Lecture 12: Cells, Viruses and STDs

Classification

The Kingdoms

<table>
<thead>
<tr>
<th>Eukaryotes</th>
<th>Prokaryotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Anamalia- Multicellular, consumers</td>
<td></td>
</tr>
<tr>
<td>- Plantae- Multicellular, consumers</td>
<td></td>
</tr>
<tr>
<td>- Fungi- Mostly decomposers</td>
<td></td>
</tr>
<tr>
<td>- Protista- One-celled, producers and consumers</td>
<td></td>
</tr>
<tr>
<td>- Eubacteria- Normal bacteria</td>
<td></td>
</tr>
<tr>
<td>- Archaebacteria- Extreme bacteria</td>
<td></td>
</tr>
</tbody>
</table>

Prokaryotes

Cell Theory

- Every organism is composed of one or more cells
- Living cells are smaller
- Life is dependent of the growth and division of cells

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

The Cell is a Fundamental Unit of Life

<table>
<thead>
<tr>
<th>Cell structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ribosomes</td>
</tr>
<tr>
<td>- Membrane-bound organelles</td>
</tr>
<tr>
<td>- Endomembrane system</td>
</tr>
<tr>
<td>- Cytoskeleton</td>
</tr>
<tr>
<td>- Flagellum (Cilia)</td>
</tr>
</tbody>
</table>

Scale of the Game

<table>
<thead>
<tr>
<th>Size of Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs 3 mm</td>
</tr>
<tr>
<td>Plant cell 100 μm</td>
</tr>
<tr>
<td>Animal cell 40 μm</td>
</tr>
<tr>
<td>Red Blood Cell 8 μm</td>
</tr>
<tr>
<td>Trypanosome 25 μm</td>
</tr>
<tr>
<td>Bacteria 1-5 μm</td>
</tr>
<tr>
<td>Virus</td>
</tr>
<tr>
<td>- HTLV(AIDS) 100 nm</td>
</tr>
<tr>
<td>- Poliovirus 30 nm</td>
</tr>
</tbody>
</table>

Drawn to approximate scale
Comparison of Prokaryotic and Eukaryotic Cells

<table>
<thead>
<tr>
<th>Prokaryote</th>
<th>Eukaryote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organism</td>
<td>Bacteria</td>
</tr>
<tr>
<td>Cell Size</td>
<td>1-10 µm</td>
</tr>
<tr>
<td>O₂ required</td>
<td>some</td>
</tr>
<tr>
<td>Membrane</td>
<td>no</td>
</tr>
<tr>
<td>Ribosomes</td>
<td>yes</td>
</tr>
<tr>
<td>DNA form</td>
<td>circular</td>
</tr>
</tbody>
</table>

Comparison of Prokaryotic and Eukaryotic Cells

<table>
<thead>
<tr>
<th>Prokaryotic</th>
<th>Eukaryotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNA location</td>
<td>cytoplasm</td>
</tr>
<tr>
<td>DNA length</td>
<td>short</td>
</tr>
<tr>
<td>Cytoskeleton</td>
<td>no</td>
</tr>
</tbody>
</table>

Bacteria

- Two different kingdoms (taxonomy term)
- Eubacteria and Archaeabacteria
- Huge Metabolic Diversity
  - Photoautotrophic
  - Chemoautotrophic
  - Photoheterotrophic
  - Chemoheterotrophic
  - Also aerobic and anaerobic
- Basic Morphology
  - Rods, Balls and Spirals or...
  - Bacilli, Cocci, and Spirillum

Basic Structural Organization

- Membrane
- Cytoplasm
- Nucleus

Cell Membrane

- Phospholipids
  - Hydrophilic- Heads
  - Lipophilic- Tails

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
### Comparison of Prokaryotic and Eukaryotic Cells

<table>
<thead>
<tr>
<th></th>
<th>Prokaryote</th>
<th>Eukaryote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organism</td>
<td>Bacteria</td>
<td>Protists, yeast, plants and animals</td>
</tr>
<tr>
<td>Cell Size</td>
<td>1-10 µm</td>
<td>10-100 µm</td>
</tr>
<tr>
<td>O₂ required</td>
<td>some</td>
<td>all</td>
</tr>
<tr>
<td>Membrane</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Ribosomes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>DNA form</td>
<td>circular</td>
<td>linear complex with protein</td>
</tr>
</tbody>
</table>

