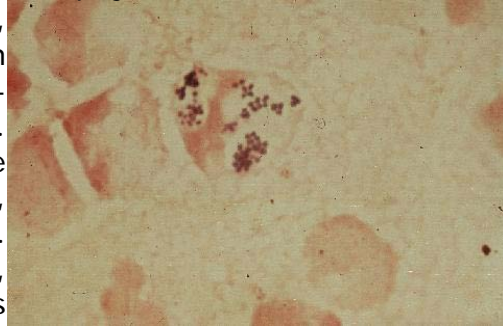


Unit Lecture 10

Gram-positive Cocci

Staphylococcus

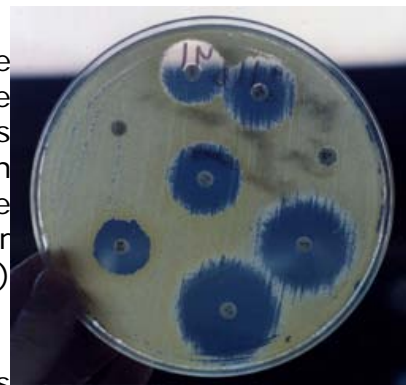
Staphylococci are gram positive cocci that grow in irregular clusters. They are facultative anaerobes that are easily cultured on many types of media. There are over thirty different species of staphylococci. We will concern ourselves with only three. The first, *Staphylococcus aureus* is a major pathogen in humans. Both pus producing and non-pus producing infections are possible. Infections that are pus producing include those that affect the skin, such as cellulitis, boils, carbuncles, [impetigo](#), and abscesses. Systemic infections like pneumonia, pyelonephritis, meningitis, osteomyelitis also are pus producing. Infections that are not purulent are based on toxins that the organism produces. These include Toxic Shock Syndrome (an exfoliatin producing infection in adults), [Scalded Skin Syndrome](#) (an exfoliatin producing infection in children), and staphylococcal food poisoning (an intoxication resulting from ingestion of preformed enterotoxin). Symptoms of food poisoning appear about two to six hours after ingestion of the heat stable toxin and include projectile vomiting, cramping, and diarrhea.



Two enzymes that *S. aureus* produces that help in its identification include [catalase](#), (which differentiate it from another gram positive cocci – the streptococci) and [coagulase](#), which differentiates it from other staphylococcus species. *S. aureus* also produces hemolysins (b-hemolytic), leukocidin, hyaluronidase, exfoliatin, enterotoxins, and staphylokinase.

Endogenous transmission are most common, however direct contact is involved in nosocomial infections. Indirect infections can occur after coming into contact with dried sputum that has survived for months.

Many strains are resistant to penicillin. Some strains are more resistant (MRSA, VRSA) and pose considerable treatment challenges as well as environmental problems. Resistance has been transferred by plasmids and phages. Since vaccines not available, prevention by proper treatment of skin wounds (primarily debridement) and good hand washing techniques is a must.

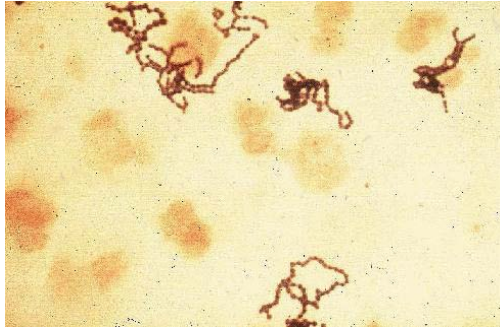


The second, *Staphylococcus epidermidis*, belongs to a group of coagulase negative staphylococci (CNS) and are the main

normal flora organism found on humans. As such they are often involved in opportunistic infections like blood catheter infections. They possess some of the same characteristics as *S. aureus* with the major exception of coagulase production. Lastly, one of the coagulase negative staphylococci, *S. saprophyticus*, is the second most common cause of urinary tract infections in sexually active female adolescents.

Streptococci

The streptococci are gram positive cocci that form chains. Streptococci are differentiated on the basis of their [action on blood agar](#), i.e. do they hemolyze the red blood cells? They can be alpha hemolytic (cause a greening of the media), beta hemolytic (complete destruction of the red blood cells), or gamma (no hemolysis). Streptococci are catalase negative which is a major test used to differentiate them from the staphylococci. Rebecca Lancefield separated the beta streptococci into groups A-R based on antigenic polysaccharides (carbohydrates on cell wall).



[Beta streptococci](#)

Group A Streptococci (*Streptococcus pyogenes*) is a facultative anaerobe that has complex growth requirements. Usually it is cultured on blood agar (beta-hemolytic). Further study indicates that there are eighty types of group A streptococci based on an M protein. This only has value in epidemiological studies. Virulence factors include the M-protein, toxins, hemolysins (Streptolysin O and Streptolysin S), streptokinase and hyaluronidase, and an erythrogenic toxin from a bacteriophage.

Primary infections include streptococcal pharyngitis ([Strep throat](#)), a non-invasive infection, [scarlet fever](#), puerperal fever (invasive), erysipelas (infected lesion of skin that spreads to dermis and hypodermis), impetigo (pyoderma and non-invasive), and necrotizing fasciitis (also called "[Flesh-eating](#)" bacteria). Necrotizing fasciitis requires Streptolysin O and erythrogenic toxin and an activation of the RES and T-lymphocytes to form "tumor necrosis factor." Group A streptococci can also cause a toxic shock syndrome (TSST) similar to staphylococcal toxic shock syndrome.

Complications following infection (sequelae) are nonsuppurative (non pus producing) infections, and include Rheumatic fever and Acute Glomerulonephritis.

Transmission is usually via respiratory droplet. There is a 5-10% is carrier rate for virulent strains. Treatment consists of penicillin, which is usually effective. Prevention through vaccines is unavailable and undesirable. To

prevent the spread of scarlet fever, isolation is the best technique along with penicillin.

Streptococcus agalactiae (Group B-GBS) is gram-positive cocci in chains. GBC is a facultative anaerobe usually cultured on blood agar (beta-hemolytic). Identification is made by a positive [CAMP \(synergistic beta hemolysis\) test](#). This organism causes neonatal sepsis and meningitis (early and late onset types), puerperal, wound, skin and UTI. Most infections in newborns are acquired from their mother during pregnancy or at birth. Risk factors include premature birth, premature rupture of fetal membranes, and prolonged labor. Late onset disease is acquired from the mother, sibling, or person who comes into contact with the infant. Because of their close association to the female genital tract (25% of women carry GBS) and neonatal disease, screening of pregnant women at 35 -37 weeks of their pregnancy for colonization of genital tract is a must. In high risk cases penicillin is given to the mother at least four hours prior to delivery.

Alpha streptococci

[*Streptococcus pneumoniae*](#), the "Pneumococcus", are gram-positive cocci in pairs (diplococci) to short chains. This facultative anaerobe is cultured on blood agar (alpha hemolytic). The organism produces a capsule (virulence factor). There are 84 serotypes, some of which are more pathogenic than others. In pre-antibiotic days a Quellung reaction was used to identify strains for antiserum treatment purposes. This organism is the primary cause of community acquired pneumonia. It usually occurs only in debilitated patients, especially after they have had a viral infection. Predisposing factors include immunosuppression, alcohol, age, and diabetes. The patient exhibits respiratory physical injury (drowning, gases) along with chills, fever, rapid breathing, and chest pain. They produce sanguino-purulent ("rusty") sputum (Consolidation with many PMN & RBC).

Other infections include most cases of childhood otitis media, meningitis, sinusitis, septicemia, endocarditis, and pleurisy. Transmission is usually due to an endogenous route (60% carrier rate). Treatment is becoming difficult because more and more strains are penicillin resistant. A vaccine (Pneumovax) is available and protects against 23 serotypes for up to 5 years. The vaccine is recommended for at risk people. Identification is based on positive optochin disk and bile solubility tests.

