

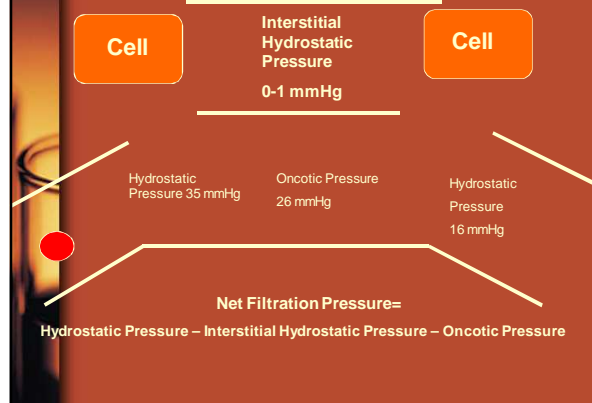
Lymphatic System and Immunity

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Functions of lymphatic system

- Returns excess interstitial fluid to circulatory system
- Absorption of fat and fat soluble vitamins from GI system
- Defense against invading pathogens and disease

Capillary Filtration



Capillary Filtration

- Not all fluid that leaves capillary is returned to capillary
- Some fluid is needed to remain as interstitial fluid

Components of lymphatic system

- Lymph fluid
 - Intermediary between blood in capillary and tissues
- Lymphatic organs
 - Lymph nodes
 - Tonsils
 - Spleen
 - Thymus
- Lymph vessels

Lymph

- 90% of fluid that leaves capillaries is returned
- The 10% that does not return becomes part of the interstitial fluid
- Similar in composition to plasma
 - Without erythrocytes and large protein molecules
 - Contains water, lymphocytes, granulocytes, respiratory gases, nutrients, hormones, ions, urea

Function of Lymph

- Intermediary between capillaries and tissue
- Carries nutrients, hormones, and oxygen to cells
- Removes carbon dioxide, and waste from cells

Lymphatic Vessels

- Accompany and parallel veins in most of body
 - Not found in; nails, hair.
- Form an extensive system that flows one way toward the heart
- Several types of lymphatic vessels
 - Lymphatic capillaries
 - Lymphatic collecting vessels
 - Lymphatic trunks
 - Lymphatic ducts

Lymphatic capillary

Lymphatic vessel

Lymph node

Lymphatic vessel

Lymphatic trunk

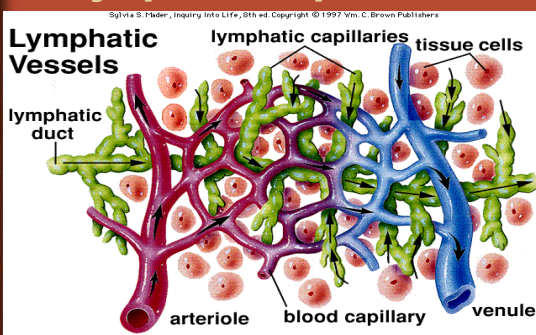
Collecting duct

Subclavian vein

Lymphatic Capillaries

- Found in most places that contain capillaries
 - Except cartilage, CNS, eye ball, spleen
- Epithelial cells overlap and attached loosely
 - Allows fluid to come in but not let fluid out
 - More permeable than blood capillaries
 - Nature of lymphatic capillaries allows WBC's pathogens, and cancer cells to enter easily

Lymphatic Capillaries

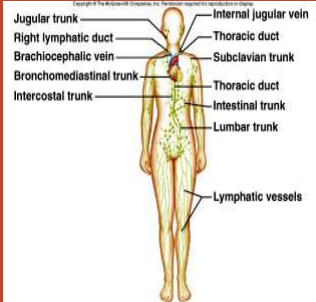


Lymphatic Collecting Vessels

- Lymphatic capillaries join together to form lymphatic collecting vessels
- Morphologically similar to veins, except contain more valves
- Pass through lymph nodes
- Can be superficial or deep

