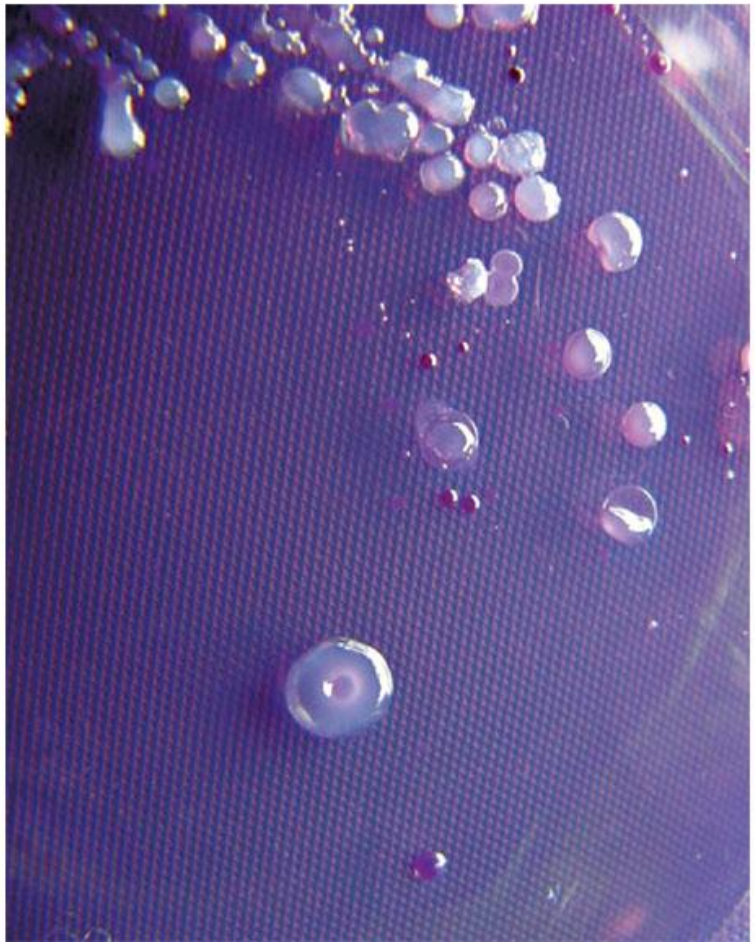
Foundations in Microbiology

Fifth Edition

Talaro

Chapter

18



Cocci of Medical Importance

Chapter 18

Cocci of Interest

- *Staphylococcus aureus*
  - *S. epidermidis, S. hominis, S. capitis*
  - *S. saprophyticus*
- *Streptococcus pyogenes*
  - *S. agalactiae,*
  - *viridans streptococci, S. mutans*
- *Streptococcus pneumoniae*
- *Enterococcus faecalis*
- *Neisseria gonorrhoeae*
- *Neisseria meningitidis*

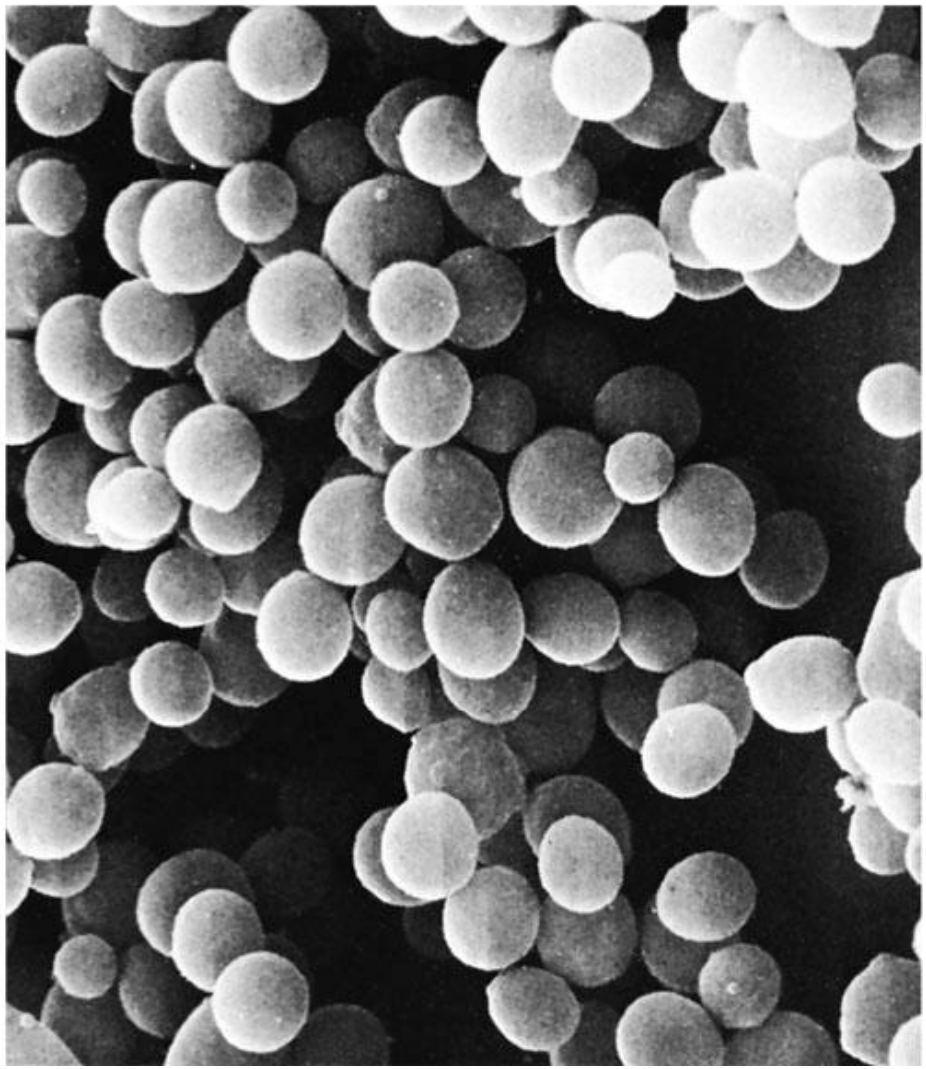
General characteristics of the Staphylococci

- Spherical cells arranged in irregular clusters
- Gram positive
- Common inhabitant of the skin & mucous membranes
- Lack spores and flagella
- May have capsules
- 31 species

Staphylococcus aureus

- grows in large, round, opaque colonies
- optimum temperature of 37^{o}C
- facultative anaerobe
- withstands high salt, extremes in pH, & high temperatures
- produces many virulence factors

S. aureus



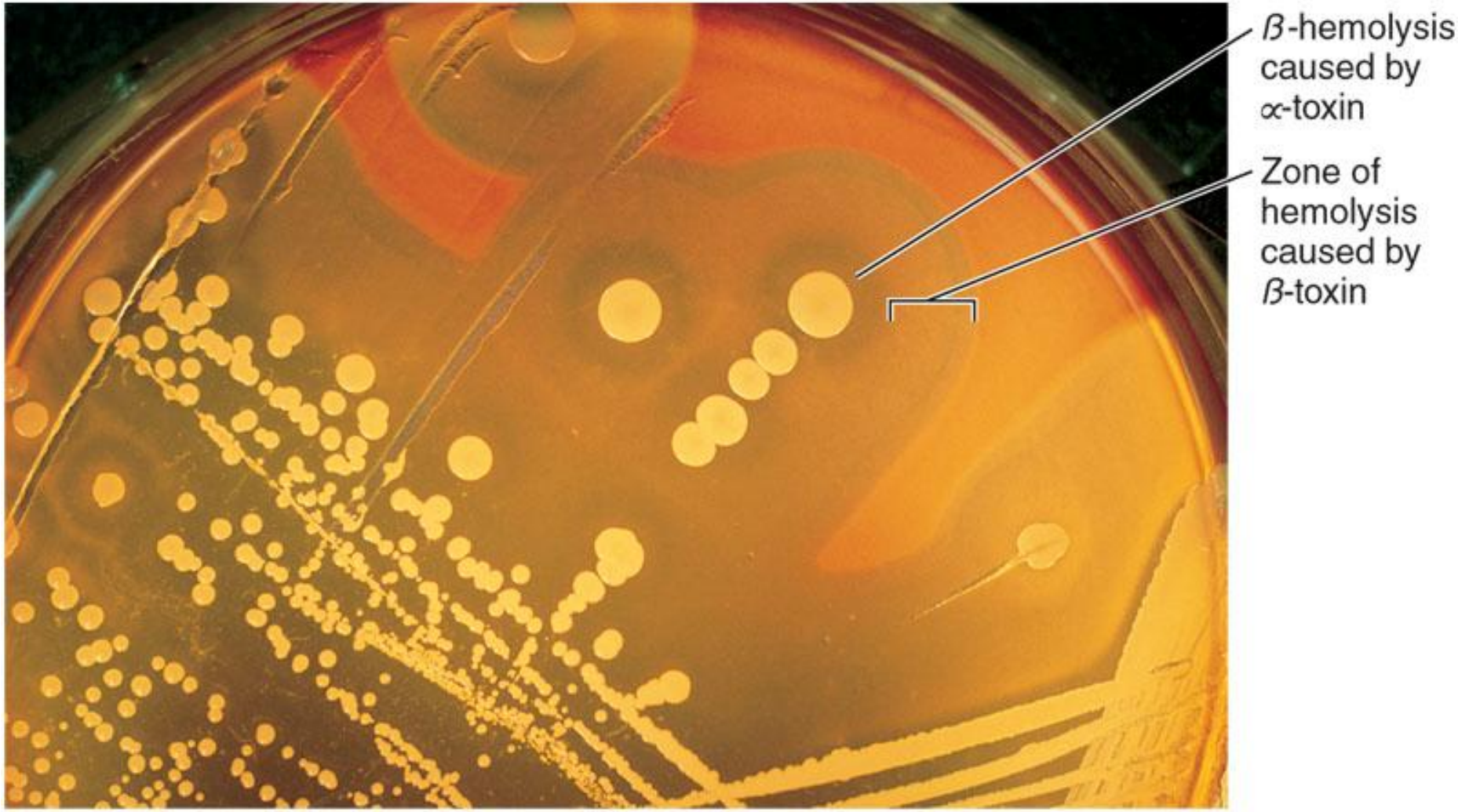
Toxins of *S. aureus*

- hemolysins – lyse RBCs;
  – α, β, γ, δ
- leukocidin
- enterotoxins
- exfoliative toxin
- toxic shock syndrome (TSS) toxin

Enzymes of *S. aureus*

- coagulase – coagulates plasma and blood; produced by 97% of human isolates; diagnostic
- hyaluronidase
- staphylokinase
- DNase
- lipases
- penicillinase

S. aureus



S. aureus

- Present in most environments frequented by humans
- Readily isolated from fomites
- Carriage rate for healthy adults is 20-60%
- Carriage is mostly in anterior nares, skin, nasopharynx, intestine