### DNA location
- Prokaryotic: cytoplasm
- Eukaryotic: nucleus

### DNA length
- Prokaryotic: short
- Eukaryotic: long

### Cytoskeleton
- Prokaryotic: no
- Eukaryotic: yes

### Cell Membrane Proteins
- Transport proteins and channels
- Adhesion proteins
- Receptors
- Enzymes
- Recognition

### Bacteria
- Two different kingdoms (taxonomy term)
- Eubacteria and Archaebacteria
- Huge Metabolic Diversity
  - Photoautotrophic
  - Chemoautotrophic
  - Photoheterotrophic
  - Chemosynthetic
  - Also aerobic and anaerobic
- Basic Morphology
  - Rods, Balls and Spirals or...
  - Bacilli, Cocci, and Spirillum

### Transport Proteins

### Adhesion Proteins
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

Basic Structural Organization

- Membrane
- Cytoplasm
- Nucleus

Inside the Cell

More Membranes!
Organelles
Few Empty Spaces
Cytoplasm 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- Rough
- Site of Protein Synthesis
  - Ribosomes- attached vs. “free”
  - Outside, Inside or in the Middle- signal peptides
- Inside the ER
  - Post-Transcriptional Modification
    - Glycosylation- sugar additions
  - Transport

Endoplasmic Reticulum- Smooth
- Transport
- Lipid metabolism
- Detoxification

Nuclear Pore Complex

Nuclear Pore Function

Ribosomes

Electron tomography- New Imaging technique 5-6 nm resolution
**Ribosomes**

- Protein production

---

**Endomembrane System**

**Golgi Apparatus**
- More post-transcriptional modification
- Sorting and transport
  - Default transport and Direction
- Carbohydrate Synthesis
  - Polysaccharides
    - Pectin and hemicellulose
    - Glycosaminoglycans

---

**Endomembrane System**

**Vessicles**
- Secretory Vessicles
- Lysosome and Peroxisome
- Vacuoles

---

**Protein Traffic**

- Follow the protein

---

**Endomembrane System**

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

---

**Recognition**

- Partially folded DRP (chaperone binding)
- Membrane-bound transport vesicle
- Transport vesicle fusion
- Vesicle bind to target membrane
- Protein enters target cell

---

**Protein Traffic**

- ER to Golgi
- Golgi to Vessicles
- Vessicles to Target Cell
Basic Structural Organization

• Membrane
• Cytoplasm
• Nucleus

Membrane-bound Organelles

Nucleus
• Contains DNA
  • Instructions for building RNA and Protein
  • Site of RNA synthesis
• Key Structures
  • Nuclear matrix- not a goop filling
  • Nucleolus
    • Ribosome producing machine
    • Nucleolar organizer- hot spots of activity

Mitochondria
• Double membrane
  • Electron transport- Chemical gradient maker
  • ATP synthesis- Chemical gradient user
  • Site of most important biochemical reaction:
    • The CREB CYCLE and β-Oxidation (Mercifully we won’t be covering this)
• Important Contents
  • Circular DNA Genome
  • Separate DNA and RNA polymerase, and some ribosomes

Nucleus

New Weird Stuff

Ribosome Components are Associated with Sites of Transcription

May be involved in surveillance complex that triggers the rapid decay of abbrant mRNA
Membrane-bound Organelles

**Plastids**
- **Chloroplast**
  - Two outer membranes - contain stroma
  - Inner membrane system - Thylakoid Membrane
    - Grumus - stacks of disks
    - Contain chlorophyll pigment for trapping light
  - Light to ATP and NADPH to sugar and starch
- **Chromoplast** - Bags of color
  - Contain carotenoids instead of chlorophyll
- **Amyloplasts** - Bags of starch
  - Found in seeds and tubers

