Lecture 11:
STD’s and Viruses in Cells

Basic Structural Organization
- Membrane
- Cytoplasm
- Nucleus

Cell Membrane
Fluid Mosaic Model
- Fluid- kind of like a bubble
- Mosaic- Full of “Stuff”
  1. Phospholipids (of course)
  2. Protein (Oh no not again!)
  3. Sterols- Structurally Important
     - Not long chains
     - Add flexibility to membrane

Receptors and Recognition
Receptors are sensors on the cell
- Nutrient levels
- Status of surrounding cells
- Divide or Die
- Activate or Suppress
Recognition
- ID tags
- Immune surveillance

Cell Membrane
Key Concepts
- The membrane is an organelle
- The membrane is dynamic
- Membranes play a key role in cell function
  - More than just a filmy covering
  - Not just on the outside

Inside the Cell
- More Membranes!
- Organelles
- Few Empty Spaces
  - Cytoplasm is the Desert in the Cell
Endomembrane System

1. Nuclear Membrane
2. Endoplasmic Reticulum (ER)
   - Rough ER
   - Smooth ER
3. The Golgi Body
4. Vessicles
5. Sarcoplasmic Reticulum

Endomembrane System

Nuclear Membrane
- Inner nuclear membrane
- Outer nuclear membrane
- Continuous with ER
- Nuclear Membrane Proteins
  - Nuclear Lamina- Inner membrane
    - Structure
    - Role in Division
  - Nuclear pores- Transport

Endomembrane System

Endoplasmic Reticulum
- Site of Protein Synthesis
  - Ribosomes- attached vs. “free”
  - Protein tags for trafficking:
    - Outside, Inside or in the Middle
  - Inside the ER
    - Post-Transcriptional Modification
      - Glycosylation- sugar additions
      - Glycosylation labels proteins for transport
      - Transport
        - New proteins shuttled to Golgi or Vessicles

Endomembrane System

Golgi Apparatus
- More post-transcriptional modification
- Sorting and transport
  - Default transport and Direction
    - If in doubt secrete it
- Carbohydrate Synthesis
  - Polysaccharides
    - Pectin and hemicellulose
    - Glycosaminoglycans

Endomembrane System

Vessicles
- Secretory Vessicles
  - Fuse with membrane and dump contents
- Lysosome and Peroxisome
  - Degrade and recycle
- Vacuoles
  - Storage containers
Protein Traffic

- Protein made in the ER is folded
- Bits of the ER are transported to the Golgi
- The Golgi labels and sorts proteins
- Bits of the Golgi are transported to “vessicles”
  - Secretory vesicles
  - Lysosome

Endomembrane System
What Happens in Each Compartment
1. ER
2. Golgi
3. Vessicles
   - Follow the protein

Basic Structural Organization
- Membrane
- Cytoplasm
- Nucleus

Membrane-bound Organelles
- Nucleus
- Mitochondria
- Chloroplast

Sexually Transmitted Disease
- Chlamydia
- Gonorrhea
- Syphilis
- Trichomonas
- Genital Warts
- Herpes Virus
- HIV/AIDS
## Chlamydia

**Cause:** Intracellular bacteria  

**Symptoms (M):** Urethritis, epididymitis, prostatitis (mild to severe burning)  

**Symptoms (F):** Urethritis, cervicitis and PID.  

**Key features:**  
- Important cause of infertility  
- No external sores  
- Asymptomatic: Up to 20%  

**Incubation:** 1-3 weeks  

**Treatment:** Antibiotics  

---

## Gonorrhea

**Cause:** Intracellular bacteria  

**Symptoms (M):** Urethritis (mild to severe burning)  

**Symptoms (F):** Urethritis, cervicitis and PID.  

**Symptoms (M/F):** 30-50% rectal infection  
Pharyngitis, isolated from pharynx (throat)  

**Key features:**  
- Scarring in fallopian tubes increases chance of ectopic pregnancy  
- No external sores  
- Asymptomatic: Up to 20%  

**Incubation:** 3 days to 3 weeks  

**Treatment:** Antibiotics  

---

## Syphilis

**Cause:** Bacteria, spirochete  

**Symptoms (M/F):**  
- **Primary:** Chancre (painless)  
- **Secondary:** Headache, fever, sore throat, rash- trunk to palms and soles.  
- **Tertiary:** Nervous system and cardiovascular damage. Leads to: meningitis, dementia, neuropathy and heart attack  