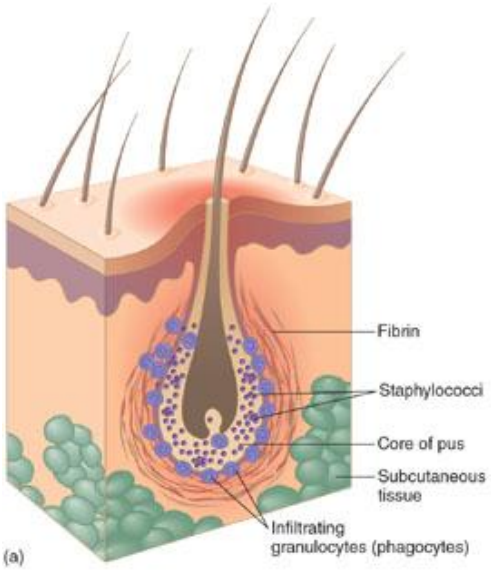
S. aureus diseases

- Ranges from localized to systemic
- localized -abscess, folliculitis, furuncle, carbuncle, impetigo
- systemic – osteomyelitis, bacteremia
- toxigenic disease – food intoxication, scalded skin syndrome (SSS), toxic shock syndrome (TSS)

Staphylococcal Infections

- Pimples, boils, and carbuncles
- Septicemia
- Abscess in any organ
- Food poisoning
- Osteomylitis
- Staphylococcal enteritis
- Wound infections
- Impetigo
- Scalded-skin Syndrome
- Endocarditis
- Meningitis
- Pneumonia
- Toxic Shock Syndrome

S. aureus

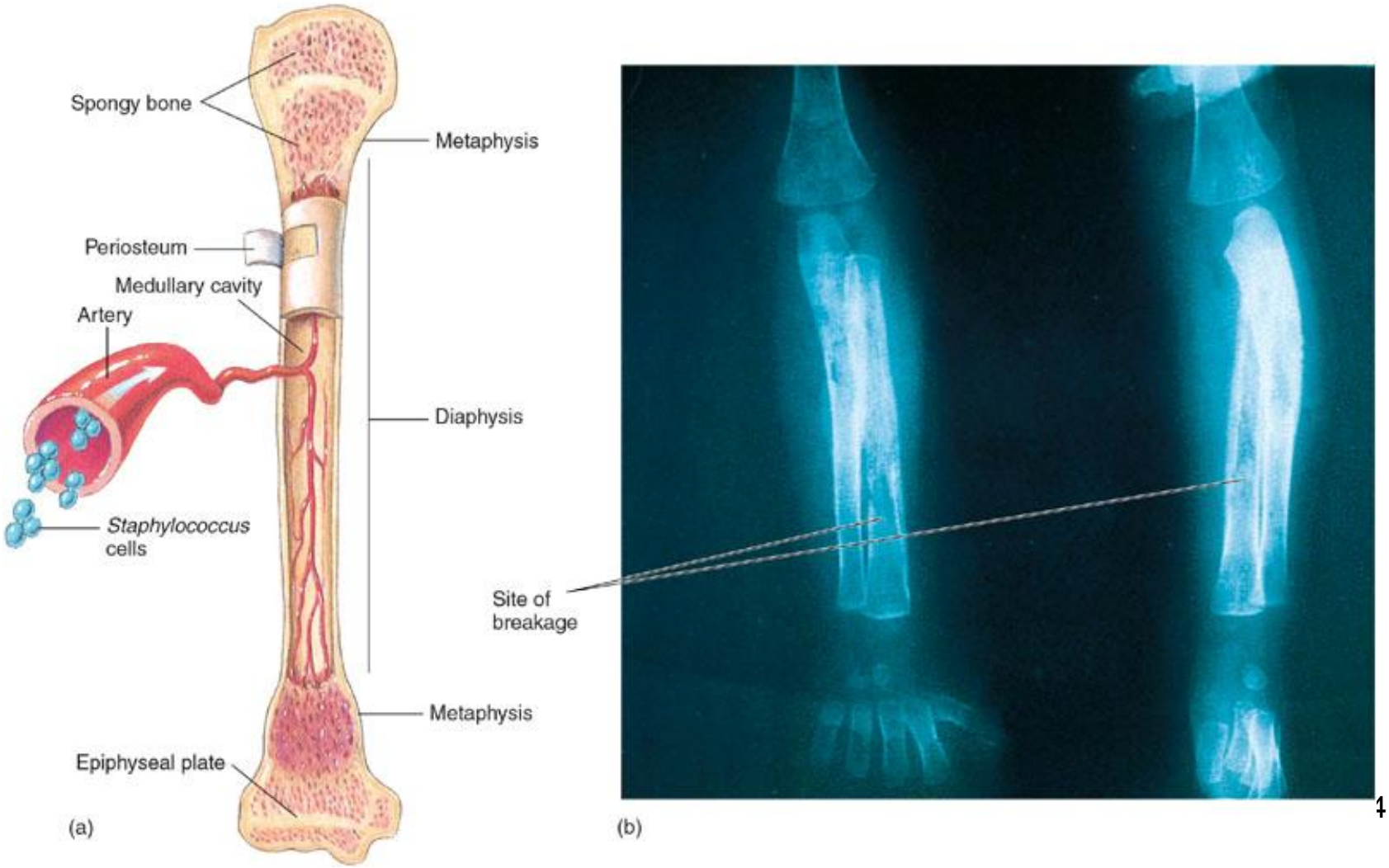


(a)

(b)

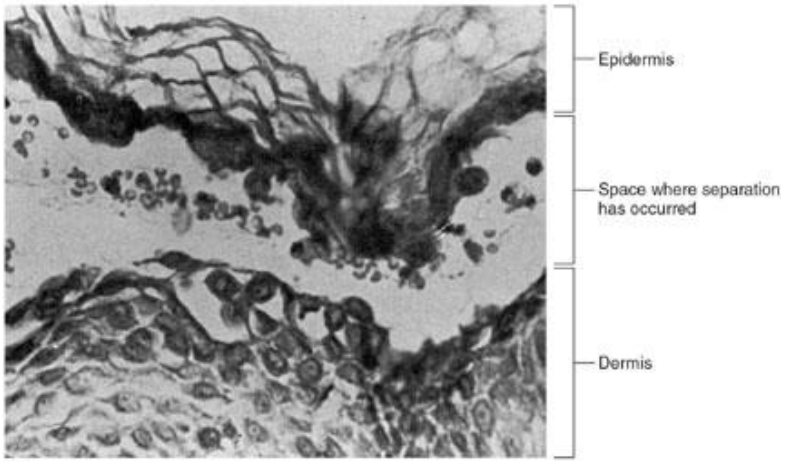
(c)

S. aureus



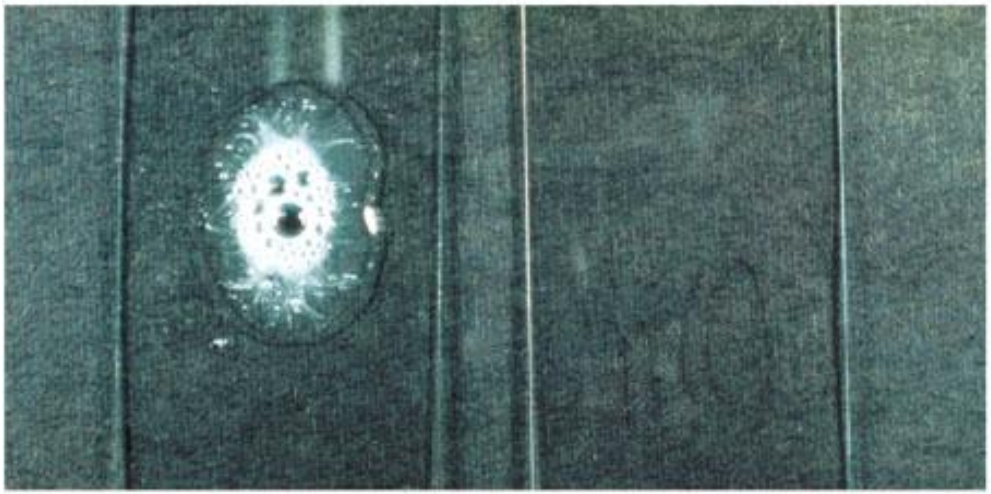
S. aureus

(a)

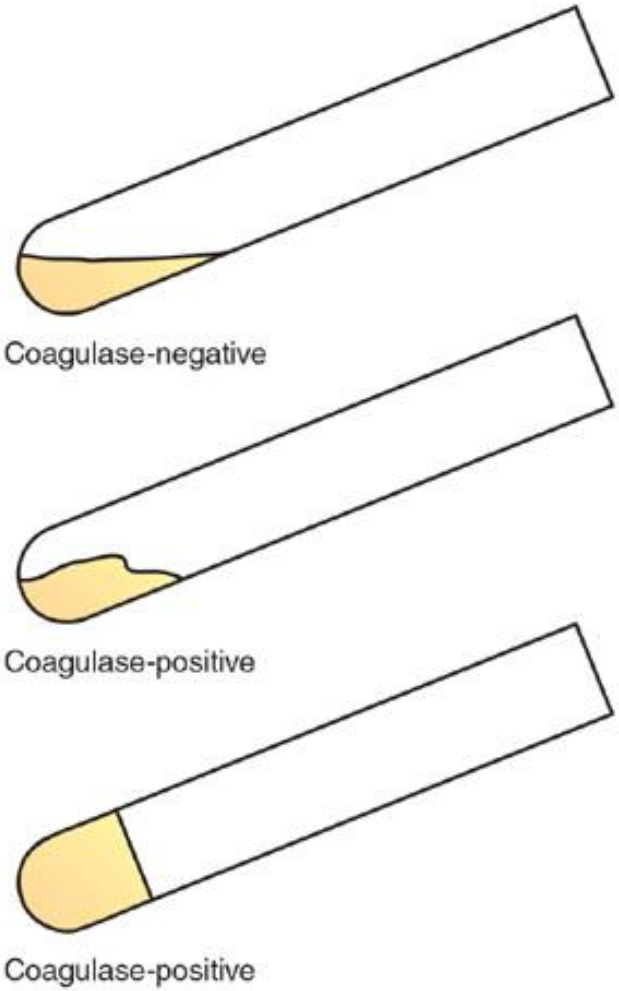


(b)

S. aureus



(a) Catalase present Catalase absent



(b)

Other Staphylococci

- *S. epidermidis* – lives on skin & mucous membranes; endocarditis, bacteremia, UTI
- *S. hominis* – lives around apocrine sweat glands
- *S. capitis* – live on scalp, face, external ear
- All 3 may cause wound infections
- *S. saprophyticus* – infrequently lives on skin, intestine, vagina; UTI