Basic Structural Organization

- Membrane
- Cytoplasm
- Nucleus

Cytoskeleton

- **Function**
  - Reinforce Membrane
  - Scaffold for proteins
  - Intracellular organelle arrangement and movement
- **Microtubules** - tubulin, cell division, movement, cell shape
- **Microfilaments** - actin, movement
- **Intermediate filaments** - mechanical strength

Movement

- Flagella and cilia
- Motility, absorption

Cell Membrane

Endoplasmic reticulum

Ribosome

Mitochondrion

Microfilament

Microtubule
Animal vs. Plant Cells

Chloroplasts
Tough Cell wall
Pectin, Cellulose, Polysaccharides, lignin
Wax Cuticle
Central Vacuole

Single Cell Organisms
Structurally “Simple” Eukaryotes

Protistan
• Normal cell parts
  – Nucleus, Mitochondria, ER, Golgi, Ribosome, Cytoskeleton.
  – Chromosomes, divide similar to mitosis
  – Some have chloroplasts and photosynthesize

Protozoans
• Eat bacteria and other protozoans
• Aquatic
• Amoebas, Flagellates, Apicomplexans (aka Sporozoans)
• Diseases
  – Trypanosoma = sleeping sickness
  – Plasmodium = malaria
Fungi
• Like a plant, but lacks chlorophyll
• Digest food externally, absorb nutrients
• Yeasts
  – Single-celled fungi

Comparison of Prokaryotic and Eukaryotic Cells

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  - Chemoautotrophic
  - Photoheterotrophic
  - Chemo heterotrophic
  - Also aerobic and anaerobic
- Basic Morphology
  - Rods, Balls and Spirals or...
  - Bacilli, Cocci, and Spirillum

**Prokaryotic vs. Eukaryotic**

Prokaryote = Bacteria  (Eukaryote = true cells)

No nucleus
- Circular chromosome
No Organelles
- Very different membrane and cell wall
  - Outer layer: Lipopolysaccharide, lipoprotein, peptidoglycan
  - Periplasmic space
  - Inner lipid bilayer

**Bacterial Membranel**

**Movement**

Bacterial Flagella

**Prokaryotic Cells of Human Importance**

- Normal Flora
- Food Poisoning/ Digestion
- Molecular Biology
- American Cheese
- Yogurt
- Cheese
- Contaminant Conversion
- N₂ Fixation
**Cholera**

- **Cause:** Vibrio cholerae
- Infection from contaminated food or drink
- Common in overpopulated countries
- Existing vaccines are useless against recent mutant forms

**Food poisoning by ingestion of bacteria:**

- **Cause:** Salmonella sp.
- **Symptoms:** fever, aches, drop in blood pressure
- Produces glycolipid endotoxin
- Some bacteria are essential for digesting certain proteins
- There are about 20 different species of bacteria commonly found in the human intestine
- Ruminants and Termites: use bacteria to digest cellulose

**Molecular Biology is Dependent on Bacteria**

- Bacteria produce enzymes that cut DNA
  - Amplify/synthesize DNA
  - Heat to 95 degrees Celsius
  - Taq Polymerase
  - Random amplified polymorphic DNA (RAPD)
- Integrate foreign DNA into own DNA

**Cheese and yogurt: Bacteria & Fungi**

- **Cheese:** from cow = Rennin
  - Fungi: Streptomyces
- **Yogurt:** acidophilus curd
  - Cats like yogurt, too!

**Contamination conversion**

- Life depends on cycling of chemical elements between organisms and non-living components of our environment
  - **Cyanobacteria**
    - Produce/restored oxygen & convert nitrogen gas to nitrogen compounds for plant and diatom food.
  - **Decomposers**
    - Breakdown of organic waste and dead organisms
    - Nitrogen converted to ammonium = atmosphere fixation
    - Some bacteria can decompose petroleum = useful for oil spills

**Nitrogen fixation:**

- **N₂** gas composes 80% of the atmosphere
- Only bacteria and fungi can convert atmospheric nitrogen (N₂) to ammonia and other nitrogen-containing molecules that can enter the food cycle
- Plants use ammonium, NH₃
  - Plants are the only source of nitrogen for animals (herbivores: animals that feed on plants) and
  - Carnivores (animals that feed on animals) convert protein to amino acids for their own metabolism
Goals:
1. Understand structure and behavior of viruses
2. Understand why viruses are important to humans: diseases, food, atmosphere
3. Understand the threat of sexually transmitted diseases and how they can and cannot be prevented