Lymphatic Trunks

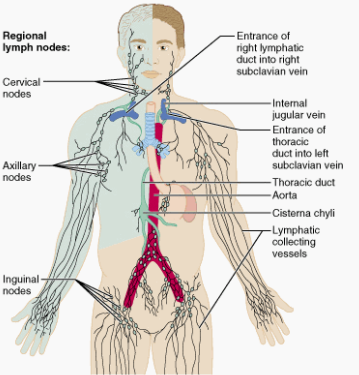
- Collecting ducts join together to form lymphatic trunks
- Each region of body has its own trunk



http://www.octc.kctcs.edu/GCaplan/anat2/notes/s/16_04.jpg

Lymphatic Ducts

- Union of lymphatic trunks
- Two lymphatic trunks in humans
 - Thoracic duct
 - Right duct
- Right duct drains right side of head, thorax, right arm
 - Enters right subclavian vein
- Thoracic duct drains left side of head, thorax, left arm, and lower 1/2 of body
 - Enters left subclavian vein



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http://www.octc.kctcs.edu/GCaplan/anat2/notes/image421.gif

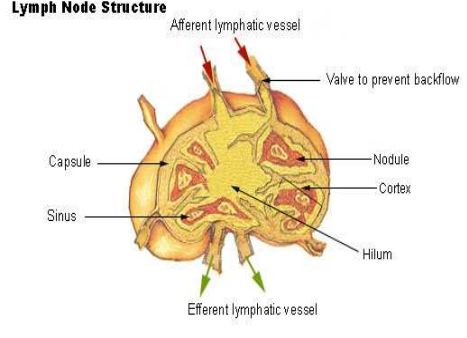
Movement of Lymph

- There is no “pump” like in circulatory system
- Very low pressure
- Flow accomplished because of three factors
 - Skeletal muscle pump
 - Respiratory pump
 - Valves prevent backflow
- Failure to move lymph results in accumulation of interstitial fluid (edema)

Lymph Nodes

- Situated in between two lymphatic collecting vessels are lymph nodes
- Nodes serve as filters to capture foreign material or abnormal cells (cancer)
- Site of lymphocyte production
- Can become inflamed/ engorged with infectious material
- Can be found in large clusters in inguinal, cervical, and axillae

Lymph Node Structure



http://en.wikipedia.org/wiki/Image:11lu_lymph_node_structure.png

Lymphoid Cells

- Lymphocytes
 - Produced in bone marrow and lymphoid organs
 - Specialize as B cells and T cells
 - T cells go after cells infected with virus and cancer
 - B cells differentiate into plasma cells and go after bacteria; secrete antibodies

Lymphoid Cells

- Macrophages
 - Phagocytes in tissue
 - Involved in immune system activation
- Dendritic Cells
 - Assist in immune system activation
- Reticular Cells
 - Fibroblast like cells that produce scaffold for construction of lymphoid tissue and organs

Lymphoid Organs Tonsils

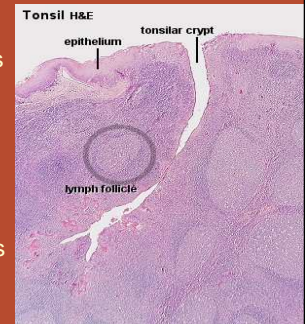
- Ring of lymphatic tissue at entrance to pharynx
- 3 pairs of tonsils
 - Palatine
 - Adenoids
 - Lingual
- Fight infections of upper respiratory system



http://en.wikipedia.org/wiki/Image:Throat_with_Tonsils_0011.jpg

Lymphoid Organs Tonsils

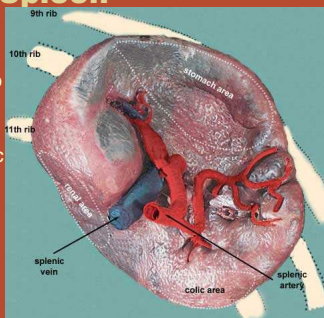
- Are not fully encapsulated like other lymphoid organs
- Contain crypts to "invite" bacteria in
- Commonly infected because of this approach
- Creates memory cells to deal with pathogens later