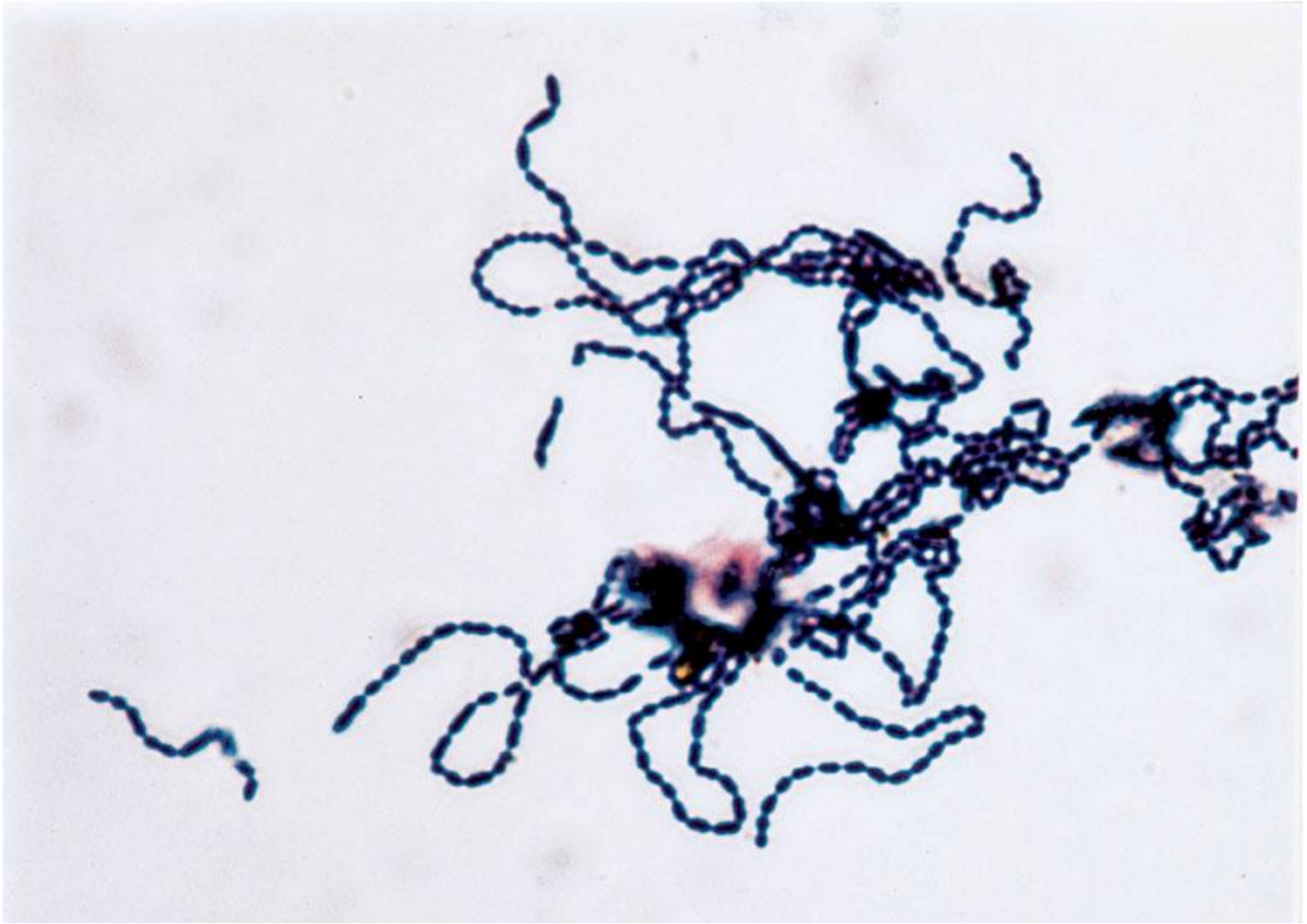
Clinical concerns

- 95% have penicillinase & are resistant to penicillin & ampicillin
- MRSA – methicillin-resistant *S. aureus* – carry multiple resistance
- Abscesses have to be surgically perforated
- Systemic infections require intensive lengthy therapy

Streptococci

- Gram-positive spherical/ovoid cocci arranged in long chains
- Non-spore-forming, nonmotile
- Can form capsules & slime layers
- Facultative anaerobes
- Do not form catalase, but have a peroxidase system
- Most parasitic forms are fastidious & require enriched media
- Small, nonpigmented colonies
- Sensitive to drying, heat & disinfectants
- 25 species

Streptococcus

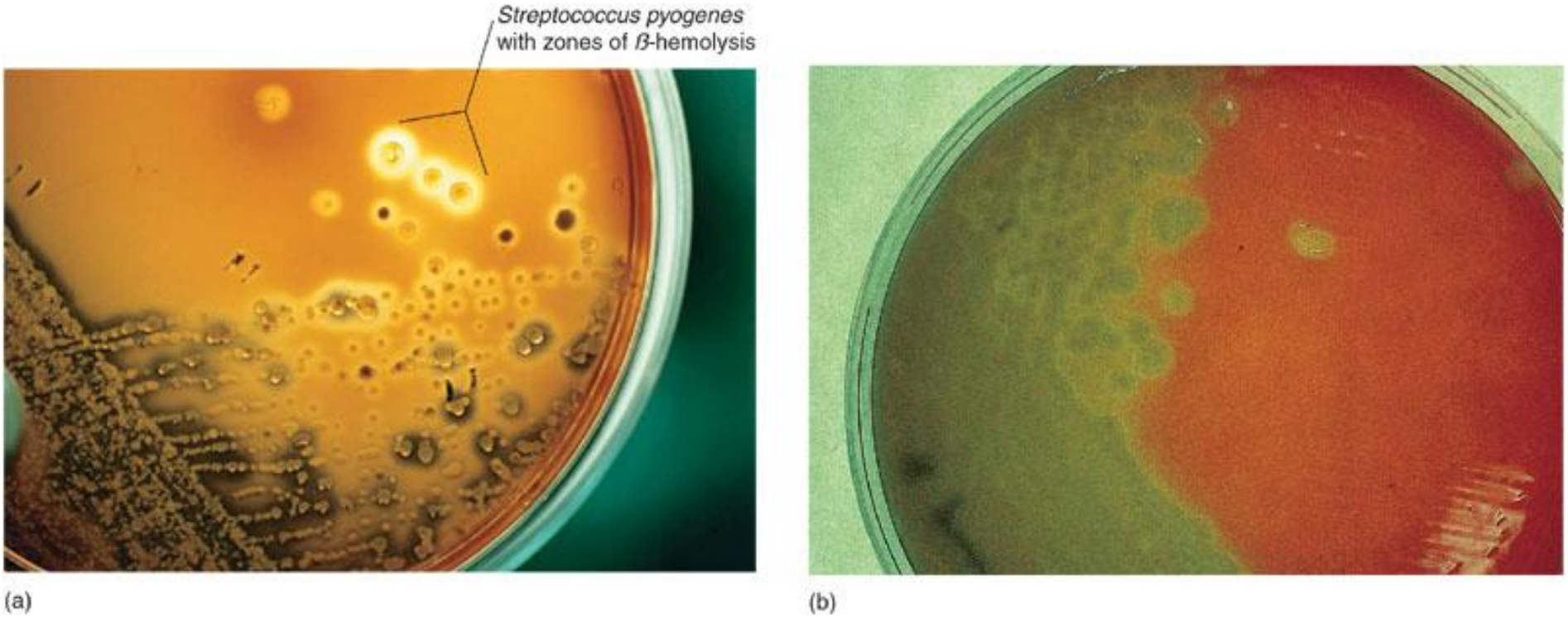


Streptococci

- Lancefield classification system based on cell wall Ag – 14 groups (A,B,C,….)
- Another classification system is based on hemolysis reactions

–β-hemolysis – A,B,C,G & some D strains

–α –hemolysis – *S. pneumoniae* & others collectively called *viridans*



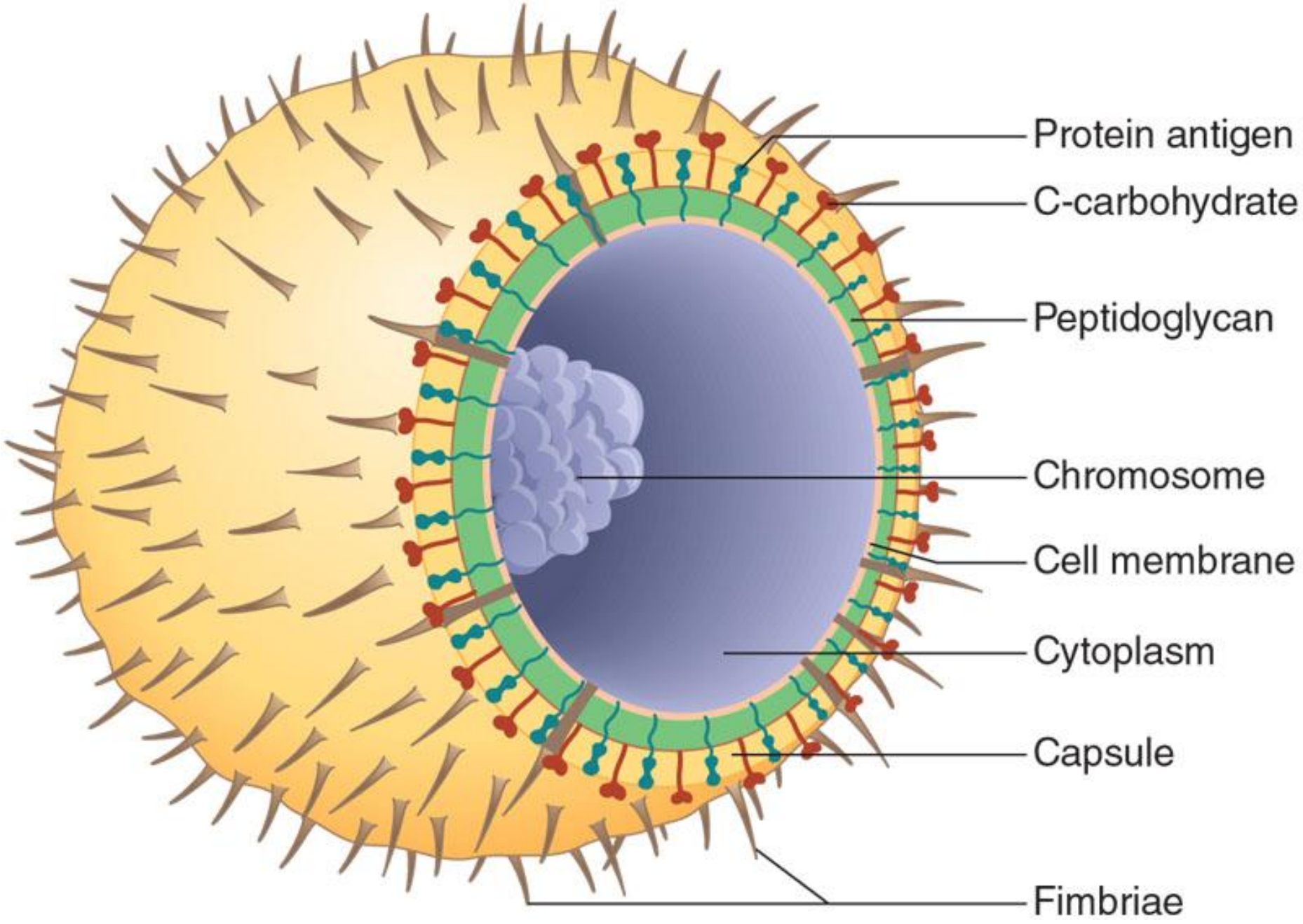
(a) (b)

Human streptococcal pathogens

- *S. pyogenes*
- *S. agalactiae*
- viridans streptococci
- *S. pneumoniae*
- *Enterococcus faecalis, E. facuim*