Assignment: Read: Chapter 20

Websites:
http://www.virology.net/Big_Virology/BVHomePage.html
http://brainphysics.com/guide/
http://www.gynpages.com/mhresearchive/SIGNIFICANT.htm
http://www.ibar.cvis.c.c/Bar03/Bar03 normalflora
http://www.xsfors.com/birthcontrol/

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

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

Virus Structure

Understanding a Virus
Components
- Nucleic acid
- Proteins
Life Cycle
Host Range
Types of Virus
- HIV
- Herpes Simplex
- Baculovirus

Virus Structure
Retrovirus
- Contains DNA or RNA but not both
Host Range and Types of viruses

Wide range of hosts

<table>
<thead>
<tr>
<th>Virus Types</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>Hantaviruses</td>
<td>Oral herpes, cold sores</td>
</tr>
<tr>
<td>Varicella-zoster Virus</td>
<td>Chicken pox, shingles</td>
</tr>
<tr>
<td>Epstein-Barr Virus</td>
<td>Infectious mononucleosis, impetigo</td>
</tr>
<tr>
<td>Papovaviruses</td>
<td>Benign and malignant warts</td>
</tr>
<tr>
<td>Paramyxoviruses</td>
<td>Rosacea, fever, rash in small children; agglutination of red-cell anemia</td>
</tr>
<tr>
<td>Picornaviruses</td>
<td>Smallpox, common cold</td>
</tr>
<tr>
<td>RNA viruses</td>
<td>Some diseases</td>
</tr>
<tr>
<td>Picornaviruses: Enteroviruses</td>
<td>Polio, hemorrhagic conjunctivitis, hepatitis A (infectious hepatitis)</td>
</tr>
<tr>
<td>Adenoviruses</td>
<td>Common cold</td>
</tr>
<tr>
<td>Togavirus</td>
<td>Encephalitis, yellow fever, dengue fever</td>
</tr>
<tr>
<td>Paramyxoviruses</td>
<td>Measles, mumps</td>
</tr>
<tr>
<td>Rhinovirus</td>
<td>Rhinitis</td>
</tr>
<tr>
<td>Coronaviruses</td>
<td>Respiratory infections</td>
</tr>
<tr>
<td>Orthomyxoviruses</td>
<td>Influenza</td>
</tr>
<tr>
<td>Arenaviruses</td>
<td>Hemorrhagic fevers</td>
</tr>
<tr>
<td>Reoviruses</td>
<td>Respiratory, intestinal infections</td>
</tr>
<tr>
<td>Retroviruses: HIV, HCV</td>
<td>Associated with cancer (leukemia, AIDS)</td>
</tr>
</tbody>
</table>

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

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

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
DNA Virus Life Cycle

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

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

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
Throughout the world, an estimated 333 million new cases of curable sexually transmitted diseases (STD) occur each year among adults. The rates of STDs are 50-100 times higher in the US (1 in 5 by age 21) than in other industrial nations. 15.3 million new cases of STDs are reported in the US each year (5% of the total population), 3 million of which occur in persons aged 13 to 19 years. 63% are under 25.

The STD Triangle Analogy

Microorganism Flora

**Principle:**
Every sexual liaison is not just fluid dynamics, it is actual sharing of microflora. In fact, one “experienced” person, can infect another “naïve” person with many of his/her micro-flora in a single sexual encounter. Its like having sex with all many of your partner’s previous partners– from a microorganism point of view!
Chlamydia

- **Cause**: Bacteria
- **Symptoms**: Painful urination, mucus, discharge, 75% of infected women and 25% of infected men have no symptoms at all
- **US reported cases**: 526,653 cases were reported in 1997, an estimated 4 million cases occur annually
- **Treatment**: Antibiotics
- **Complications**: Pelvic inflammatory disease (PID), Fetal transmission, arthritis, ectopic pregnancy, pneumonia