<http://www.lab.anrb.uwa.edu.au/mb140/CorePages/Lymphoid2/Images/trs0216.jpg>

Lymphoid Organs Spleen

- Largest lymphoid organ
- Primary purpose is to remove aged RBCs
- Provides a place to screen for pathogenic agents
- Stores large amount of RBCs that can be accessed during periods of stress



http://docs.shoreschool.org/humanbody/spleen/003FCTC3-000F5BF7_1/spleen-1.jpg

Thymus

- Found in superior mediastinum
- Produces lymphocytes
- Does not directly fight antigens
- Can be considered an endocrine organ because it produces the hormone thymosin
- Thymosin stimulates production of lymphoid cells
- Largest in infancy and early childhood
- Atrophies as we age

Immunity

- First line of defense is intact integumentary system
- In the event of failure, immune system aids in prevention of a developing pathology
- Differ among individuals
- Differ among an individuals time of life
- Collection of mechanisms that protect against disease by identifying and killing pathogens and tumors

Immunity

- Can be innate (natural) or acquired
- Innate immunity is immunity that you are born
- It is inherent and permanent
- Includes factors that are constitutively expressed and mobilized immediately when presented with a pathogen
- Acquired from parents (genetics)

Innate Immunity

- Species resistance
 - Not all microbial species can infect humans
 - They lack specific factors needed for attachment/ colonization
 - Ex: avian flu
- Anatomical defenses
 - Skin and mucous membranes
- Anti-microbial substances in human tissue
 - Lysozyme
 - Serum complement
 - Peroxidases

Innate Immunity

- Inflammation
 - Focuses all circulating defense mechanisms to site of infection
 - Includes cellular and humoral components
- Phagocytic cells
 - Neutrophils
 - Macrophages

Acquired Immunity

- Develops in response to exposure to specific antigens
- Attempt to make itself permanently resistant to pathogen
- Can be passively or actively acquired

Passive Acquired Immunity

- “Borrowed Immunity”
- Acquired by injection of antibodies from other persons or animals
- Immediate protection, but limited duration of protection
 - 3- 5 weeks
- Used for protection from exposure to virulent diseases
- Babies immunity comes from mother
 - Placenta and breast milk

Active Acquired Immunity

- Lasts longer than passive acquired immunity
- Two types of active acquired immunity
 - Natural
 - Artificial

Natural Acquired Immunity

- Occurs after someone recovers from an illness
- Results in the manufacture of antibodies against specific pathogens

Artificial Acquired Immunity

- Comes from inoculation with vaccine, antigen, or toxoid
- Some cases you are injected with a weakened bacteria or virus that lacks replication factors
- Most children receive series of immunizations to boost immune response
- Results in production of antibodies