β-hemolytic *S. pyogenes*

- Group A Strept
- Most serious streptococcal pathogen
- Strict parasite
- Inhabits throat, nasopharynx, occasionally skin
- Produces C-carbohydrates, M-protein (fimbrae), streptokinase, hyaluronidase, DNase, hemolysins (SLO, SLS), pyogenic toxin

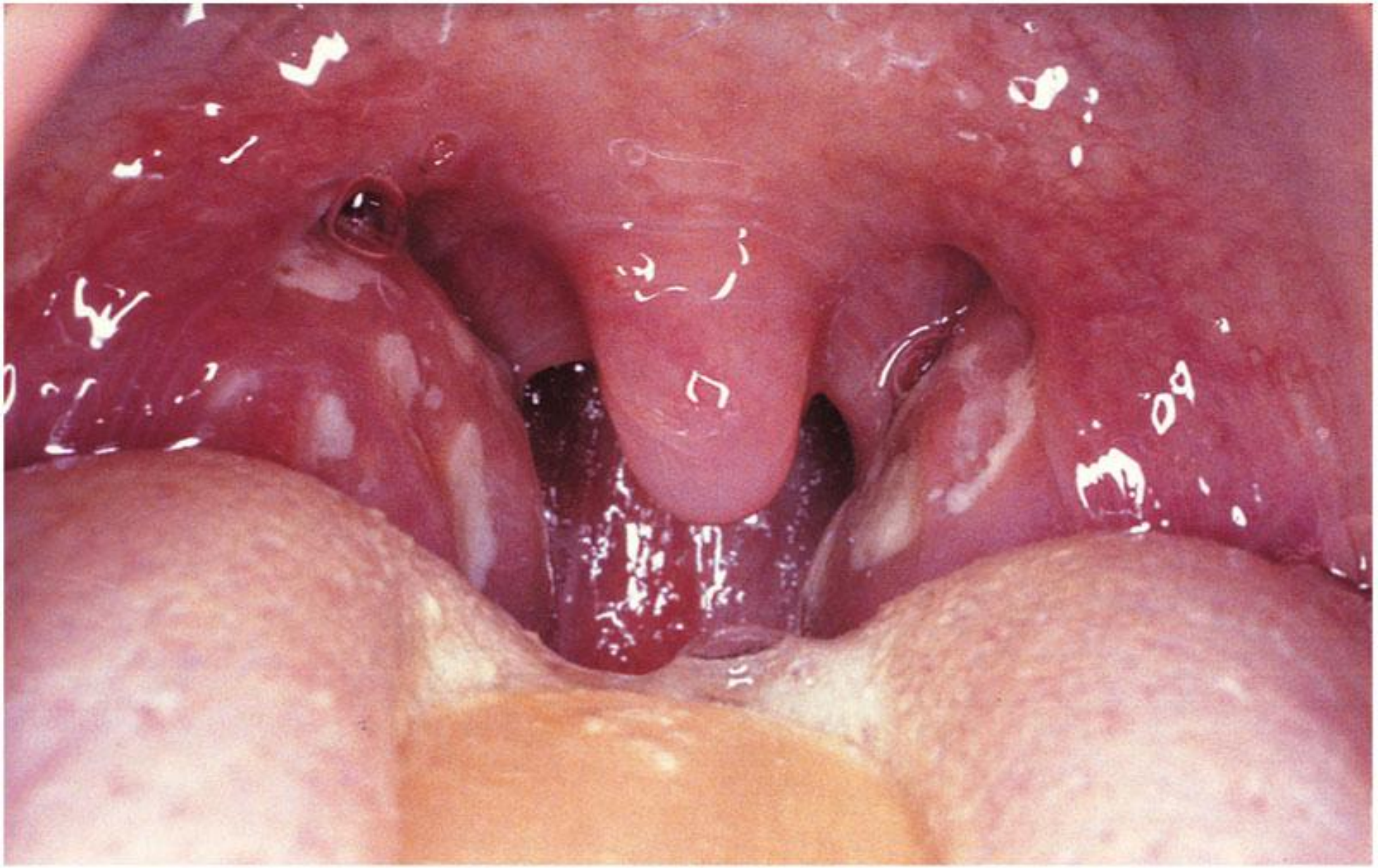


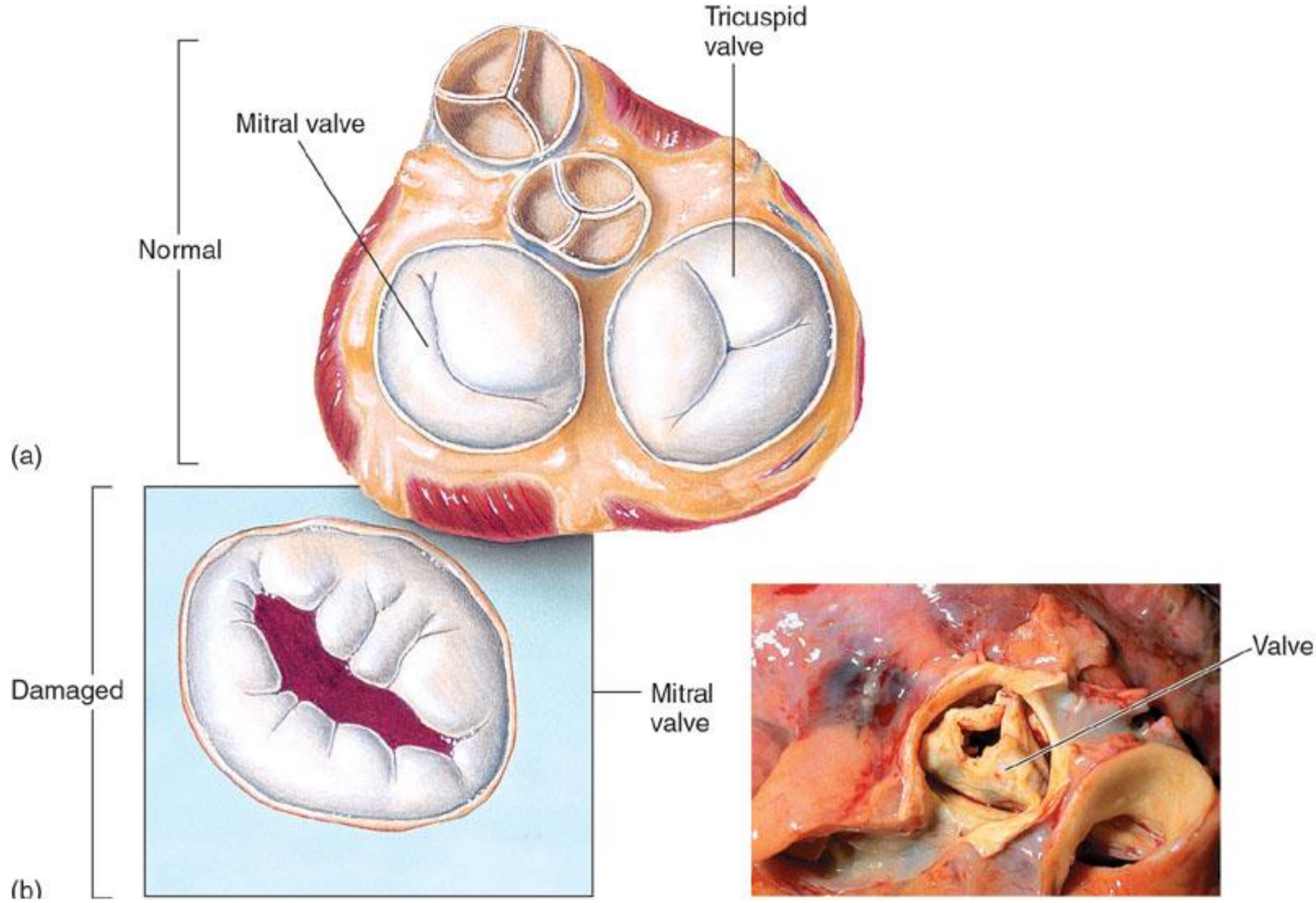
S. pyogenes

- Humans only reservoir
- Transmission – contact, droplets, food, fomites
- Skin infections –pyoderma, impetigo, erysipelas
- Systemic infections – strep throat, pharyngitis, scarlet fever
- Sequelae -rheumatic fever, glomerulonephritis

(a)

(b)





Streptococcal Diseases

- Pharyngitis
- Impetigo
- Cellulitis
- Wound Infections
- Meningitis
- Erysipelas
- Septicemia
- Otitis media
- Endocarditis; acute and subacute
- Urinary Tract Infections
- Brain Abscesses
- Puerperal Sepsis
- Scarlet Fever
- Rheumatic Fever
- Acute Glomerulo-nephritis

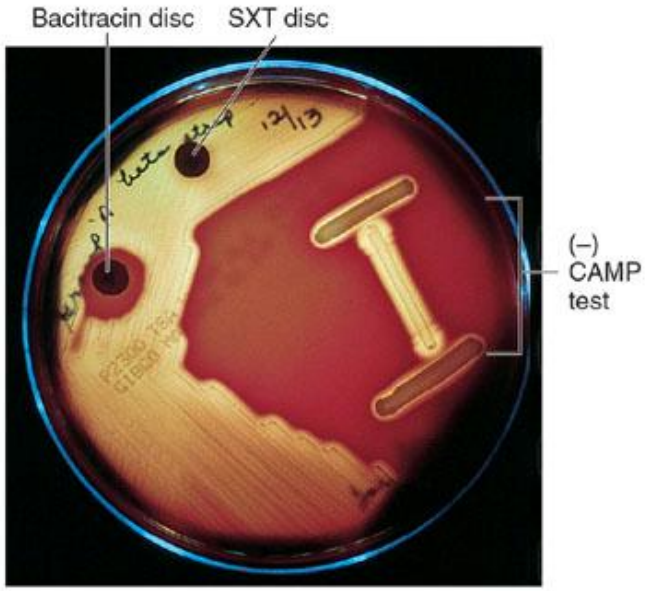
Group B: *S. agalactiae*

- Regularly resides in human vagina, pharynx & large intestine
- can be transferred to infant during delivery & cause severe infection
  - Most prevalent cause of neonatal pneumonia, sepsis, & meningitis
  - 15,000 infections & 5,000 deaths in US
  - Pregnant women should be screened & treated
- wound and skin infections & endocarditis in debilitated people

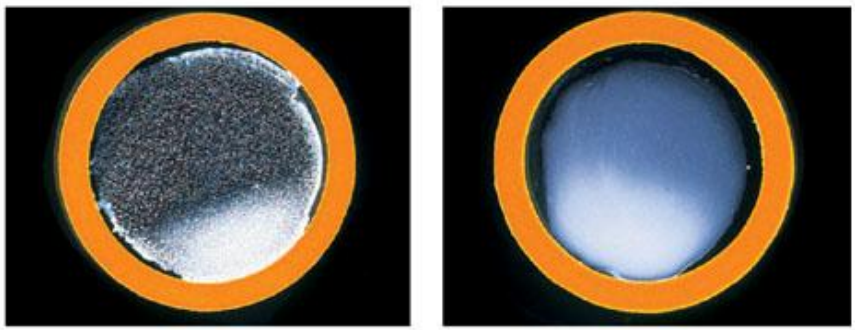
Enterococcus faecalis, & E. faecium

- Was Group D now elevated to genus
- Normal colonists of human large intestine
- Cause opportunistic urinary, wound, and skin infections, particularly in debilitated persons

