanus or lockjaw, a neuromuscular disease.
- Most commonly among IV drug abusers and neonates in developing countries.



Medically Important Gram-Positive Bacilli

Clostridium - *Clostridium tetani* : Tetanus

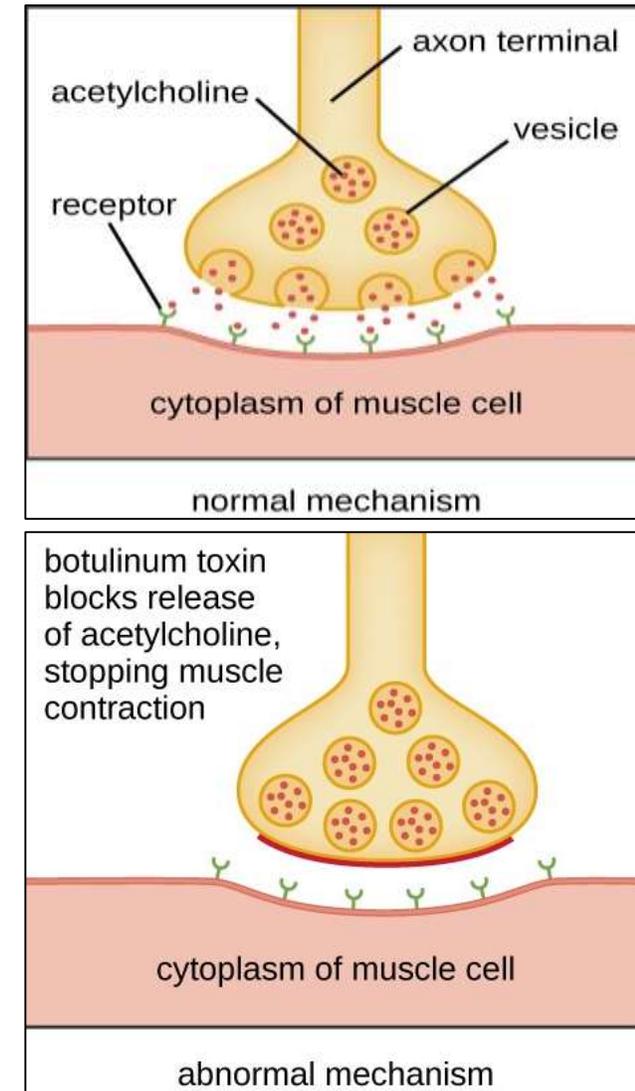
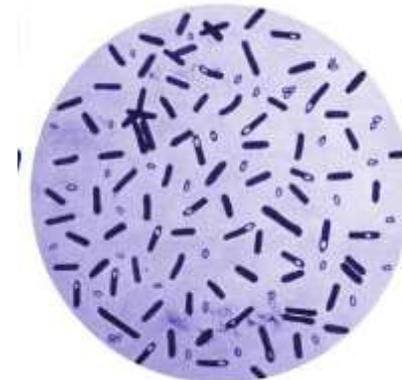
C tetani causes disease not through tissue invasion but by producing a potent metalloprotease **exotoxin** (tetanospasmin) that is deadly in nanogram quantities. The toxin first binds to receptors on the presynaptic membranes of peripheral motor neurons. From there, it migrates by **retrograde axonal transport** to central inhibitory neurons in the spinal cord and brain stem and prevents release of the inhibitory neurotransmitters **glycine** and **gamma-aminobutyric acid (GABA)**. Suppression of inhibitory nerve activity results in **increased activation** of motor nerves, causing **muscle spasms** and **hyperreflexia**.