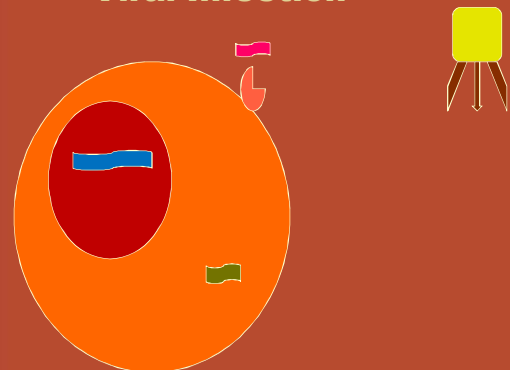
Autoimmunity

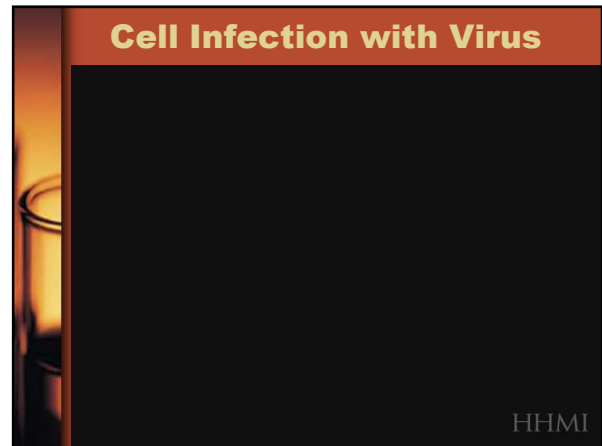
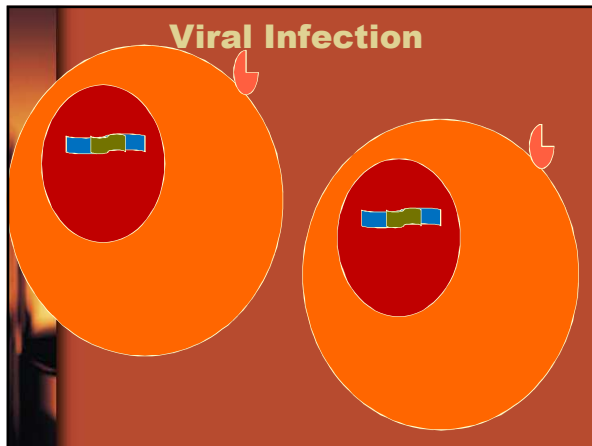
- Cells of the individual become a target of the immune system
 - Autoimmune disorder
- Many different autoimmune disorders and symptoms depend upon disorder
- Can be genetic or triggered by an environmental cause

Hypersensitivity

- Occurs when immune system fails to protect from foreign material and react with certain cells of the body
 - Example: Allergic rhinitis- IgE antibodies binding to mucous membranes and causing hayfever symptoms
- Specific antigens trigger the reaction => allergen
- In some cases, antigen-antibody reaction stimulates massive release of histamine => anaphylactic shock

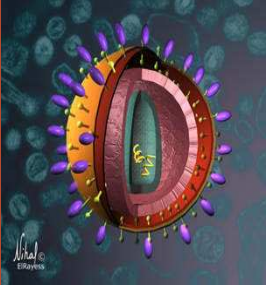
Viral Infection





HIV/ AIDS

- First reported in 1981 and spread worldwide since then
- Becoming epidemic in Africa
- Caused by HIV (Human immunodeficiency virus)
- HIV infects T4 (CD4) lymphocytes and inhibits body's response to infection