US cases age 15-24/year: F= 1 in 10 M= 1 in 20

Gonorrhea

- **Cause**: *Neisseria gonorrhea*
- **Symptoms**: Women: none  Men: painful urination, fever
- **US reported cases**: >10 million, 800,000 new cases a year.
- **Treatment**: Antibiotics
- **Complications**: arthritis, rash, infertility, PIV, fetal transmission

US cases age 13-24/year: F= 3 in 2500  M= 1 in 800

Gonorrhea

- **Cause**: Neisseria gonorrhea
- **16 species known**
- **Long-term effects**: Immune system failure
- **More noticeable in males than females**
- **Can cause sterility in females**

Nongonococcal urethritis

- **Cause**: Mycoplasma
- **Symptoms**: Painful urination, mucus, discharge
- **US reported cases**: >10 million
- **Treatment**: Antibiotics
- **Complications**: Pelvic inflammatory disease (PID), Fetal transmission

US cases age 13-24/year: F= 1 in 20  M= 1 in 40

Genital Warts

- **Cause**: Human Papilloma virus (HPV)
- **Symptoms**: warts on genitals
- **US reported cases**: 1 in 4 coeds (1 in 10 Americans)
- **14,000 new cases annually**
- **Treatment**: chemical or surgical
- **Complications**: arthritis, rash, infertility, PID, cervical cancer

US cases age 13-24/year: F= 12 in 25  M= 23 in 50

Syphilis

- **Cause**: Spirochete
- **Treponema pallidium**
- **Enters body through**: glands or tears in epidermis
- **Miscarriage**
- **Stillbirth**
- **Syphilitic newborn**
- **Can cause paralysis**
### Syphilis
- **Cause:** Bacteria: *Treponema pallidum*
- **Symptoms:** canker sore, rash, vital organ damage
- **US reported cases:** >38,000
- **Treatment:** Antibiotics
- **Complications:** Death, fetal transmission, prematurity, birth defects, stillborn

**US cases age 13-24/year:**
- F= 1 in 12,500
- M= 3 in 11,250

### Genital Herpes
- **Cause:** Virus: Herpes Simplex I or II
- **US reported cases:** > 45 million (20% of all Americans over the age of 12), 200,000 to 500,000 new cases a year, and this is not the most common STD
- **Treatment:** Acyclovir, incurable
- **Complications:** Cervical cancer, fetal transmission, brain damage, still births

**US cases age 13-24/year:**
- F= 1 in 4
- M= 1 in 5

### AIDS (Acquired Immune Deficiency Syndrome)
- **Cause:** Human Immunodeficiency Virus (HIV)
- **Symptoms:** fever, weakness, multiple infections, cancer
- **Reported AIDS cases in Michigan:** 13,500
- **An estimated 850,000 people in the US have HIV**
- **Approximately 40,000 new HIV infections occur every year**
- **One-third of infected Americans have not been tested and are unaware of their status.**
- **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.**

1 in 100 college students has HIV

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.

### Global HIV Epidemic

#### Adults and children estimated to be living with HIV/AIDS as of end 1999

<table>
<thead>
<tr>
<th>Region</th>
<th>Estimated Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Europe</td>
<td>520 000 – 680 000</td>
</tr>
<tr>
<td>Eastern Europe &amp; Central Asia</td>
<td>1.2 – 1.8 million</td>
</tr>
<tr>
<td>East Asia &amp; Pacific</td>
<td>700 000 – 1.3 million</td>
</tr>
<tr>
<td>South &amp; South-East Asia</td>
<td>4.6 – 8.2 million</td>
</tr>
<tr>
<td>Asia &amp; Pacific</td>
<td>6.5 million</td>
</tr>
<tr>
<td>Australia &amp; New Zealand</td>
<td>12 000 – 18 000</td>
</tr>
<tr>
<td>Total</td>
<td>34.3 million</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Region</th>
<th>Estimated Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caribbean</td>
<td>350 000 – 590 000</td>
</tr>
<tr>
<td>Latin America</td>
<td>1.3 – 1.9 million</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>25.0 – 28.2 million</td>
</tr>
<tr>
<td>North Africa &amp; Middle East</td>
<td>470 000 – 730 000</td>
</tr>
<tr>
<td>South &amp; South-East Asia</td>
<td>4.6 – 8.2 million</td>
</tr>
<tr>
<td>East Asia &amp; Pacific</td>
<td>700 000 – 1.3 million</td>
</tr>
<tr>
<td>North America</td>
<td>12 000 – 18 000</td>
</tr>
<tr>
<td>Total</td>
<td>34 – 46 million</td>
</tr>
</tbody>
</table>

