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°C
- Facultative anaerobe
- Withstands high salt, extremes in pH, & high temperatures
- Produces many virulence factors

Enzymes of S. aureus

- Coagulase – coagulates plasma and blood; produced by 97% of human isolates; diagnostic
- Hyaluronidase
- Staphylocinase
- DNase
- Lipases - enhance colonization on skin
- Penicillinase (very common)

Toxins of S. aureus

- Hemolysins – lyse RBCs; α, β, γ, δ
- Leukocidin
- Enterotoxins
- Exfoliative toxin
- Toxic shock syndrome toxin
**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
- Increase in community acquired methicillin resistance - MRSA

**S. aureus diseases**

- Ranges from localized to systemic
- Localized - abscess, folliculitis, furuncle, carbuncle, impetigo
- Systemic – osteomyelitis, bacteremia
- Toxigenic disease – food intoxication, scalded skin syndrome, toxic shock syndrome

**Clinical concerns**

- 95% have penicillinase & are resistant to penicillin & ampicillin
- Abscesses must be surgically perforated
- Systemic infections require intensive lengthy therapy

**Prevention of Staphylococcal Infections**

- Universal precautions by healthcare providers to prevent nosocomial infections
- Hygiene and cleansing

**Streptococci**

- Gram-positive spherical/ovoid cocci arranged in long chains
- Can form capsules & slime layers
- Facultative anaerobes
- Do not form catalase, but have a peroxidase system
- Most parasitic forms are fastidious & require enriched media
- 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

Human Streptococcal Pathogens

- S. pyogenes 
- S. agalactiae 
- viridans streptococci 
- S. pneumoniae 
- Enterococcus faecalis

β-hemolytic S. pyogenes

- Most serious streptococcal pathogen 
- Strict parasite 
- Inhabits throat, nasopharynx, occasionally skin 
- Produces C-carbohydrates, M-protein (fimbriae), streptokinase, hyaluronidase, DNase, hemolysins (SLO, SLS), erythrocytic toxin
**S. pyogenes**

- Humans are only reservoir
- Transmission – contact, droplets, food, fomites
- Skin infections – impetigo, erysipelas
- Pharyngitis – strep throat
- Systemic infections: scarlet fever

**Long-Term Complications of Group A Infections**

- Rheumatic fever – follows overt or subclinical pharyngitis in children; carditis with extensive valve damage possible, arthritis, chorea, fever
- Acute glomerulonephritis – nephritis, increased blood pressure, occasionally heart failure; can become chronic leading to kidney failure

**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

**Group D Enterococci and Groups C and G Streptococci**

- **Group D:**
  - *Enterococcus faecalis, E. faecium, E. durans*
  - Normal colonists of human large intestine
  - Cause opportunistc urinary, wound, and skin infections, particularly in debilitated persons
- **Groups C and G:**
  - Common animal flora, frequently isolated from upper respiratory tract; pharyngitis, glomerulonephritis, bacteremia

**Clinical Considerations**

- Group A & B are treated with penicillin
- Enterococci usually treated with ampicillin and gentamicin
- No vaccines available

**Viridans group**

- α-hemolytic
- Large complex group (ex. *S. mutans*)
- 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 pre-existing heart disease are at high risk & receive prophylactic antibiotics before surgery or dental procedures

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% CO₂
- Lack catalase & peroxidases – cultures die in O₂

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

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
Treatment and Prevention

- Traditionally treated with penicillin G or V
- Increased drug resistance
- Two vaccines available for high risk individuals:
  - capsular antigen vaccine for older adults and other high risk individuals—effective 5 years
  - conjugate vaccine for children 2 to 23 months