<http://www.eleventhavenue-south.com/HIV1.jpg>

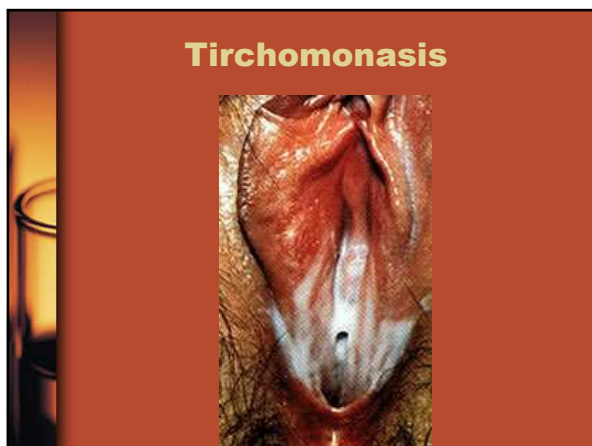
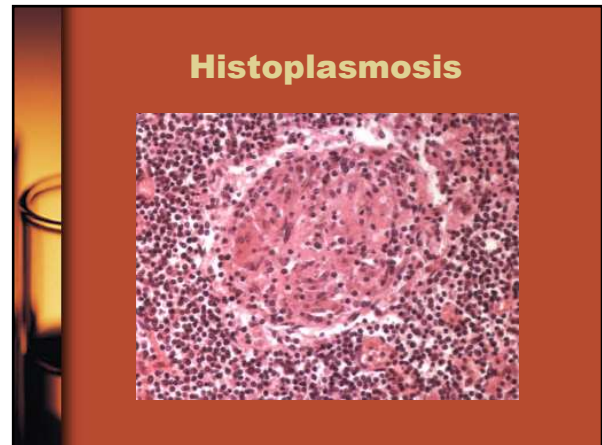
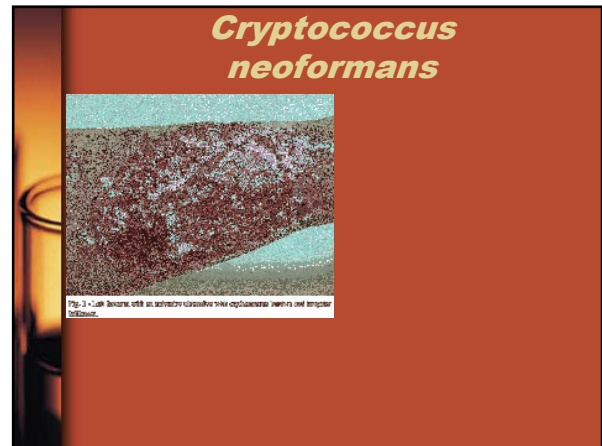
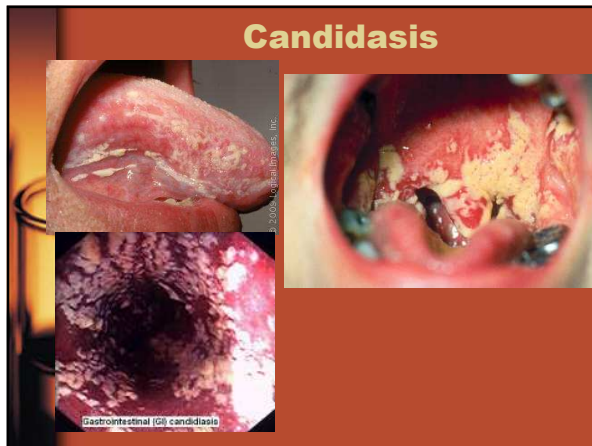
HIV Infection

- Primary Infection
 - High levels of HIV in blood
 - Often complain of flu like illness
 - Undetectable antibodies in blood
 - Begin process of seroconversion
- Asymptomatic Stage
 - Lasts an average of 10 years
 - Blood contains antibodies
 - Able to transmit infection
 - May notice enlarged lymph glands

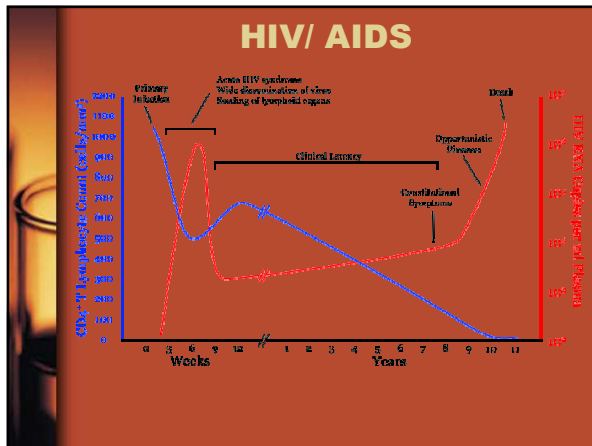
HIV Infection

- Symptomatic stage
 - Results from severe damage to immune system
 - Damaged lymph nodes and glands
 - Inability to produce new T4 lymphocytes
 - HIV mutation
 - Susceptible to opportunistic infections
 - Kaposi's sarcoma
 - Parasitic infections
 - Fungal infections (candidiasis, histoplasmosis, cryptococcus)
 - Viral infections