**Total: 2.5 – 3.5 million**
Estimated number of children (<15 years) newly infected with HIV during 2003

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

<table>
<thead>
<tr>
<th>Number of people living with HIV/AIDS</th>
<th>Total</th>
<th>40 million (34 – 46 million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>37 million (31 – 43 million)</td>
<td></td>
</tr>
<tr>
<td>Children under 15</td>
<td>2.5 million (2.1 – 2.9 million)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>People newly infected with HIV in 2003</th>
<th>Total</th>
<th>5 million (4.2 – 5.8 million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>4.2 million (3.6 – 4.8 million)</td>
<td></td>
</tr>
<tr>
<td>Children under 15</td>
<td>700 000 (590 000 – 810 000)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AIDS deaths in 2003</th>
<th>Total</th>
<th>3 million (2.5 – 3.5 million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>2.5 million (2.1 – 2.9 million)</td>
<td></td>
</tr>
<tr>
<td>Children under 15</td>
<td>500 000 (420 000 – 580 000)</td>
<td></td>
</tr>
</tbody>
</table>

Global HIV Epidemic

Lifetime Risk of AIDS Death for 15-year-old Boys, Selected Countries

20 year decrease in 10 years

Occurrence of AIDS among different races

Life expectancy in African countries with high rates of HIV
HIV = Death

Extra Credit Paper Requirements
1. Write a paper
   a. Standard 5 paragraph essay with a strong thesis statement and coherent conclusion
   b. Position paper describing pros and cons of one significant issue
   c. Original, not copied from anywhere else
   d. Length: 2 to 5 pages of unformatted text
2. Submit your essay by e-mail by the set deadline: Feb 17 by 12:00 am
3. Send Essays and Reviews to: pelowsk2@msu.edu
   • The subject line of your submission e-mail must follow the following format:
     ISB202 ID number Name (type ISB202, then one space, then your ID number, then one space, and your name)

ONE MORE CHANCE...
Everyone must resubmit their paper by Friday, February 20th at 5:00PM.
MUST meet the following requirements:
• Length: 2 to 5 pages of unformatted text
• 12pt font, 1 inch margins, single spaced
• Send essays to: pelowsk2@msu.edu
  • Preferably sent as a "doc" or "rtf" attachment
• The subject line of your submission e-mail must follow the following format:
  ISB202 ID number Name (type ISB202, then one space, then your ID number, then one space, and your name)

Birth Control Methods

Barriers
- Hormonal
- Surgical
- Device
- Abortion
**Condom**
- Mechanism: barrier, blocks sperm
- Pregnancies per year under 24: 14-21%
- Disadvantages: Does not prevent transmission of HIV, herpes, warts but is better than nothing

**Condom + Spermicide**
- Mechanism: barrier, blocks and kills sperm
- Pregnancies per year under 24: 15%
- Disadvantages: Does not prevent transmission of STD’s

**Diaphragm**
- Mechanism: barrier, blocks uterus
- Pregnancies per year under 24: 21-34%
- Disadvantages: does not prevent transmission of STD’s

**Diaphragm + Spermicide**
- Mechanism: barrier, blocks uterus and kills sperm
- Pregnancies per year under 24: 20%
- Disadvantages: does not prevent the transmission of STD’s

**Sponge**
- Mechanism: barrier, kills, blocks and absorbs sperm in vagina
- Pregnancies per year under 24: 20-40%
- Disadvantages: does not prevent the transmission of STD’s