Medically Important Gram-Positive Bacilli

Clostridium - *Clostridium Botulinum*: Flaccid paralysis

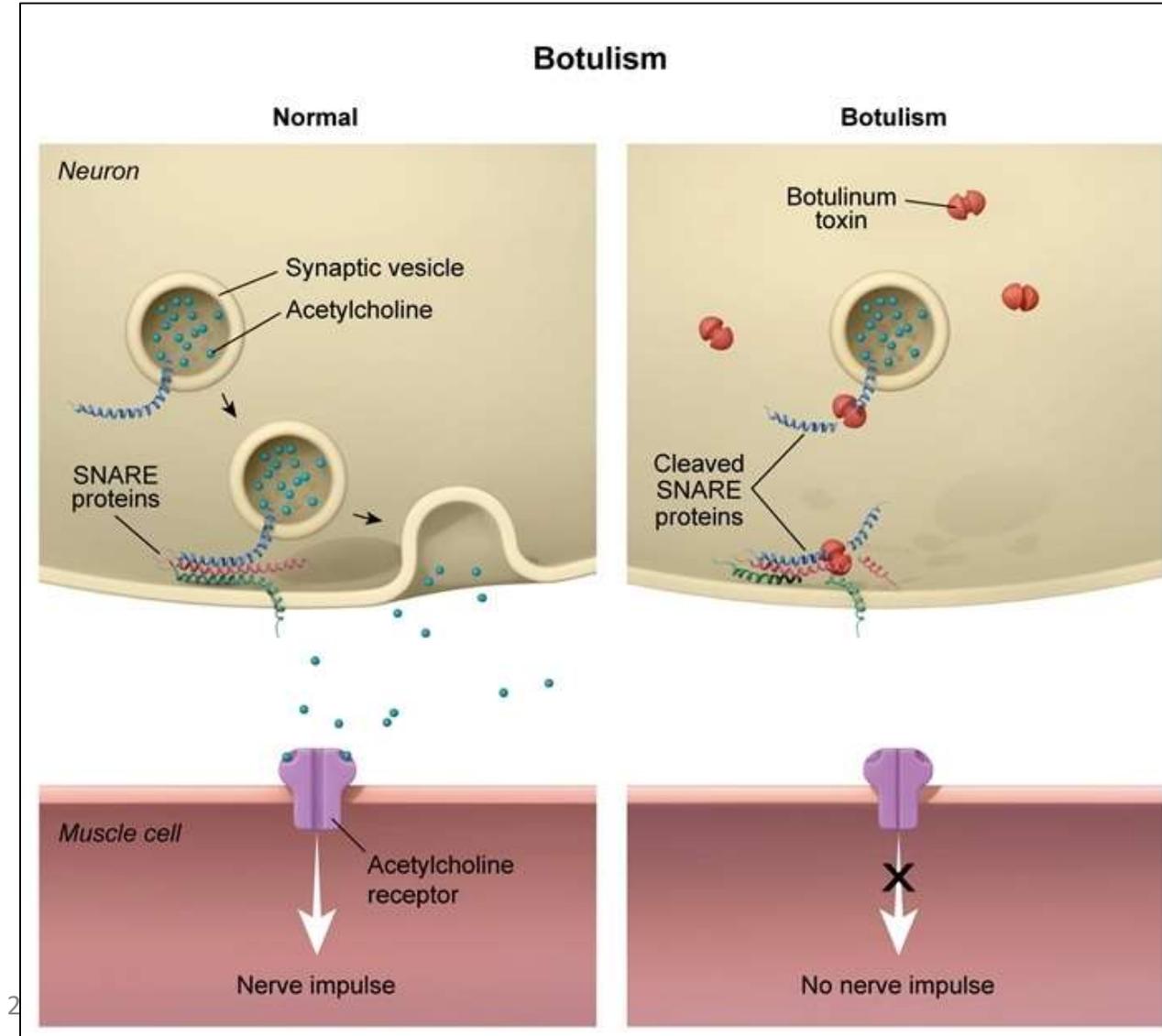
- Botulism—intoxication associated with inadequate food preservation
- Spore formation, which occurs in the **subterminal location** (in between the middle and end of the cell), allows the bacteria to survive adverse conditions (eg, heat, high-oxygen environment).
- Toxin carried to neuromuscular junctions: blocks the release of acetylcholine: necessary for muscle contraction to occur.
- Clinically
 - Double or blurred vision
 - Difficulty swallowing
 - Neuromuscular symptoms