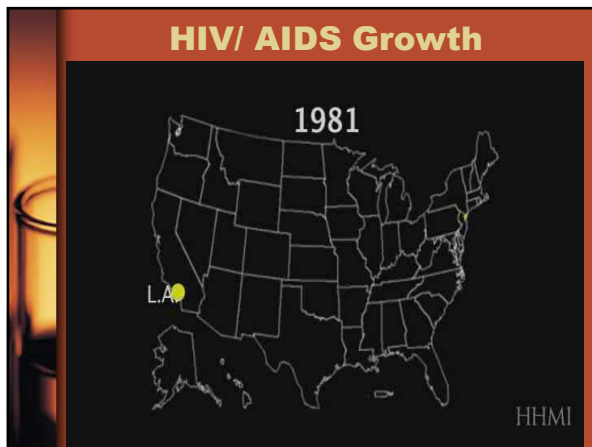
Kaposi's Sarcoma

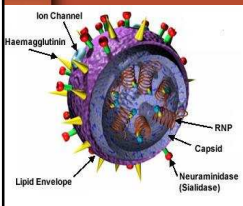


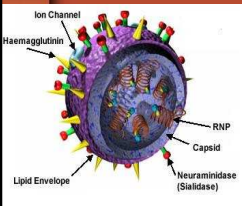
- ### What Happens During an HIV Infection
- The viral load of HIV increases
 - Infected cells duplicate; increasing the number of HIV copies in the infected host
 - The body creates antibodies to the HIV virus
 - As viral load increases, T4 cells (CD4+) cells decrease
 - When T4 count drops, host becomes sick and eventually dies

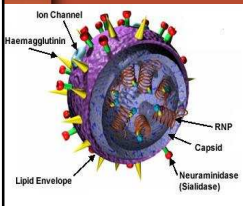


- ### HIV Treatment
- No cure but progression can be slowed
 - Reverse transcriptase inhibitors (AZT)
 - Prevent infection of new T4 cells by blocking conversion of RNA to DNA
 - Protease inhibitors
 - Inhibits viral replication
 - Ligase inhibitors
 - Block integration of HIV DNA into host cells



- ### Influenza
- 
- Infectious virus that infects mammals and birds
 - RNA type virus
 - Not a retrovirus
 - Often confused with gastroenteritis
 - Nothing alike
 - GE is a bacterial infection that causes vomiting and diarrhea
 - Influenza attacks the resp. system

- ### Influenza
- 
- Transmitted in aerosolized format through coughing and sneezing
 - Direct or indirect contact is possible
 - Virus is susceptible to sunlight, soap and detergent
 - Best treatment is prevention by hand washing

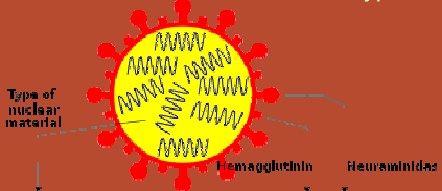
- ### Influenza
- 
- Three types of viruses
 - A = Most virulent and cause of pandemic outbreaks
 - Infects mammals and birds
 - Common cause of severe illness
 - Fast mutator
 - B = Never causes pandemics but can cause some local epidemics
 - Only infects humans
 - Slower evolver
 - Illness is less severe
 - C = Infects humans, dogs, and pigs
 - Illness is minor and usually only occurs in children

Influenza Genome

- RNA genome encodes 11 genes on 8 RNA segments
 - There are 2 critical proteins involved in influenza infection
 - Hemagglutinin protein allows virus to binds to certain molecules on surface of epithelial cells
 - Hemagglutinin determines where the protein binds
 - H1 binds to cells in nose and throat
 - H5 binds deep in lungs and causes pneumonia
 - While the cell is infected, the virus directs the cell to reproduce the viral genome and builds new viral particles
 - Neuraminidase protein cleaves the attachment point of influenza virus and allows new viral particles to detach and infect other cells