**Key Features:**  
- Incubation: 21 days  
- Primary symptoms: 3-6 weeks  
- Secondary symptoms: for 3-6 weeks, 3-6 weeks after primary, spontaneously resolve  
- Tertiary symptoms: years after infection  
- Treatment: most successful in first and secondary stages  

---

## Trichomonas

**Cause:** Flagellated protozoan  

**Symptoms (M):** Asymptomatic, sporadic urethritis  

**Symptoms (F):** Vaginosis with discharge (frothy green) and abdominal pain  

**Key Features:**  
- Non-bacterial parasite  

**Incubation:** 3 to 28 days
Trichomoniasis

- Trichomoniasis is one of the most common sexually transmitted diseases
- Mainly affects 16-to-35-year-old women.
- In the United States, it is estimated that 2 million women become infected each year.

http://www.cdc.gov/ncidod/dpd/parasites/trichomonas/factsht_trichomonas.htm

Genital Warts

Cause:
Human papilloma virus (HPV = DNA virus)

Symptoms (M/F):
- Painless
- Coalesced condylomate may cause discomfort from size and location
- A appear as flat, smooth, small bumps, or quite large, pink, cauliflower-like lumps.

Key Features
- Correlated with cancer
- Treatment:
  - Cryotherapy
  - Difficult to distinguish
  - Asymptomatic (F) detection with PAP smear
  - Asymptomatic (M) no HPV test for men

Genital Warts

HPV infects the genital area and is spread through genital contact.

Most HPV infections have no signs or symptoms; therefore, most infected persons are unaware they are infected, yet they can transmit the virus to a sex partner.

Herpes Virus

Cause:
Herpes Virus (DNA virus)

Symptoms (M/F):
- Fever, headache, retention, swollen lymphnodes. Genital sores

Key Features
- Lifelong recurrent episodes of painful genital lesions, 4 or 5 each year
- Increased likelihood of HIV transmission and acquisition
- Women who acquire genital herpes in pregnancy: potentially fatal neonatal infection
- Incubation: 8 to 16 days

Herpes simplex I and II: Cold sores vs. STDs

Herpes can make people more susceptible to HIV infection, and it can make HIV-infected individuals more infectious.

There is no treatment that can cure herpes.

Epidemic?
- Nationwide, one out of five
- Between the late 1970s and the early 1990s, increased by 30%

AIDS (Acquired Immune Deficiency Syndrome)

- Cause: Human Immunodeficiency Virus (HIV)
- Symptoms: fever, weakness, multiple infections, cancer
- Report:
  - An estimated 1 in 200 college students has HIV
  - People with HIV who are not aware of their status accounted for 32 percent of those reported between July 1999 and June 2000

The AIDS epidemic is shifting toward women. Women account for 28 percent of HIV cases reported since 1981, they accounted for 32 percent of those reported between July 1999 and June 2000
**Human Immunodeficiency Virus (HIV)**

**Cause:**
- Retro virus (RNA virus)
- Virus that causes Acquired Immune Deficiency Syndrome (AIDS)

**Key Features**
- No cure
- No immune system
- Sexually transmitted
- Blood transmission
- Needles, and transfusions

---

**Adults and children living with HIV/AIDS as of end 2003**

- Total: 34 – 46 million

---

**Estimated adult and child deaths from HIV/AIDS during 2003**

- Total: 2.5 – 3.5 million

---

**Estimated number of children (<15 years) newly infected with HIV during 2003**

- Total: 590 000 – 810 000

---

**About 14 000 new HIV infections a day in 2003**

- More than 95% are in low and middle income countries
- Almost 2000 are in children under 15 years of age
- About 12 000 are in persons aged 15 to 49 years, of whom:
  - almost 50% are women
  - about 50% are 15–24 year olds
Global summary of the HIV/AIDS epidemic, December 2003

Number of people living with HIV/AIDS
- Total: 40 million (34 – 46 million)
- Adults: 37 million (31 – 43 million)
- Children under 15: 2.5 million (2.1 – 2.9 million)

People newly infected with HIV in 2003
- Total: 5 million (4.2 – 5.8 million)
- Adults: 4.2 million (3.6 – 4.8 million)
- Children under 15: 700 000 (590 000 – 810 000)

AIDS deaths in 2003
- Total: 3 million (2.5 – 3.5 million)
- Adults: 2.5 million (2.1 – 2.9 million)
- Children under 15: 500 000 (420 000 – 580 000)

