

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

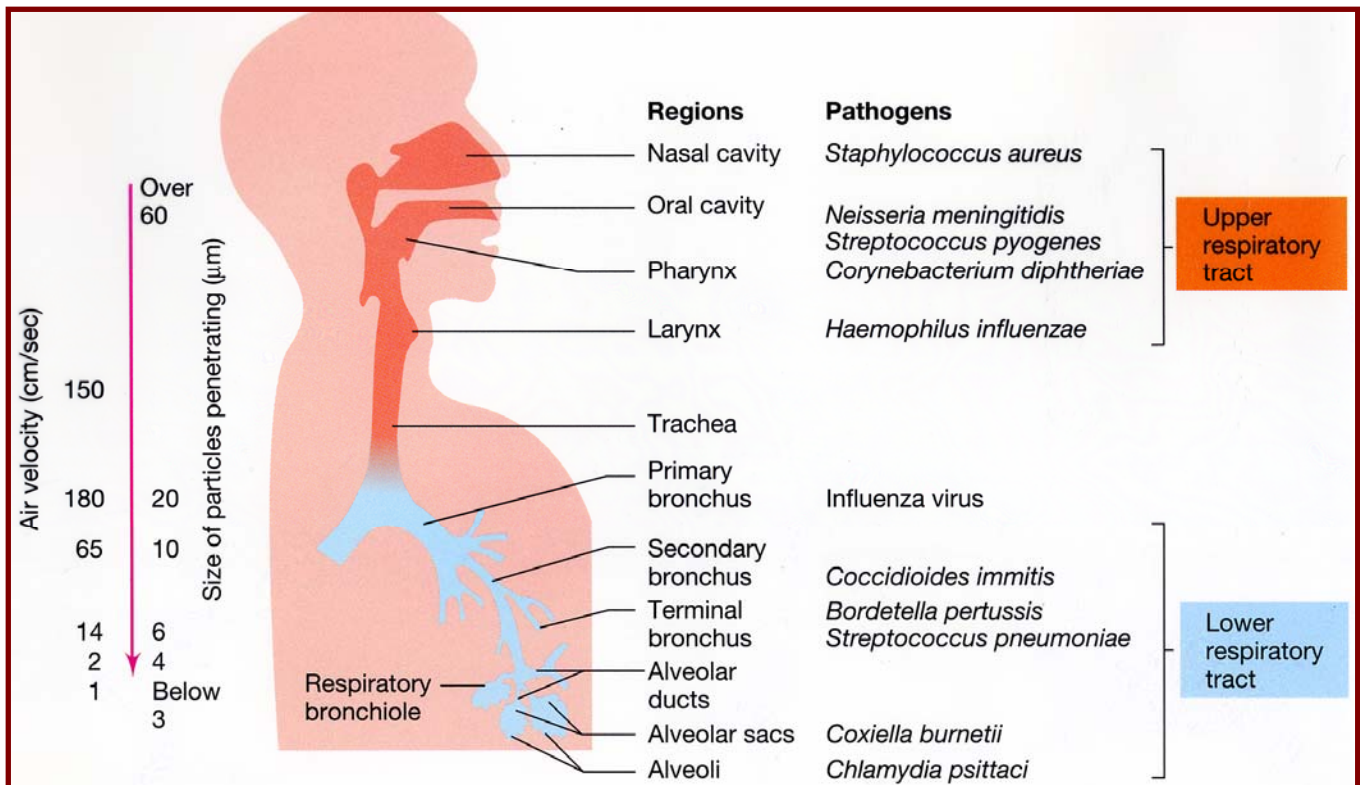
- Eradication of the pathogen (smallpox)

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

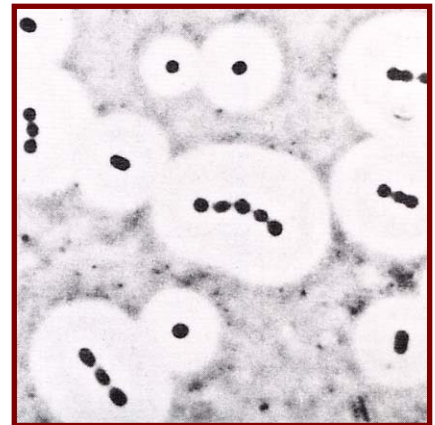
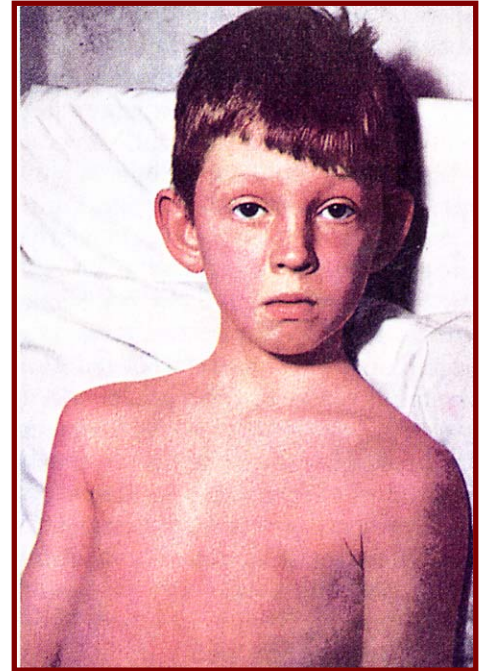
A tour of some common diseases