**Pill**
- Mechanism: Hormonal, prevents ovulation and implantation
- Pregnancies per year under 24: <5%
- Disadvantages: Does not prevent transmission of HIV and other STDs, cardiovascular disease, weight gain
  - Only 28 percent of women always take the Pill correctly.
  - Only 42 percent take the Pill every day.
  - At least 16 percent have pills left at the end of the month.
  - About 25 percent stop using the Pill before a year has passed and do not use another method.
  - About 33 percent of teen women missed a pill in a three-month period.
  - About 17 percent do not take the pills in the right order.
### Minipill
- **Mechanism**: Hormonal, block implantation, deactivates sperm
- **Pregnancies per year under 24**: >9%
- **Disadvantages**: Does not prevent transmission of HIV, weight gain

### Depo-Provera
- **Mechanism**: Hormonal injection every 3 months, suppress ovulation
- **Pregnancies per year under 24**: 3%
- **Disadvantages**: Does not prevent transmission of HIV, STD’s, not habitual, long term use effects unknown
  - **Side-effects**: headache, weight gain (5 pounds per year of use), nervousness, and menstrual irregularities, dizziness, allergy, depression, and ovarian cysts, significant loss of bone density, may increase the chances of cervical cancer and breast cancer, and can also cause hormone imbalances. Similar hormones are known to cause fetal defects.

### Emergency Contraceptive Pills (ECP)
- **Mechanism**: Hormonal, suppress ovulation
- **Pregnancies per year under 24**: 15%
- **Disadvantages**: Does not prevent transmission of HIV, STD’s, long term side-effects unknown, can only be obtained from a doctor, nausea, vomiting, risk of ectopic pregnancy.

“The Morning-After Pill” = large dose of ordinary oral contraceptives taken after intercourse has occurred. ECPs were first used in the 1960's for rape victims, but recently the FDA has begun promoting oral contraceptives for emergency use when a woman has had unprotected intercourse within the previous 72 hours.

### Norplant
- **Mechanism**: Hormonal surgical implant, suppresses ovulation
- **Pregnancies per year under 24**: 1-5%
- **Disadvantages**: Does not prevent transmission of HIV, STD’s, expensive ($500-700/insertion), side effects include nausea, weight gain, headaches, acne, menstrual disturbances, hair loss, breast discharge, ovarian cysts.

Norplant is a progesterin implant, consisting of six small plastic rods surgically placed under the skin of the upper arm for up to five years while they release the hormone. Effectiveness varies due to numerous factors; teens, heavier women, long-term users, and women using hard capsules vs. soft ones will have higher failure rates. 1/2 of all women taking Norplant continue to ovulate, risking fertilization. If conception does occur, changes in the uterus will cause the expulsion of the embryo.

Due to the extreme nature of the side effects, 1/2 of all Norplant users have the implants surgically removed before the third year, despite the fact that Norplant is intended as a five-year contraceptive. Insurance companies, which are increasingly covering insertion, do not always pay for removal. Removal takes more time, costs more, and can cause severe scarring.

### Male “Pill” and hormone injections
- **Mechanism**: Hormonal, oral dose or weekly injection, suppresses sperm production
- **Pregnancies per year under 24**: still in testing phase, but injections test at 4% failure rate and Pill tests at 0% failure (7/17/00)
- **Disadvantages**: Does not prevent transmission of HIV, STD’s, 2% of users never get lower sperm levels, must wait 2-3 months before injections take effect, long-term side-effects have not been measured.
  - **Pill** = desogestrel + testosterone
  - **Injections** = testosterone

### Vasectomy
- **Mechanism**: Surgical, cut sperm vesicle
- **Pregnancies per year under 24**: <1%
- **Disadvantages**: does not prevent STD’s, very few young men consent to operation, expensive, occasionally vesicles grow closed.

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21
### Tubal Ligation
- **Mechanism:** Surgical, cut fallopian tubes
- **Pregnancies per year under 24:** <1%
- **Disadvantages:** Does not prevent STD’s, very few young women consent to operation, expensive.

### Intrauterine device
- **Mechanism:** Device, prevents implantation
- **Pregnancies per year under 24:** >5%
- **Disadvantages:** Does not prevent STD’s, risk of infection, expensive.