Streptococcal tests



(a)

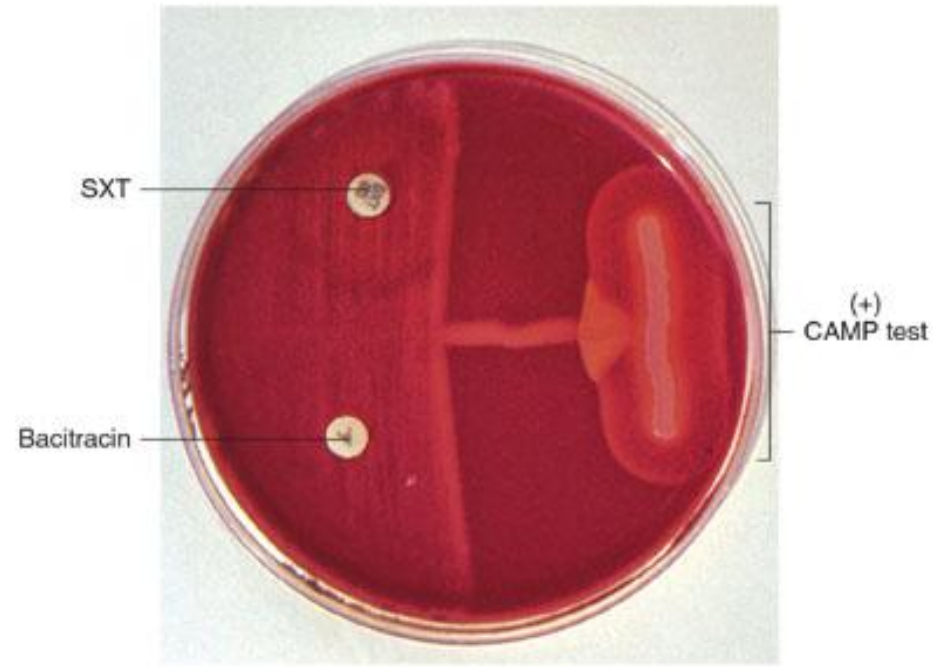


Positive reaction

Negative reaction

(b)

Streptococcal tests



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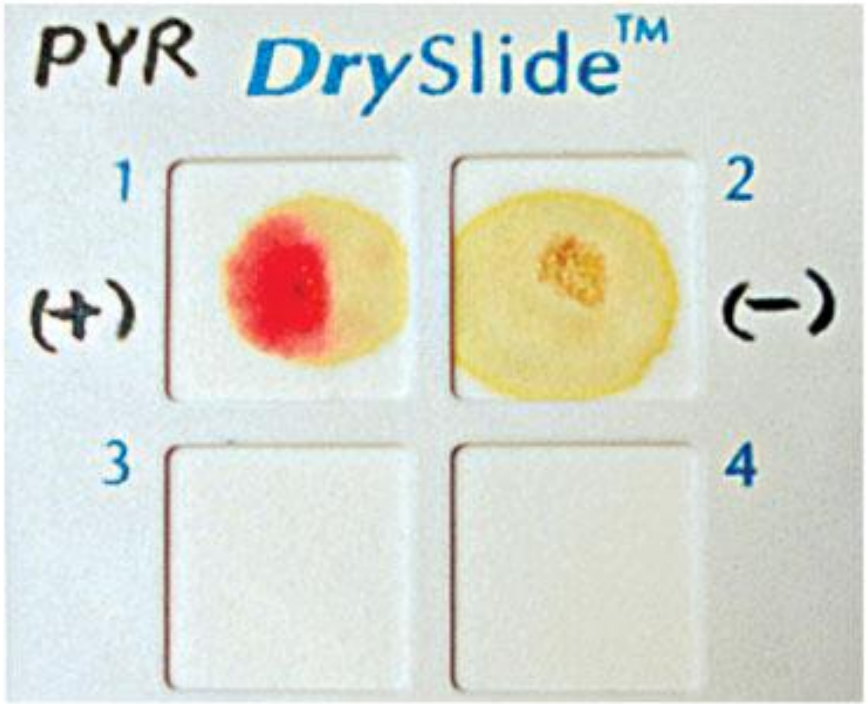


(b)

- Group A & B are treated with penicillin
- Sensitivity testing needed for enterococci
- No vaccines available

Viridans group

– α-hemolytic

- Large complex group
- Most numerous & widespread residents of the oral cavity & also found in nasopharynx, genital tract, skin
- Not very invasive, dental or surgical procedures facilitate entrance

Viridans group

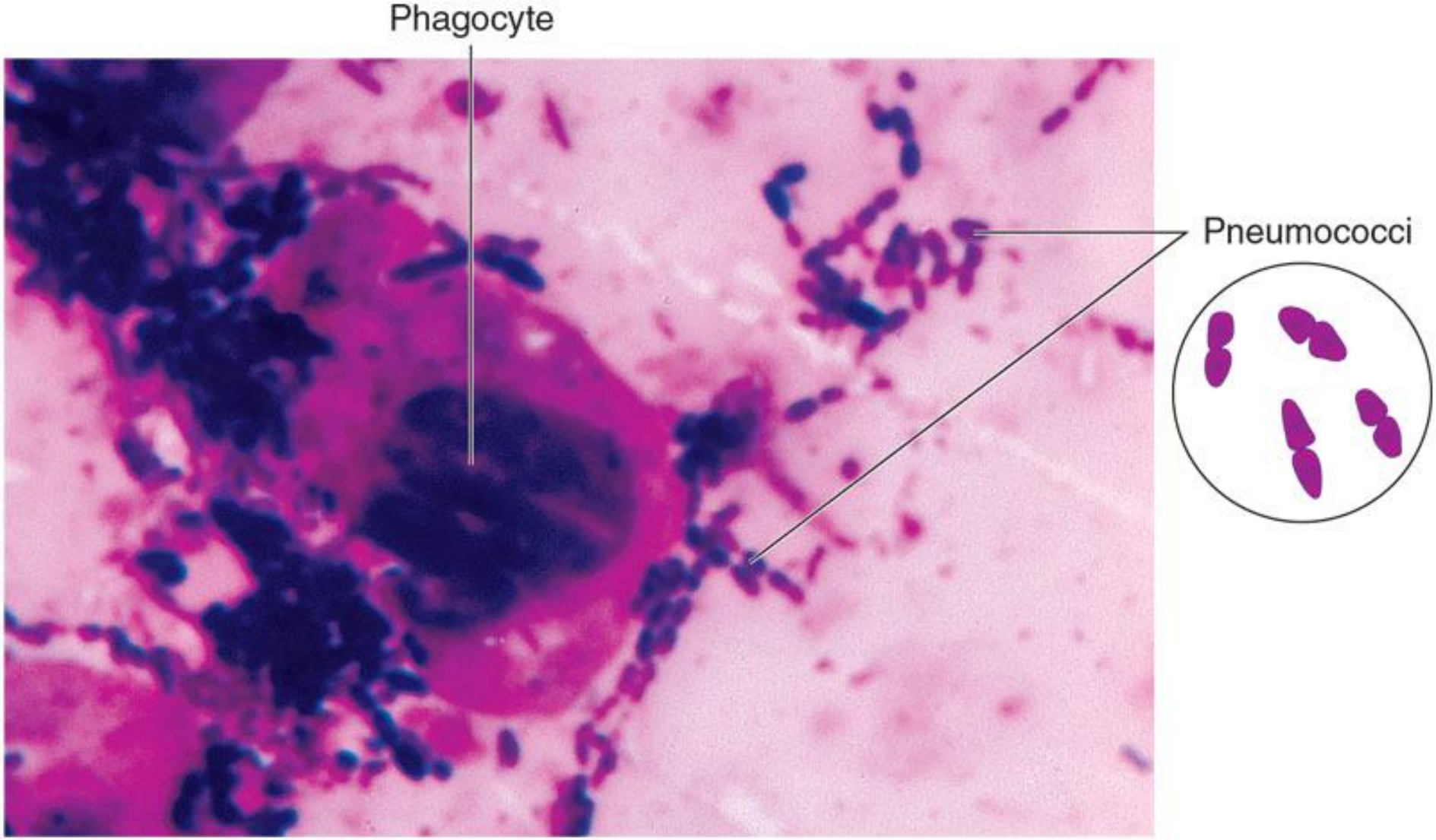
- Bacteremia, meningitis, abdominal infection, tooth abscesses
- Most serious infection – subacute endocarditis – blood-borne bacteria settle & grow on heart lining or valves
- Persons with preexisting heart disease are at high risk & receive prophylactic antibiotics before surgery or dental procedures

Viridans group

- *S. mutans* produces slime layers that adhere to teeth, basis for plaque
- involved in dental caries

S. pneumoniae

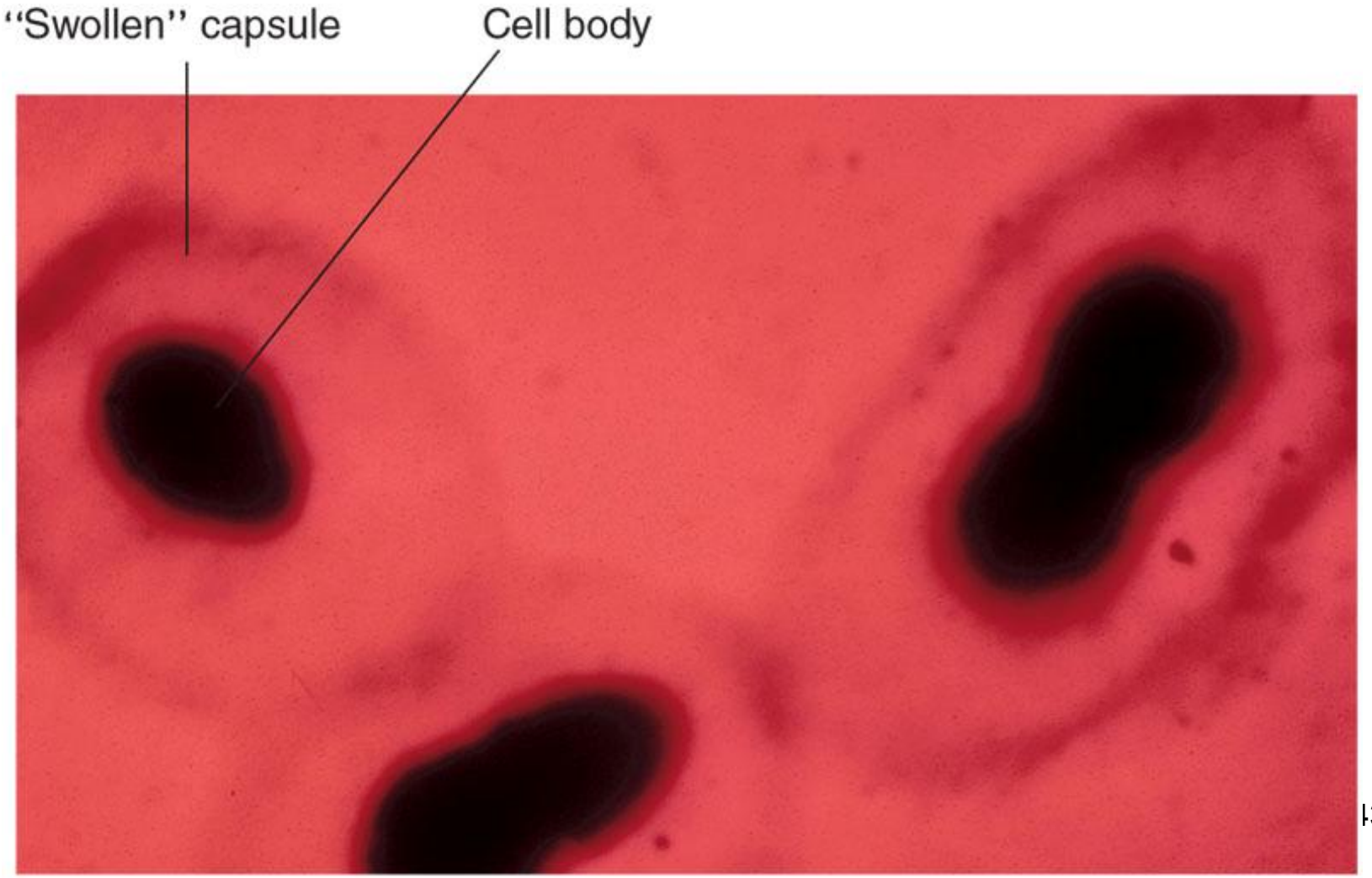
- Causes 60-70% of all bacterial pneumonias
- small, lancet-shaped cells arranged in pairs and short chains
- Culture requires blood or chocolate agar
- Growth improved by 5-10% CO_2
- Lack catalase & peroxidases – cultures die in O_2