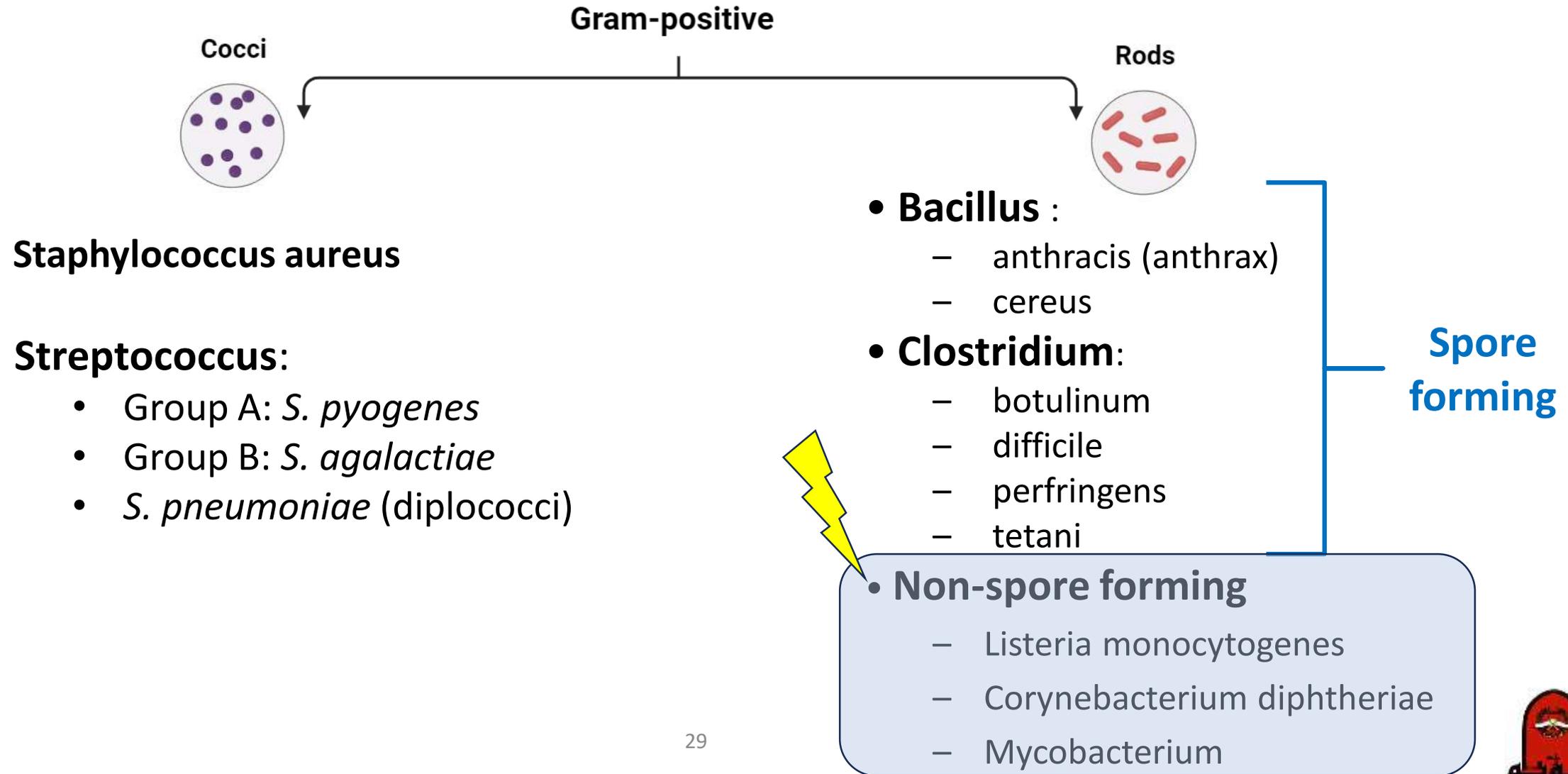
Medically Important Gram-Positive Bacilli

Clostridium - *Clostridium Botulinum*: Flaccid paralysis

- **Botulinum toxin** causes disease by inhibiting nicotinic and muscarinic motor neurons.
- It enters the nerve terminals through endocytosis, where it prevents binding and fusion of acetylcholine-containing synaptic vesicles with the plasma membrane through the destruction of SNARE proteins. This effectively **blocks ACh release** into the synapse.
- Botulinum toxin is highly potent; a very small quantity can be lethal without ventilatory support. The toxin is **heat labile**, so disease can be prevented by thoroughly heating food prior to consumption.