### Rhythm
- **Mechanism:** Behavioral
- **Pregnancies per year under 24:** 23-33%
- **Disadvantages:** Does not prevent STD’s

### Abstinence
- **Mechanism:** Behavioral
- **Pregnancies per year under 24:** 0%
- **Disadvantages:** Does not always prevent STD’s if membranes contact

### Abortion

**Vacuum Aspiration** (6 to 9 weeks): The fetus is torn apart by the force of the suction and sucked into a collection bottle, along with the placenta and amniotic sac. Possible complications: infection, uterine perforation, cervical laceration.

**Dilation and Curettage** (8 to 16 weeks): A steel loop-shaped blade is inserted into the uterus through the cervix. It is used to scrape clean the walls of the uterus, removing the fetus and placenta. Possible complications: uterine perforation, infection, serious blood loss.

**Mifepristone or RU-486** (5 to 7 weeks): Blocks the action of progesterone and the uterine lining degrades—the embryo starves to death. Administration of mifepristone is followed 36-48 hours later by misoprostol, a synthetic prostaglandin, which causes uterine contractions that expel the unborn child. Some women will deliver while still at the clinic, while others will do so later, at home or at work. Bleeding can be quite heavy and lasts for an average of nine days. This method of abortion fails 5-10% of the time, and must then be followed by a surgical abortion.

**Methotrexate or “M&M”** (5 to 9 weeks): Methotrexate is normally used for treatment of certain cancers, rheumatoid arthritis, and certain dermatological conditions. It is not approved for abortions by the FDA. This drug is given by injection; it interferes with the growth process of rapidly dividing cells. Like RU-486, it is followed by misoprostol (hence the “M&M” nickname) to expel the fetus. This method fails at least 4% of the time. Potential complications: severe anemia, ulcers and bone marrow depression.

**Herbal Abortifacients:** Though touted as natural ways to do-it-yourself, such herbs are powerful drugs with potentially fatal consequences. Unregulated by the FDA, herbal abortifacients can vary in potency and effect. Pennyroyal, Black or Blue Cohosh and other similar herbs are toxic in excess and can easily overtax the liver and kidneys, causing headaches, extreme nausea, bleeding, or even death. Never take an herbal abortifacient.

**D&E (13 to 20+ weeks):** In this late term abortion the cervix is dilated, either mechanically or with laminaria. The physician uses forceps to dismember the fetus, which must then be reassembled to confirm that no parts have been left inside. Possible complications include infection, cervical laceration and uterine perforation.

**D&X (20 to 32+ weeks):** This late in the pregnancy it is very difficult to dismember the fetus in the womb. Therefore the physician begins, but does not complete, a breech (feet first) delivery, taking care to leave the head inside the uterus. The physician then punctures the base of the skull and suction out the brains. The child dies, the head collapses, and the delivery is completed. This unsafe procedure has been denounced by the AMA as “bad medicine.”
Hysterotomy (24 to 38 weeks): The procedure is simply an early Caesarean section. After an incision is made through the abdomen and uterus, the unborn child is lifted out and allowed to die. The risks are the same as for a normal Caesarean section.

Prostaglandin (16 to 38 weeks): This synthetic hormone is administered via injection or suppository. It causes powerful uterine contractions similar to labor. Live births are a common result. Possible risks include convulsions, vomiting, and cardiac arrest.

Digoxin Induction (20 to 32 weeks): To avoid the live birth complication described above, digoxin is first injected into the child's heart, killing it. This is followed by a prostaglandin induction.

Saline (16 to 32+ weeks): A needle is inserted through the abdomen to remove amniotic fluid. A strong salt solution is then injected, which poisons the fetus and badly burns the lungs and skin. The child is usually delivered within 24 hours. This method is rarely used any more, since it can present serious, even fatal risks to the mother.

Goals

1. Define ribosome, nucleus, mitochondria, chloroplast, endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles, cytoskeleton, flagellum
2. Understand how organelles interact to perform cell function, energy conservation, transport function, cell signalling, cell growth and cell adhesion
3. Relate cell structure and function to science, health and agriculture

Assignment:

Read: Chapter 4

Websites:

http://library.thinkquest.org/12413/index.html
http://ampere.scale.uiuc.edu/~m-lexa/cell/cell.html
http://128.171.207.10/leabtt/PRO410/CellsTissues/pages/ORMembrane-1.htm

Life is a sexually transmitted, terminal disease.
--Colin Greene