Epidemiology and a tour of some diseases (pages 818-922)

Epidemiology is the study of the occurrence, distribution, and control of disease in populations.

How do diseases become epidemic or pandemic?

- **Reservoirs**
  - Sites where the pathogen persists
    - Animate
    - Inanimate
  - Zoonosis (animal reservoirs)
  - Carriers
    - Recall discussion of normal flora and atypical normal flora
    - Acute carriers: disease in the incubations state without outward symptoms
    - Chronic carriers: largely asymptomatic

- See text pages 822-823 for a table of potential reservoirs

- **Transmission**
  - Host-to-host
    - Sputum sprays
    - Direct contact
  - Indirect host-to-host
    - Living vectors
    - Insects, animals
  - Non-living vectors
    - Fomites
  - Common-sources (non-point)
  - Drinking water
  - Communal food
  - Special case of hospitals
    - Already contains sick people
    - High frequency of potential contagions
    - High frequency of highly virulent organisms
    - High frequency of antibiotic resistant organisms

- **Controls**
  - Directed against
    - Reservoir
      - Eliminate the source (kill the animal)
      - Drain a watery breeding ground
      - Eliminated the insect
    - Transmission
      - Effect proper controls on food handling, water and waste water management
    - Immunize
    - Quarantine
- Eradication of the pathogen (smallpox)

Emerging Diseases

- This is the emergence of new or the sudden re-emergence of old well-know diseases.

- Reasons for this:
  - Human demographics and behavior
  - Technology (antibiotic resistant organisms)
  - Economic development (altering land use…creation of wetlands)
  - International travel
  - Microbial evolution
  - Failure of technology (breakdown in treatment processes)

- See text pages 838-839 for tables of emerging diseases

A tour of some common diseases

A quick look at anatomy
Streptococcal:
- **S. pyrogenes**
  - Typically found in upper respiratory pathways
  - Normal flora, opportunistic
  - Can produce a toxin that lysed red blood cells
  - Infection of the pharynx are known as ‘strep-throat’
  - Severe sore throat, enlarged tonsils, tonsillar exudates, mild fever, malaise
  - Very funky
  - If lysogenized, the phage may code for erythrogenic toxin
    - Toxin produces inflammation of capillaries and a red rash…Scarlet Fever
  - Occasionally causes severe destruction of subcutaneous tissue ‘flesh-eating’
- **S. pneumoniae**
  - Organism attacks alveolar sacs
  - Elicits strong inflammatory response (fluid build up in lungs)
  - Review some symptoms and speed of disease

Staphylococcal
- **S. aureus**
  - Typically found on the skin surface
  - Normal flora, opportunistic, frequently produce a collection of nasty enzymes and toxins, many Staphylococcal infections are pus forming
  - Associated with
    - Acne
    - Boils
o Impetigo
  ▪ Disease characterized by thin-walled blisters that break easily and weep. Crust over and crack to weep some more

o Toxic shock syndrome
  ▪ Mediated by a T-cell reaction resulting in strong inflammatory response

o Food poisoning
  ▪ Stimulates T cells in the intestine resulting in a large response. Response is short lived but usually intense.

Diptheria
  ▪ *Corynebacterium diphtheria*
    o Infection results from sputum sprays and centers in throat and tonsils
    o Inflammatory response in throat results in formation of a lesion consisting of damaged host cells and bacterium
    o This pseudomembrane may be dislodged and block airways.
    o If diphtheria cells are lysogenized with bacteriophage beta, an exotoxin may be produced...diphtheria toxin kills host cells by inhibiting protein synthesis

Whooping Cough
  ▪ *Bordetella pertussis*
    o Highly infections respiratory disease
    o Produces and exotoxin that induces synthesis of cAMP which damages host tissues
    o Disease is characterized by a recurrent, violent cough that can last up to 6 weeks (this disease is recurrent and may last for months...it has three stages)
    o Very effectively controlled by the DPT vaccination (purified cell fractions)
Tuberculosis

- *Mycobacterium tuberculosis*
  - Very infectious respiratory disease
  - Spread by sputum sprays
  - Organism causes irritation and inflammation of the lung tissue that evokes a T-cell hypersensitivity
  - Macrophages are frequently unable to kill the organism and this results in tissue segments that are walled off (tubercles).
  - Eventually these lead to caseous lesions of the lung tissue
  - In many cases the disease seems to become almost dormant but the victim maintains a good T cell reaction to typical cellular antigens (Tine test)
  - Eruptions of the disease may occur in later life or under conditions of poor nutrition or health.
  - Concern today is of antibiotic resistant forms of the bug.

*Neisseria* types

- *Neisseria meningitidis*
  - Encapsulated diplococcus of which at 13 strains are recognized as pathogenic
  - In a great many people, this organism is considered normal flora
  - Organism causes inflammation of the membranes that line the central nervous system
  - Likes to show up in close quarters (military, schools)
  - Onset of symptoms is rapid typically headache, vomiting, stiff neck, and a general feeling of malaise.
  - Very rapidly progresses from feeling bad to not feeling anything anymore.
  - Other causes of meningitis include *Haemophilus influenzae*
    - H. influenzae likes to infect small children and is commonly the cause of outbreaks in schools.
    - A full vaccine is available for this organism.

- *Neisseria gonorrhoeae*
  - Does not live for minutes outside of a host
  - Typically found in the genital-urinary tract
  - In females the infection is characterized by mild vaginitis
  - In males the infection causes a painful infection of the urethra
  - Many strains are penicillin resistant but responsive to other antibiotics

An old favorite.