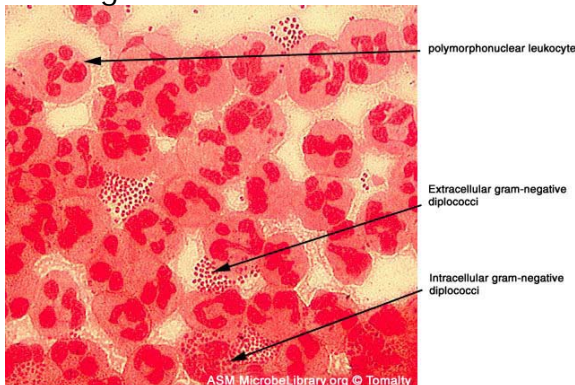
Enterococcus is a gram-positive coccus in chains. This facultative anaerobe can be alpha, beta, or non-hemolytic on blood agar. There is a tremendous concern in the medical community because of the rising incidence of multi-drug resistant strains (VRE) that are transmitted from person-to-person and for which there is no antibiotic available for cure.

Gram-Negative Cocci

Neisseria are gram-negative cocci in pairs. They are facultative anaerobes that grow best in a 5-10% carbon dioxide atmosphere. *Neisseria* are oxidase and catalase positive. Oxidation of various sugars separates the various species.

Neisseria meningitidis, the meningococcus, causes epidemic meningitis or spinal meningitis. Primary infection is in the nasopharynx where up to 50% of the population has it as normal flora. Extension may be due to debilitation. A secondary infection is meningitis characterized by headache, fever, stiff neck and malaise. Coma and death occur in 24 hours for 85% of patients if untreated and in 15% of patients who are treated. A possible complication that may develop is meningococemia and Waterhouse-Friderichsen (WFS) syndrome. Symptoms in WFS include high fever, chills, and rash. The rash affects the adrenal gland and produces [skin hemorrhages](#) that progress to disseminated intravascular coagulation causing circulatory collapse in 2 hours. Of the serological types, Type A is most virulent and epidemic whereas Types B and C are most common and endemic. This organism is notorious for striking college students and military personnel that live in crowded conditions. Treatment with Penicillin G, chloramphenicol or broad spectrum cephalosporins for resistant strains are drugs of choice. Vaccines are available for Types A and C.

Neisseria gonorrhoeae, the gonococcus, causes a sexually-transmitted (venereal) disease called gonorrhea. Symptoms in the male include a burning urethral infection with cream-colored pus. Gram stains of the pus



show many intra and extracellular gram negative diplococci in pairs. There is retrograde involvement of prostate and vas deferens. Strictures cause sterility in the male. In the female 50% of infections are asymptomatic. Infections primarily are of the cervix and urethra. Retrograde involvement of uterus and Fallopian tubes can lead to strictures that may cause sterility or

ectopic pregnancies. Ten to twenty percent of the cases lead to Pelvic Inflammatory Disease. Dissemination via blood to other organs creates suppurative infections of joints, skin, and meninges. In prepubescent females the infection may be a vulvovaginitis, which is the same infection as gonorrhea but includes vagina. If the mother is infected, her baby may become infected as it passes through the birth canal. The organism has an affinity to the mucous membranes of eye may become infected causing ophthalmia neonatorum. If left untreated scarring of cornea results in blindness. This was once the most common cause of blindness in children. Blindness has been prevented by performing the Crede's method: silver

nitrate or erythromycin is rubbed into the eyes. Gonorrhea is almost always sexually transmitted. Of concern are the transfers of R-plasmids causing penicillinase producing *Neisseria gonorrhoeae* (PPNG) and tetracycline resistant *Neisseria gonorrhoeae* (TRNG). This results in the requirement for synergistic antibiotic therapy. Because the organism mutates surface receptors quite easily, there is no long-lasting immunity.