Medically Important Gram-Positive Cocci



Medically Important Gram-Positive Bacilli

Gram Positive Non-Spore-Formers

Listeria monocytogenes

- Found in soil, water, luncheon meats, hot dogs, cheese.
- Resistant to long storage and refrigeration, heat, salt, pH extremes and bile.



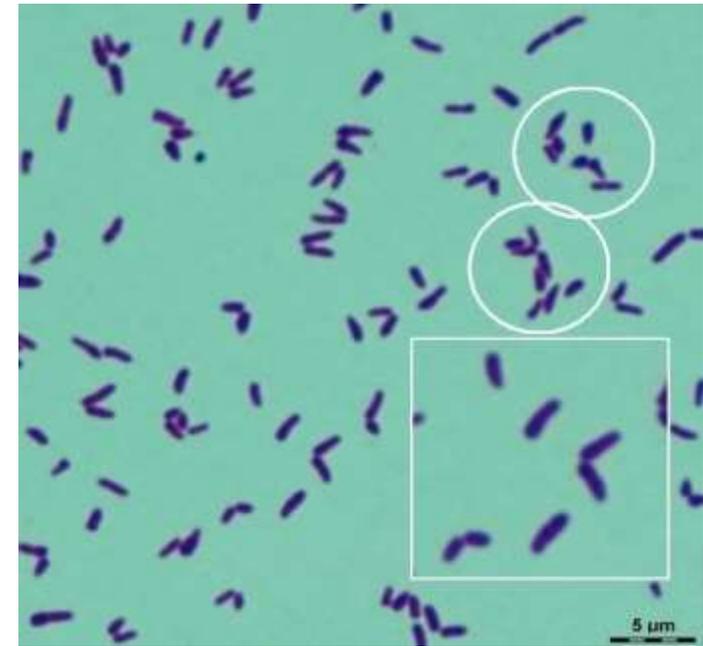
Muller Hinton agar

Medically Important Gram-Positive Bacilli

Gram Positive Non-Spore-Formers

Corynebacterium diphtheriae

- Virulence factors: diphtherotoxin.
- Vaccine (DPT).
- Causes a pseudomembrane which can cause asphyxiation.
- Acquired via respiratory droplets from carriers or actively infected individuals.