A quick look at anatomy



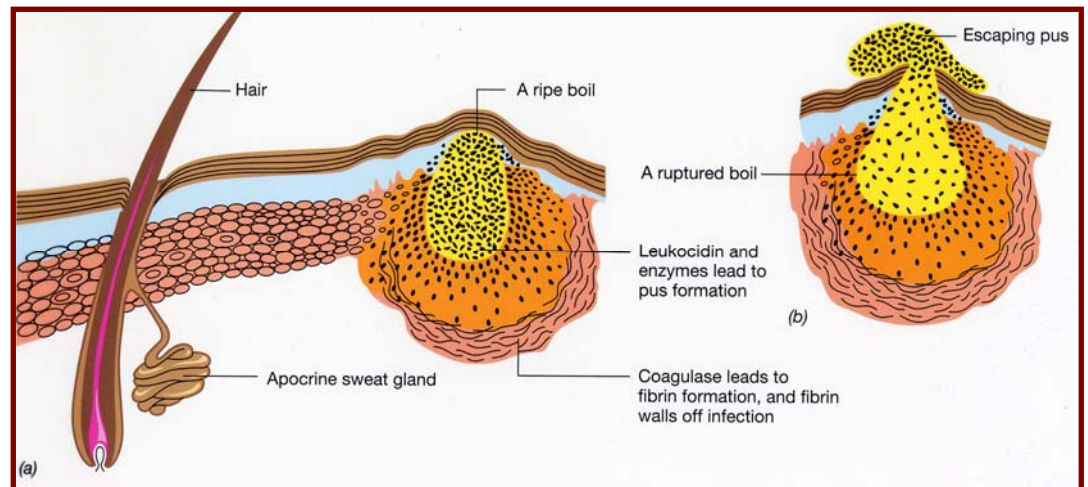
Streptococcal:

- *S. pyogenes*
 - Typically found in upper respiratory pathways
 - Normal flora, opportunistic
 - Can produce a toxin that lyses 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'
 - Sequelae
 - Rheumatic fever
 - Antibodies against *S. pyogenes* cross-react with host tissues causing damage to heart valves, joints, and kidneys.
- *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

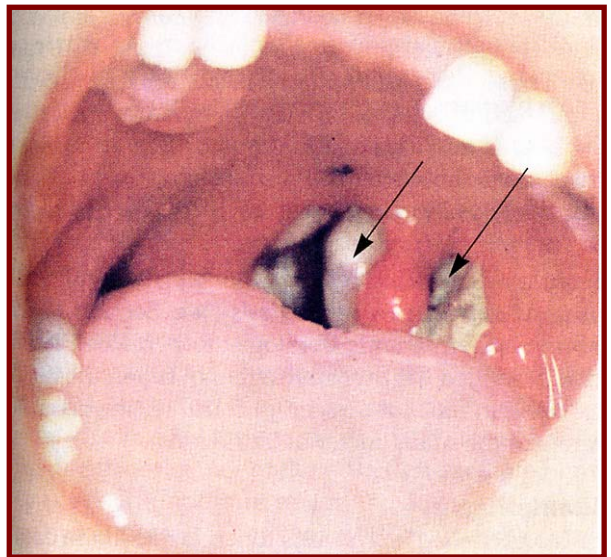


- Impetigo
 - Disease characterized by thin-walled blisters that break easily and weep. Crust over and crack to weep some more
- Toxic shock syndrome
 - Mediated by a T-cell reaction resulting in strong inflammatory response
- Food poisoning
 - Stimulates T cells in the intestine resulting in a large response. Response is short lived but usually intense.



Diphtheria

- *Corynebacterium diphtheria*
 - Infection results from sputum sprays and centers in throat and tonsils
 - Inflammatory response in throat results in formation of a lesion consisting of damaged host cells and bacterium
 - This pseudomembrane may be dislodged and block airways.
 - 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*
 - Highly infectious respiratory disease
 - Produces an exotoxin that induces synthesis of cAMP which damages host tissues
 - 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)
 - 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 case 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..hmmmm)

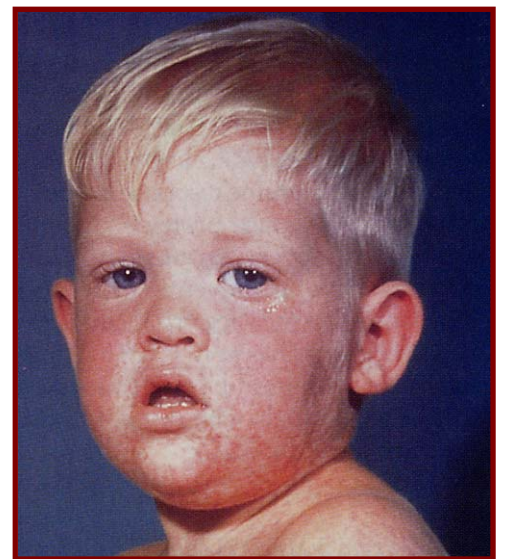
Some Viral Infections

- 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 26.1 Hepatitis viruses

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

- 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



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

- 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 in 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:

Madigan, M. T., J.M. Martinko, and J. Parker. 2002. Brock Biology of Microorganisms 10th ed. Prentice Hall.