S. pneumoniae

- All pathogenic strains form large capsules – major virulence factor
- Specific soluble substance (SSS) varies among types
- 84 capsular types have been identified using Quellung test or capsular swelling reaction
- Causes pneumonia & otitis media
- Vaccine available for high risk people

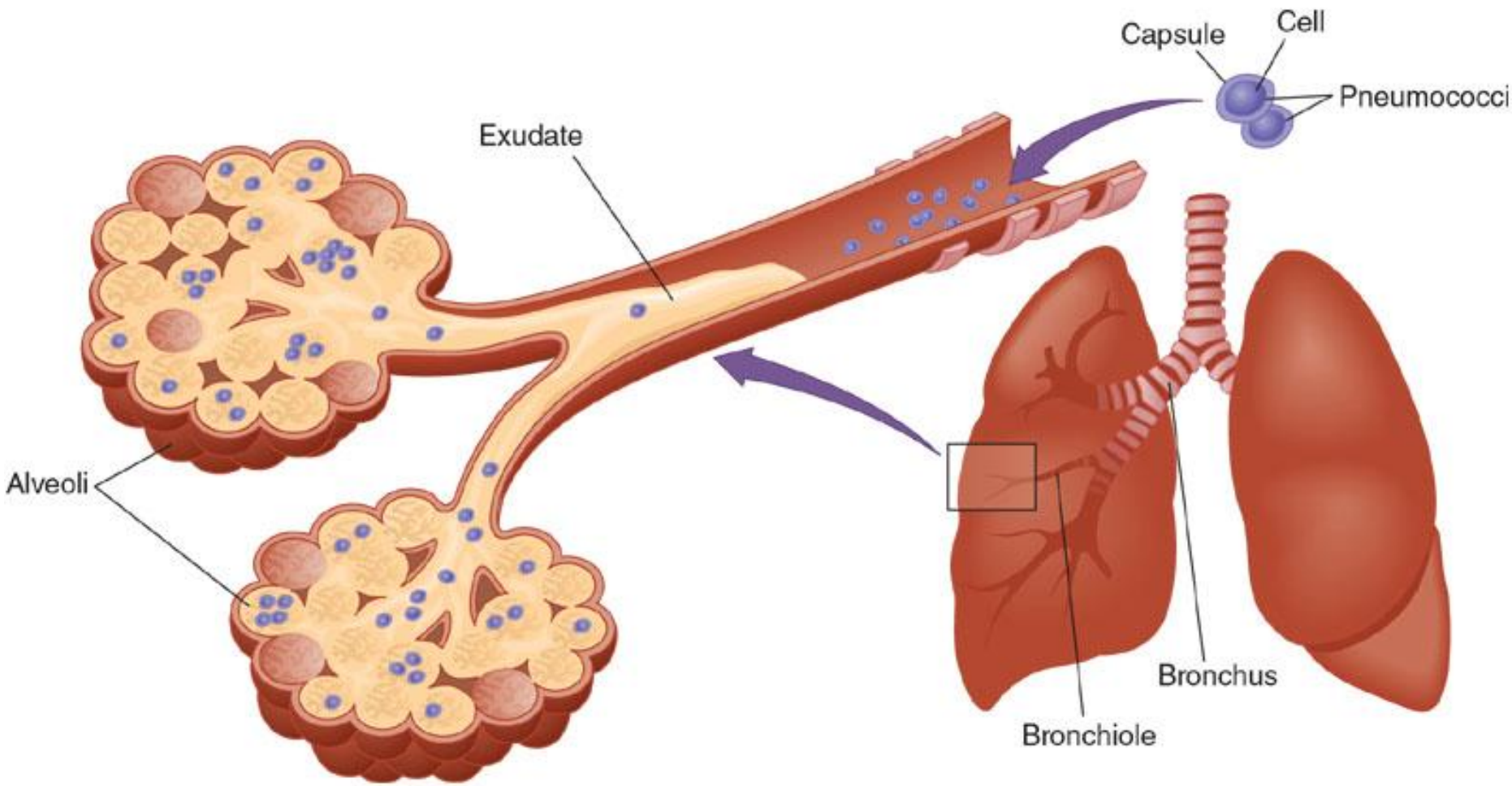
S. pneumoniae



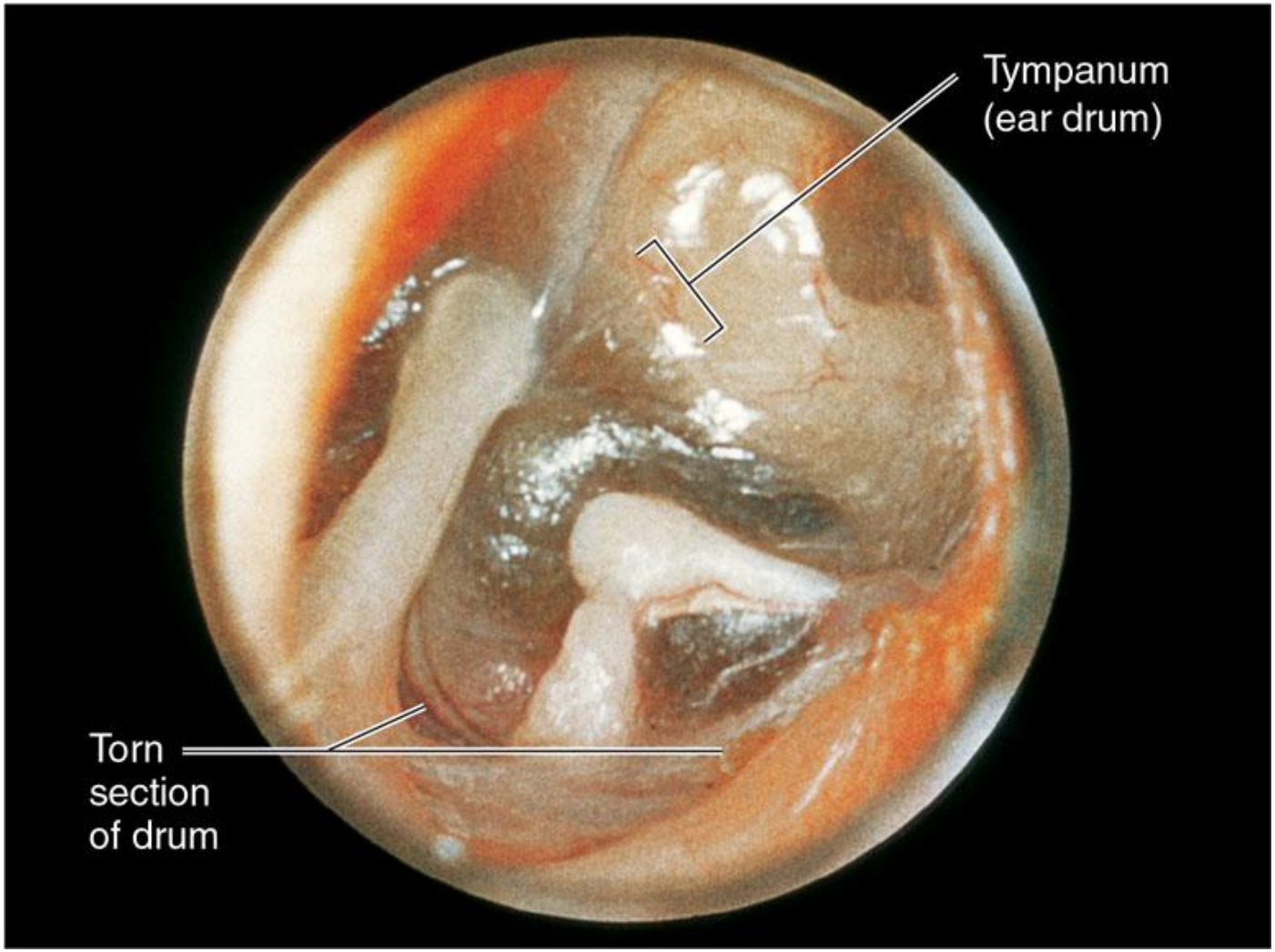
S. pneumoniae

- 5-50% of all people carry it as normal flora in pharynx
- Very delicate, does not survive long outside of its habitat
- Pneumonia occurs when cells are aspirated into the lungs of susceptible individuals
- Pneumococci multiply & induce an overwhelming inflammatory response
- Treated with penicillin

S. pneumoniae



S. pneumoniae



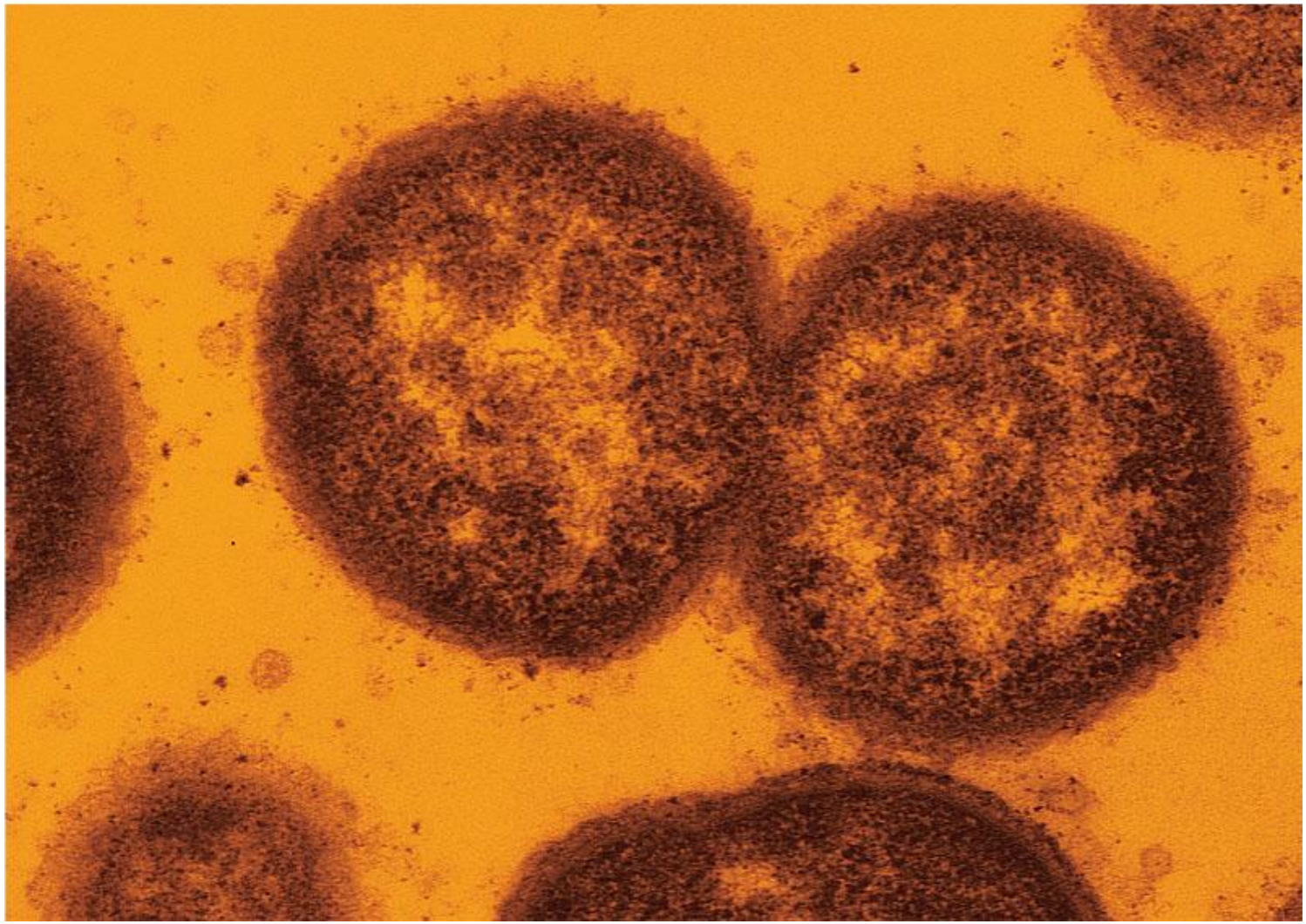
Family Neisseriaceae

- Gram-negative cocci
- Residents of mucous membranes of warm-blooded animals
- Genera include *Neisseria, Moraxella, Acinetobacter*
- 2 primary human pathogens
  - *Neisseria gonorrhoeae*
  - *Neisseria meningitidis*

Neisseria

- Gram-negative, bean-shaped, diplococci
- none develop flagella or spores
- capsules on pathogens
- pili
- Strict parasites, do not survive long outside of the host
- Aerobic or microaerophilic
- Oxidative metabolism
- produce catalase & cytochrome oxidase
- Pathogenic species require enriched complex media and CO_2

Neisseria

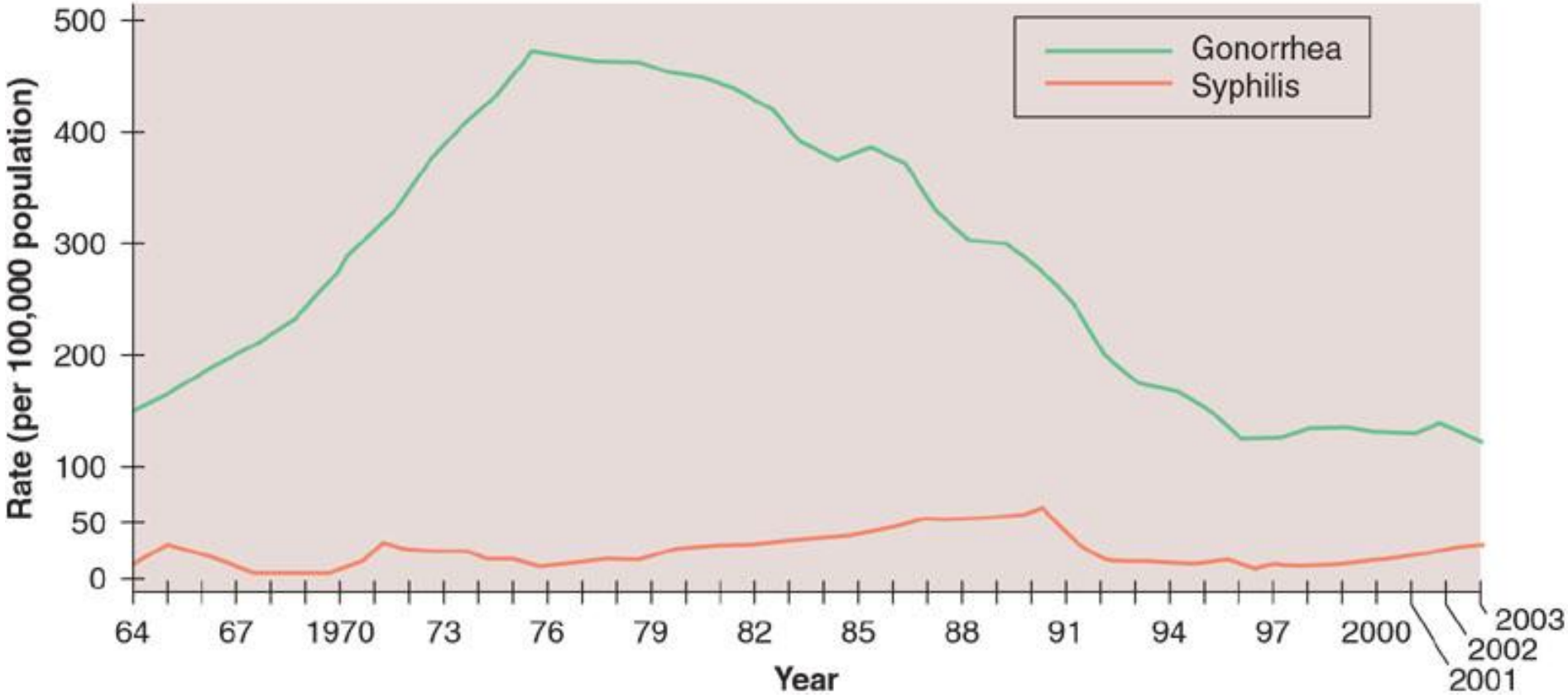


Neisseria gonorrhoeae

- Causes gonorrhea, an STD
- Virulence factors: pili, other surface molecules, IgA protease
- Strictly a human infection
- In top 5 STDs
- Infectious dose 100-1,000
- Does not survive more than 1-2 hours on fomites
- Infection is asymptomatic in 10% of males and 50% of females

Neisseria gonorrhoeae

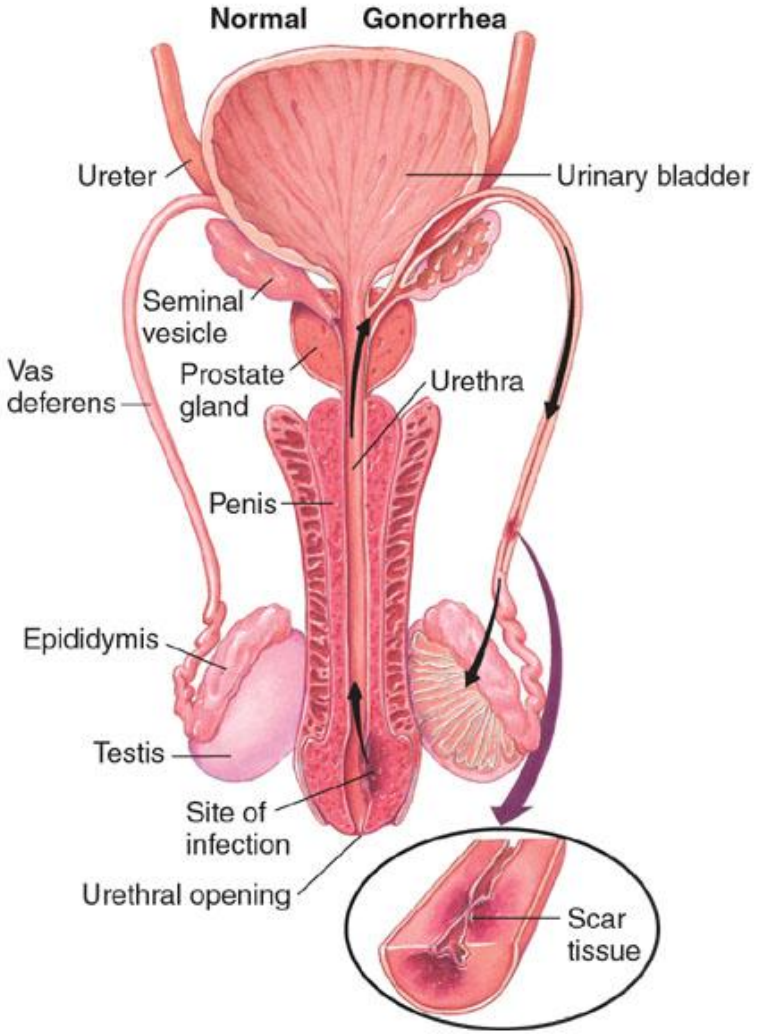
Gonorrhea and Syphilis—Reported Rates: United States, 1964–2003