Influenza Nomenclature

- Hemagglutinin = There are nine types
- Neuraminidase = There are five types



A/Fujian/411/2002 (H3N2)

Virus type
Geographic origin
Strain number
Year of isolation
Strain subtype

Symptoms of infection

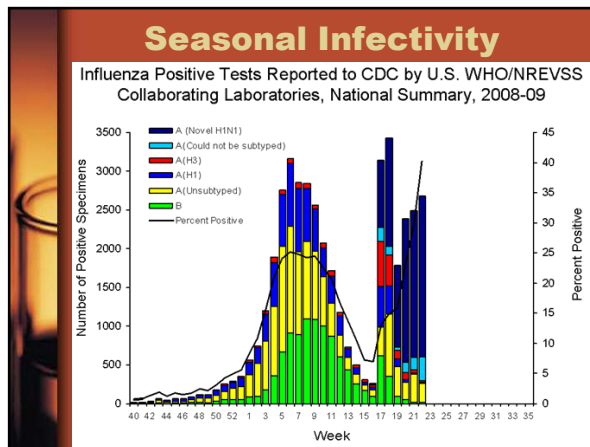
- Body aches
- Fever = often very high and can be first sign of infection
- Cough
- Running nose
- Headache

Prevention of Influenza

- Vaccination
 - Trivalent vaccine designed to prevent about 85% of cases
 - Chooses the 2 most prominent A subtypes and the most prominent B subtype
 - Engineered by infecting hens with gene products of HA gene and NA gene, harvesting viral particles from eggs and deactivating with detergent
- Handwashing and Cleanliness

Treatment of Influenza

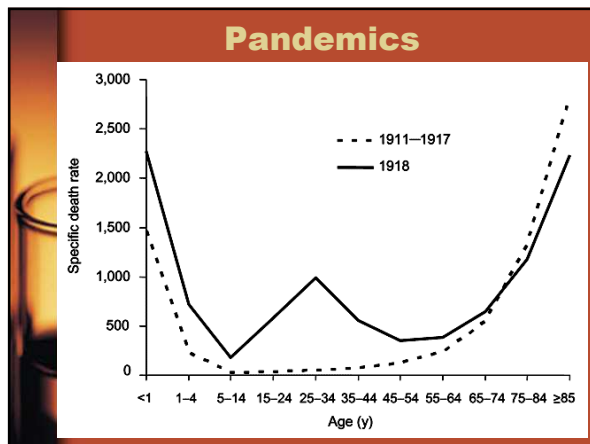
- Neuraminidase inhibitors (Tamiflu)
 - Inhibit the flu virus from leaving the infected cell and halts the progression of illness
 - Must be given within 48 hours of exposure
 - Some strains are resistant to Tamiflu
 - Current pandemic H1N1



Pandemics

Pandemic	Year	Death Rate	Subtype	Type
Asiatic Flu	1889 -1890	1,000,000	H2N2	A
Spanish Flu	1918-1920	50,000,000	H1N1	A
Asian Flu	1957 -1958	2,000,000	H2N2	A
Hong Kong Flu	1968 - 1969	1,000,000	H3N2	A
Current	2009-	5000	H1N1	A

In April 2009, Margaret Chan declared a “ [This strain to be] a public health emergency of international concern”



Current Pandemic

FLUVIEW

A Weekly Influenza Surveillance Report Prepared by the Influenza Division
Weekly Influenza Activity Estimates Reported by State and Territorial Epidemiologists*

Week Ending August 01, 2009- Week 30

- No Report
- No Activity
- Sporadic
- Local
- Regional
- Widespread

*This map indicates geographic spread and does not measure the severity of influenza activity.