Bacterial Classification and Disease
Purpose

- To provide an overview of how physicians think when confronted with a bacterial infection
- To alert you to the importance of bacterial classification in treatment
- The importance of knowing the etiology of organ system based infection and the Gram stain
Purpose

- Some microbiology courses teach infectious diseases in a "bug parade" - Here are all of the gram-positive cocci, and here's what they do. Here are their random virulence factors, ...

- That is not our philosophy (see Schaechter).

- This lecture provides that framework for students who want the bug parade organization.
Purpose

- The detail in this lecture is NOT to be memorized for exams.

- The principles ARE testable.
Bacterial Classification

- Based on several major properties
  - Gram stain (and other stains)
  - Morphology
  - Metabolic behavior (e.g., oxygen)
  - Infection patterns (e.g., zoonoses)
  - Obligate intracellular
  - Antigenic composition
  - DNA sequence
Metabolic properties

- May influence the type of disease caused, but not necessarily
  - Anaerobes have a greater propensity to cause abscesses
  - *Mycobacterium tuberculosis* is an obligate aerobe – affects tissue tropism
  - Acid fast organisms grow slowly - chronic infections
  - *Vibrio vulnificus* grows fast - rapid progression
Bacterial classification

- **Cell morphology**
  - Shapes
    - Rod
    - Cocci
    - Spiral
    - Filamentous
  - Associations
    - Individual
    - Diplo-
    - Staphylo-
    - Strepto-
    - Filaments
Classification and Disease

- Gram-positive cocci - pyogenic
  - *Streptococcus pyogenes*
  - *Staphylococcus aureus*

- Gram-negative cocci - pyogenic
  - *Neisseria gonorrhoeae*
  - *Neisseria meningitidis*

- Spirals - chronic infections
  - *Treponema pallidum*
  - *Borrelia burdorferi*
  - *Leptospira*
How a physician approaches bacterial diseases

- Organ system approach
  - Which bacteria cause disease in a certain location
  - The "usual suspects"

- Gram stain approach
  - The Gram stain is used to treat empirically before cultures are completed
  - Requires that one is able to get a Gram stain directly from a patient sample, which is not always the case (e.g., stool, sinus, endocarditis)

- The combination of these is ideal
Upper Respiratory Tract

- Pharyngitis
  - mostly viral
  - lots of normal flora (Gram stain little value)
  - rapid test (e.g., Phadebact), culture
  - If *Streptococcus pyogenes* (Group A strep) must treat - why?

- Other causes - young adult
  - Mononucleosis
  - Gonorrhea
  - Diphtheria (not likely - why?)
Pneumonia

- Sputum Gram stain (and other stains) very helpful (why?)

- Coupled with chest X-ray

- Other signs, symptoms, history
Gram stain
What is this?
Gram stain
What is this?
Acid fast stain
What is this?
Silver stain
What is this?
Otitis media and Sinusitis

- Gram stain and culture not practical
  - Otitis media - tympanostomy
  - Sinusitis - must access sinus

- Usual suspect list (same)
  - *Streptococcus pneumoniae*
  - *Haemophilus influenzae*
  - *Moraxella catarrhalis*

- Empiric therapy
Meningitis

- Gram stain practical and extremely important
  - CSF sterile, few host cells
  - Note bacteria and host cells

- Couple with age
  - Neonate
  - Child
  - Adult
Meningitis

- **Neonate**
  - *E. coli* K1
  - Group B streptococcus (*S. agalactiae*)
  - *Listeria monocytogenes*

- **Children and adults**
  - *Streptococcus pneumoniae*
  - *Neisseria meningitidis*
Meningitis
Meningitis
Meningitis
Endocarditis

- Gram stain not practical
  - Can't access infection site!
  - Bacteremia too low
  - Usual suspects

- Oral streptococci
- Enterococci
- Staphylococci
Enteric infections

- Gram stain not practical
  - Can't access infection site
  - Too much stuff in stool
  - Mostly viral

- Blood and pus indicators of disease
Abdomen

- Organisms come from the GI tract
- Gram-negative rods
  - Facultative anaerobes (Enterobacteriaceae)
  - Obligate anaerobes (*Bacteroides*, *Fusobacterium*)
- Sometimes gram positive cocci
  - Aerobic (*Enterococcus* and *Streptococcus*)
  - Anaerobic (*Peptostreptococcus*)
- Obligate anaerobic gram positive rods (*Clostridium*)
Skin Infections

- Skin flora - gram-positive cocci
  - *Staphylococcus aureus*
  - *Streptococcus pyogenes*

- Complex skin infections
  - Skin flora plus enteric flora and environmental flora
Urinary tract infection

- Because of proximity to GI tract, enteric flora are the prime suspects.
  - Facultative aerobic enteric gram-negative rods predominate (*E. coli*)
  - Unusual to find staphylococci and streptococci or anaerobes
Sexually Transmitted

- Only a few bacteria
  - *Neisseria gonorrhoeae*
  - *Chlamydia trachomatis*
  - *Treponema pallidum*
Sexually Transmitted
Sexually Transmitted
Sexually Transmitted
Dark field
Take home messages

- Classification is boring but important for initial therapy.
- Know what organisms are common at the various sites of infection as you go through the course.
- Know the Gram stain and metabolic properties of the common bacteria found at each organ system infection.
- Don’t memorize it for this lecture. It will be taught in the lectures that follow.