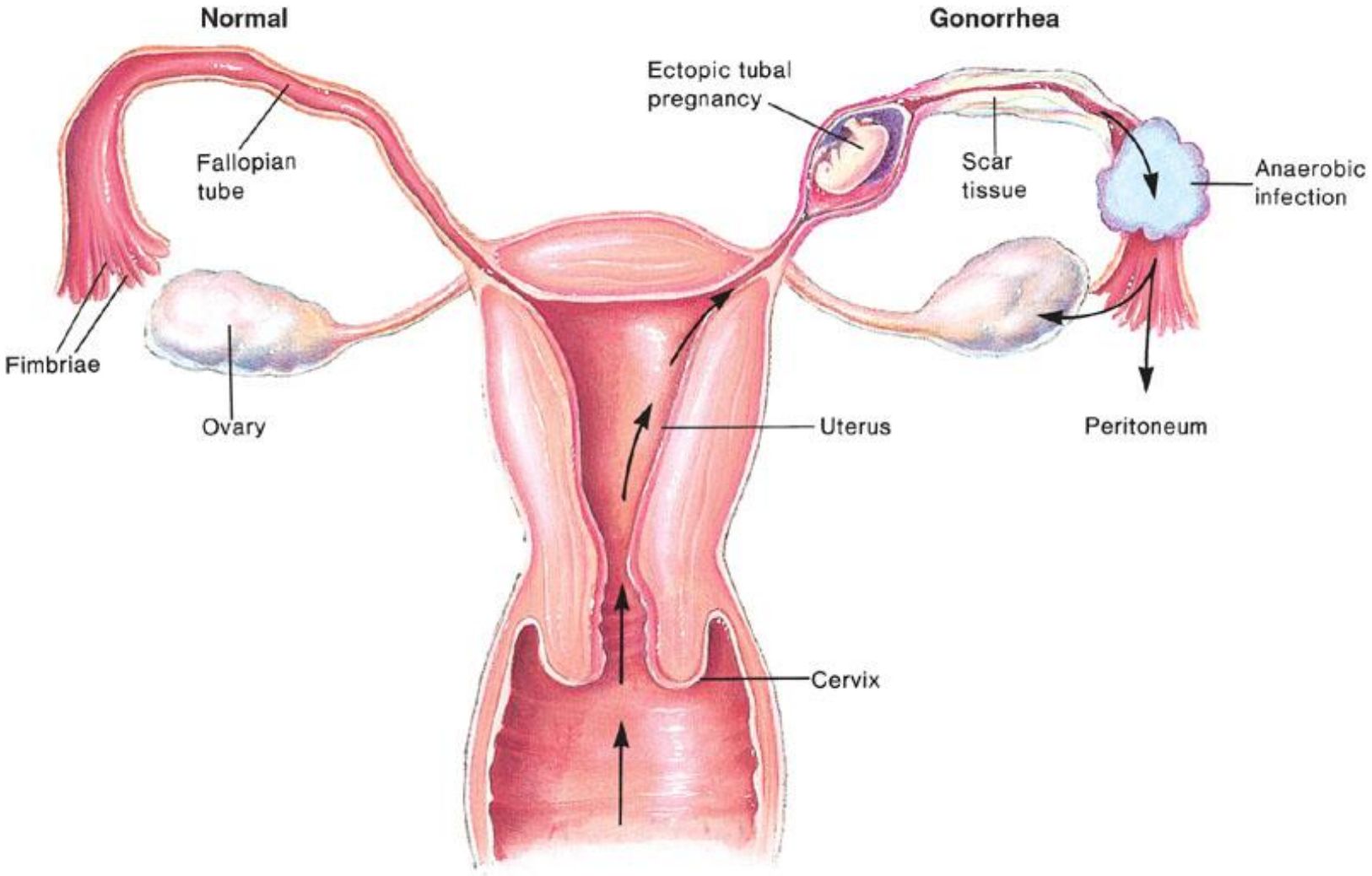
gonorrhea

- Males – urethritis, yellowish discharge, scarring & infertility
- Females – vaginitis, urethritis, salpingitis (PID) mixed anaerobic abdominal infection, common cause of sterility & ectopic tubal pregnancies
- Extragenital infections – anal, pharygeal, conjunctivitis, septicemia, arthritis

gonorrhea



gonorrhea

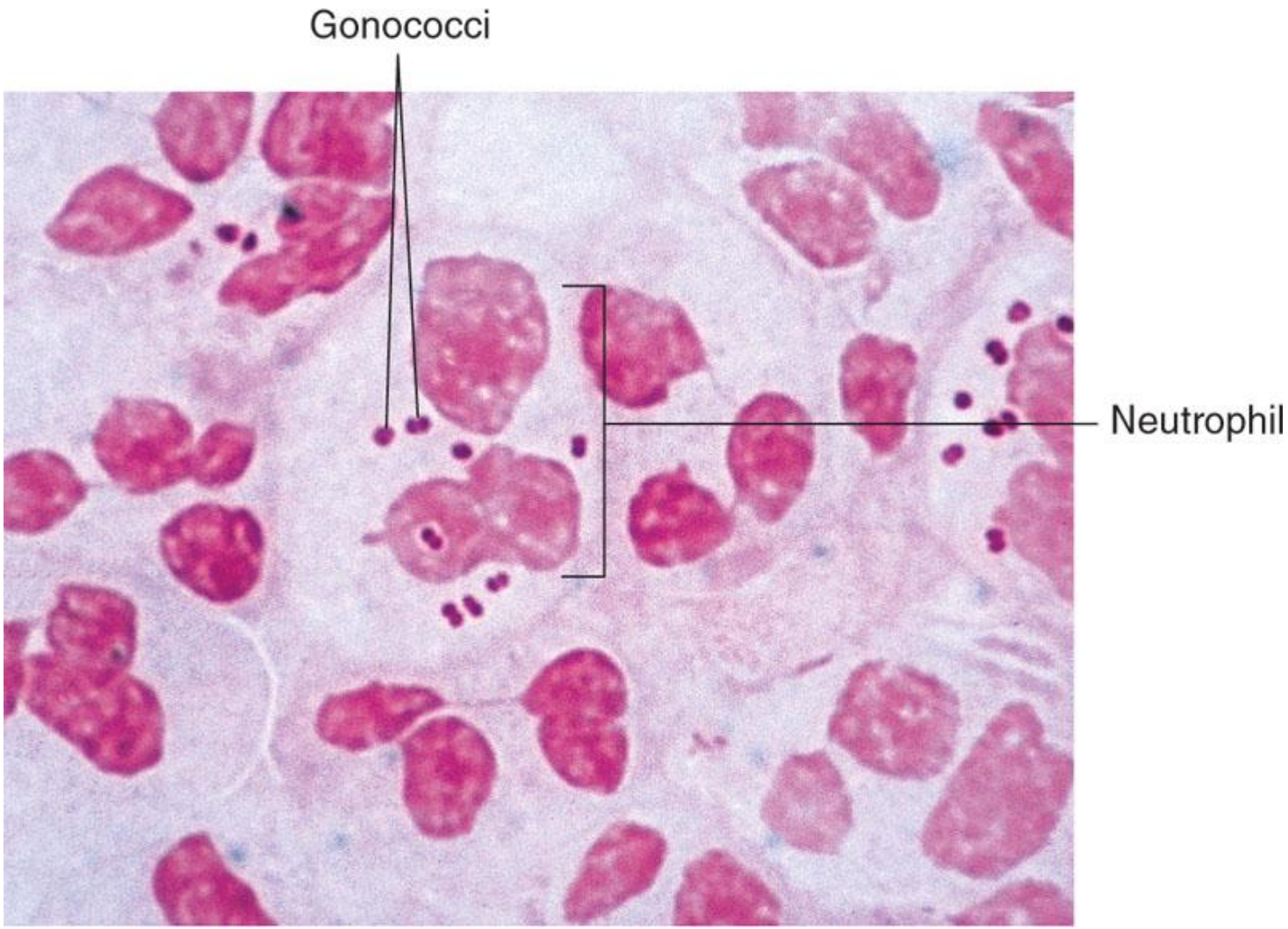


Gonorrhea in newborns

- Infected as they pass through birth canal
- Eye inflammation, blindness
- Prevented by prophylaxis after birth

Gonorrhea in newborns

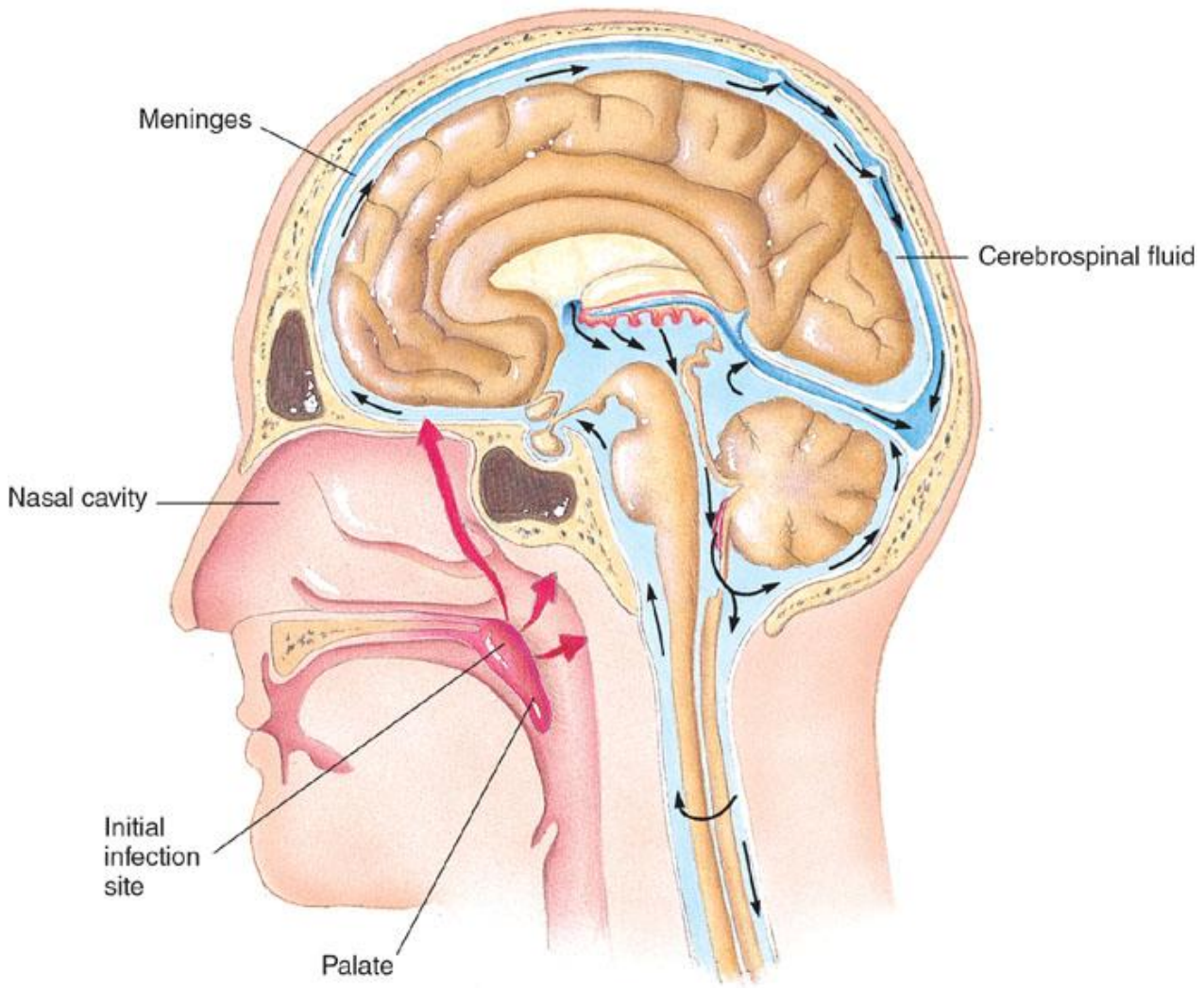
Gonorrhea diagnosis



Neisseria meningitidis

- Virulence factors – capsule, pili, IgA protease
- 12 strains; serotypes A, B, C, cause most cases
- Prevalent cause of meningitis
- Disease begins when bacteria enter bloodstream, pass into cranial circulation, multiply in meninges; very rapid onset; endotoxin causes hemorrhage and shock; can be fatal
- Treated with penicillin, chloramphenicol
- Vaccines exist for group A and C

Neisseria meningitidis



Neisseria meningitidis

Z

Zit, n.

Pus based life-form whose main habitat is the teenage face. Normally peaceable, but can react violently if threatened.

'Innocent Elliot Pitts
was casually picking his zits,
when one he eroded
abruptly exploded,

and blew the poor fellow to bits.'