Occurrence of AIDS among different races

Life expectancy in African countries with high rates of HIV

20 year decrease in 10 years

Global HIV Epidemic

Occurrence of AIDS among different races

What we’ve learned about therapy

Bad News
- Can’t Cure HIV
- Viral replication even with NO Detectable Virus (<20 c/ml)
- Long term toxicity and intolerance
- Virologic failure leads to resistance
  - Variables: Time, Load, Agent
- Resistant strains are transmitted
- Adherence (>80-95%) critical for virologic suppression
- Good care requires experts

Where does this leave a virus?

- Not able to replicate alone
- Not able to metabolize alone
- Not a life form

Vi`rus
Noun, virus - (virology) ultramicroscopic infectious agent that replicates itself only within cells of living hosts; many are pathogenic; a piece of nucleic acid (DNA or RNA) wrapped in a thin coat of protein
Classification

**The Kingdoms**

Eukaryotes
- Anamalia - Multicellular, consumers
- Plantae - Multicellular, consumers
- Fungi - Mostly decomposers
- Protista - One-celled, producers and consumers
- Eubacteria - Normal bacteria
- Archaebacteria - Extreme bacteria

Prokaryotes

Virus

**General Description**
1. Non-cellular infectious agent
2. Protein coat wrapped around nucleic acids
3. Cell dependent replication

**General Features**
- Genetic material
  - RNA or DNA
- Viral envelope
  - Viral coat protein
  - Glycoproteins
  - Plasma membrane from previous host
- Specialized Proteins

**Host Range and Types of viruses**

Wide range of hosts

<table>
<thead>
<tr>
<th>Virus Families</th>
<th>Some Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenoviruses</td>
<td>Respiratory infections</td>
</tr>
<tr>
<td>Hepatitis virus</td>
<td>Liver diseases</td>
</tr>
<tr>
<td>Herpesviruses</td>
<td>Oral herpes, cold sores</td>
</tr>
<tr>
<td>Polio virus</td>
<td>Paralysis</td>
</tr>
<tr>
<td>Papovaviruses</td>
<td>Berox and malignant warts</td>
</tr>
<tr>
<td>Parovaviruses</td>
<td>Roseola, fever, rash in small children; agglomeration of sickle-cell anemia</td>
</tr>
<tr>
<td>Poxviruses</td>
<td>Smallpox, chickenpox</td>
</tr>
</tbody>
</table>

**DNA Viruses**

Bacterial Virus Model

- 1917, Discovery of Bacteriophage
  - Why doesn't everyone die of bacterial dysentery?
  - What's eating the bacteria?
- The MSU story
  - 1950, Harold Sadoff U of Ill: Micro aerosols
  - 1952, Hershey and Chase Experiment

**Virus Structure**

Understanding a Virus
Components
- Nucleic acid
- Proteins

Life Cycle

Host Range

Types of Virus
- HIV
- Herpes Simplex
- Baculovirus

**Virus Structure**

- Ribo Virus
  - Contains RNA
- DNA Virus
  - Contains DNA

Bacteriophage

- 1 micron
The Hershey and Chase Experiment

1. Label protein or DNA with radio isotopes
2. Infect bacteria with phage particles
3. Sheer off the phage (blender)
4. Separate bacteria and phage protein
5. Progeny of the phage

DNA Virus Life Cycle

1. Attach and Enter
2. Integration
3. Transcription and Translation
4. Assembly
5. Release

Bacteriophage

DNA is the infective material not protein

Bacteriophage are an example of a DNA virus

Baculovirus

Double-strand DNA Virus

Two Morphologies
1. Polyhedryl inclusion bodies - insect to insect
2. Single viron derived from plasma membrane of host

Very important tool for molecular biology

Retrovirus Life Cycle

1. Attach and Enter
2. Reverse Transcription
3. Integration
4. Transcription and Translation
5. Assembly
6. Release
Retrovirus Life Cycle

1. Attach and Enter
2. Reverse Transcription
3. Integration
4. Transcription and Translation
5. Assembly
6. Release

STRUCTURE OF HIV

1. Attach and Enter
2. Retro transcription
3. Integration
4. Transcription and Translation
5. Assembly
6. Release

HIV Transmission

How HIV causes AIDS

The Immune System

Programmed Cell Death

Proteins in HIV