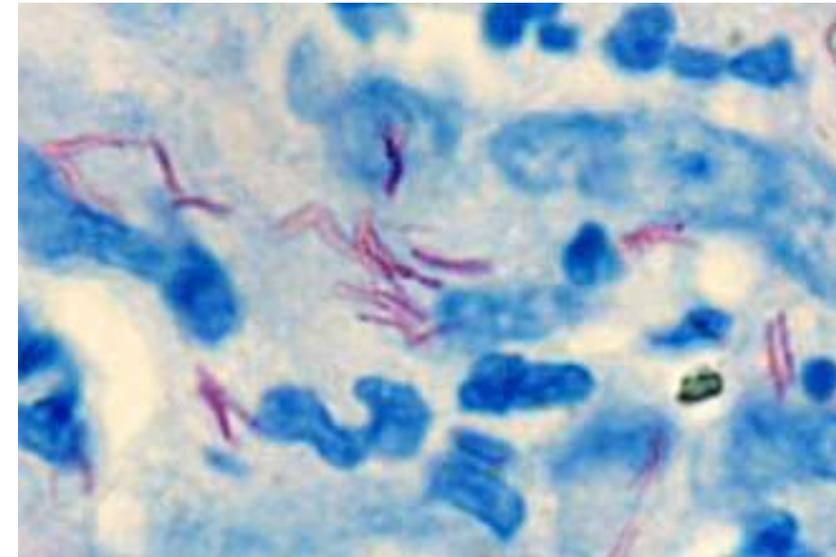


Medically Important Gram-Positive Bacilli

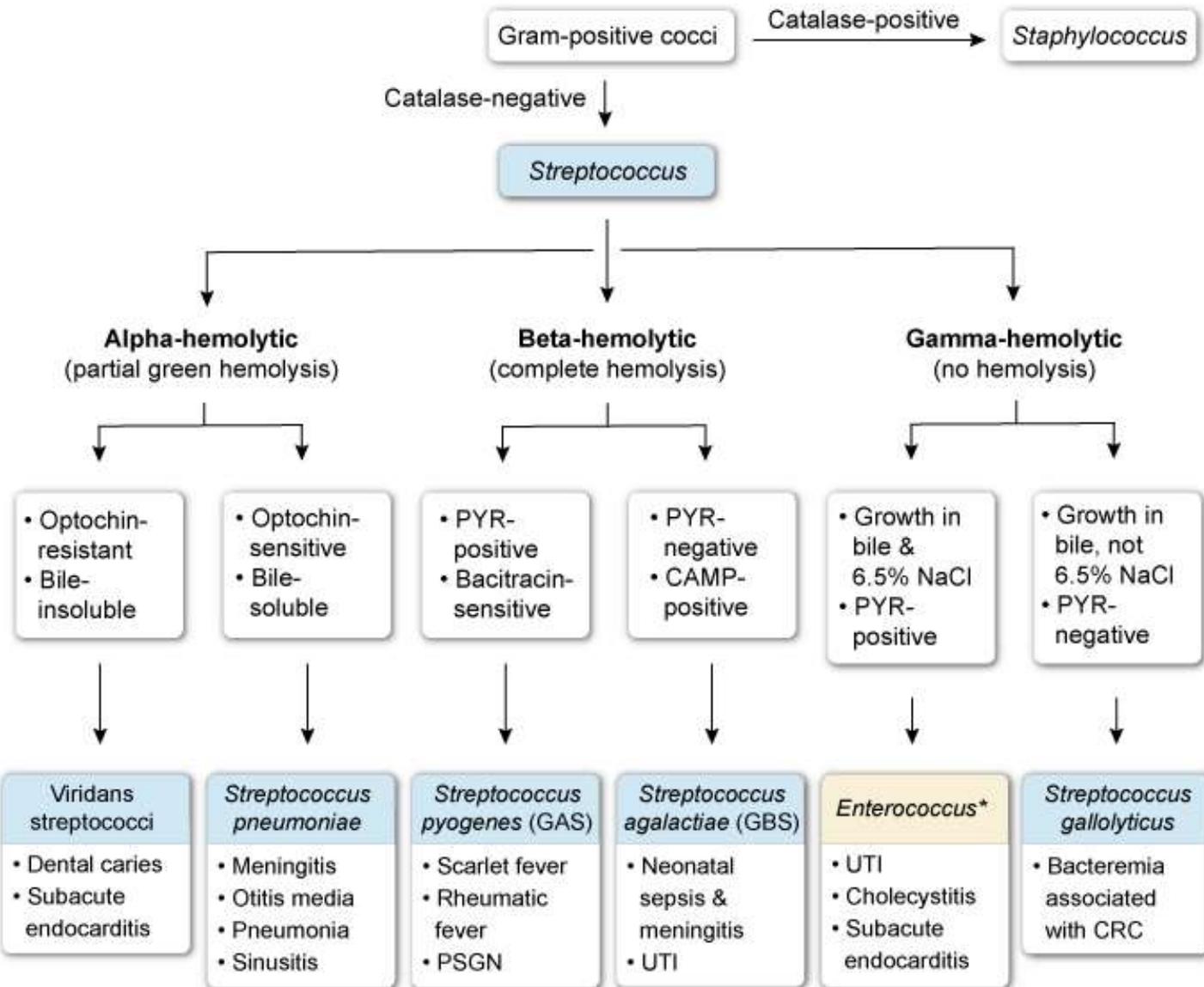
Gram Positive Non-Spore-Formers

Mycobacterium

- Gram-positive irregular bacilli.
- Acid-fast staining: mycolic acids.
- Strict aerobes.
- Grow slowly.
- Virulence factors - Mycobacteria inhibits phagosome lysosome fusion (Sulfatides factor)



Microbiologic laboratory identification of streptococci



*Formerly group D streptococci

CAMP = Christie, Atkins & Munch-Petersen test; **CRC** = colorectal cancer; **NaCl** = sodium chloride; **PSGN** = poststreptococcal glomerulonephritis; **PYR** = pyrrolidonyl arylamidase; **UTI** = urinary tract infection.

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