- *Treponema pallidum*
  - Does not live for minutes outside of a host
  - Does not infect intact skin but enters through small lesions.
  - Usually multiplies at the initial site of infection and a primary lesion called a chancre develops with 2-3 weeks of infection (Primary Syphilis)
  - Chancre usually heals spontaneously.
  - Organisms spread throughout the body and a hypersensitivity reaction takes place usually characterized by a papillar rash. Highly infectious at
this stage but curiously, the organism typically disappears from lesions and person becomes less infectious (Secondary Syphilis)
- About 25% of cases appear to heal spontaneously
- About 25% remain asymptomatic but infection persists
  - About 50% enter Tertiary Syphilis with mild to serious infections and lesions of bone and tissues.
  - Typically about 150 cases per 100,000 population (do the math….UTA 25,000….so about 40 cases in the university population..hmmmmm)

Some Viral Infections
- Hepatitis
  - Various types of the disease caused by different viruses TABLE 26.1 from Madigan et al. 2002 see Table 26.2 in Madigan and Martinko 2005. here
  - But all are characterized by inflammations of the liver. In some case the disease may be chronic and eventually lead to destruction of the liver.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Virus and genome</th>
<th>Vaccine</th>
<th>Disease</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis A</td>
<td>Hepatovirus (HAV) ss RNA</td>
<td>Yes</td>
<td>Acute</td>
<td>Enteric</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>Orthohepadnavirus (HBV) ds DNA</td>
<td>Yes</td>
<td>Acute, chronic, oncogenic</td>
<td>Parenteral, sexual</td>
</tr>
<tr>
<td>Hepatitis C</td>
<td>Hepacivirus (HCV) ss RNA</td>
<td>No</td>
<td>Chronic, oncogenic</td>
<td>Parenteral</td>
</tr>
<tr>
<td>Hepatitis D</td>
<td>Deltavirus (HDV) ss RNA</td>
<td>No</td>
<td>Fulminant, only with HBV</td>
<td>Parenteral</td>
</tr>
<tr>
<td>Hepatitis E</td>
<td>Caliciviridae family (HEV) ss RNA</td>
<td>No</td>
<td>Fulminant disease in pregnant women</td>
<td>Enteric</td>
</tr>
<tr>
<td>Hepatitis G</td>
<td>Flaviviridae family (HGV) ss RNA</td>
<td>No</td>
<td>Asymptomatic</td>
<td>Parenteral</td>
</tr>
</tbody>
</table>

- Measles
  - Rubeola virus
    - The virus is transmitted by airborne sputum sprays
    - Childhood disease characterized by nasal discharge, red-irritated eyes, cough, fever, and generally feeling like crap.
    - A red diffuse rash appears.
    - The disease lasts anywhere between 7 and 10 days and is characterized by systemic viremia.
    - Sequelae include inner ear infection, pneumonia
    - Vaccination commonly available (MMR) and is very effective.
- Mumps
  - Caused by a highly infectious virus
  - Infection brings about inflammation of the salivary glands leading to a very swollen neck.
- Rubella
  - German measles
    - Resembles Measles but brought about by a different virus (Rubella)
    - Mild infections with symptoms like measles.
    - This organism can cross placental barriers and during the first trimester of pregnancy can cause severe damage to a fetus.
- Chickenpox
  - Varicella virus
    - Very common childhood disease
    - Highly contagious and transmitted by sputum sprays
    - Systemic viremia causes a papular rash that heals quickly and spontaneously
    - Organism remains dormant in nerve cells for years with no symptoms but may erupt later in life as Shingles
- Colds and influenza

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Common cold</th>
<th>Influenza</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>Rare</td>
<td>Common (39–40°C); sudden onset</td>
</tr>
<tr>
<td>Headache</td>
<td>Rare</td>
<td>Common</td>
</tr>
<tr>
<td>General malaise</td>
<td>Slight</td>
<td>Common; often quite severe; can last several weeks</td>
</tr>
<tr>
<td>Nasal discharge</td>
<td>Common and abundant</td>
<td>Less common; usually not abundant</td>
</tr>
<tr>
<td>Sore throat</td>
<td>Common</td>
<td>Much less common</td>
</tr>
<tr>
<td>Vomiting and/or diarrhea</td>
<td>Rare</td>
<td>Common</td>
</tr>
</tbody>
</table>

- Herpes
  - Herpes simplex type 1
    - Attacks the epithelial cells around the mouth and lips causing cold sores and fever blisters but may infect other areas
    - Lesions heal is 2-3 weeks and the virus appears to become latent
    - Recurrent outbreaks are frequent
  - Herpes simplex type II
    - Attacks are primarily centered upon the anogenital regions where painful blisters erupt but the virus may infect other areas as well.
    - The virus is infectious in the blister stage and has been linked to cervical cancer
AIDS and HIV
- Human immunodeficiency virus (HIV) causes the disease acquired immunodeficiency syndrome (AIDS)
- Two distinct types of the virus HIV 1 and HIV 2 (reduced virulence)
- The virus infects cells containing the CD4 cell surface protein (this is a protein commonly associated with MHC) and the two cell types most commonly infected are macrophages and T-helper cells. Recall that $T_H$ cells communicate with B cells to produce antibody.
- Net result is a destruction of macrophages and a catastrophic failure of immunity.
- Decidedly Not Good.

All figures except where noted, are from Madigan et al. 2002 or Madigan et al. 2000

References: