NOTES: CH 35
The Immune System and Disease

ARE YOU SURE YOU CAN'T COME INTO SCHOOL TODAY?
CH 35: Key Terms/Concepts

• Key Terms
  – Infectious disease
  – Pathogen
  – Antigen
  – Antibody
  – Immunity
  – Vaccination

• Concepts
  – What causes infectious diseases and how do they spread?
  – What is our bodies response to these pathogens?
  – How do we prevent infectious diseases to spread?
35.1 – Infectious Disease

**PATHOGEN**: a disease-causing agent; disrupt normal body functions

-pathogens include:

- viruses
- fungi
- bacteria
- protozoans
Examples of viruses:

- Smallpox
- Polio
- Herpes
- Common Cold
- Polio
How are Diseases Spread?

1. Coughing, sneezing, physical contact
   a. minimizing infection easy by frequently washing hands
   b. examples are the flu, tuberculosis

2. Exchange in body fluids
   a. need specific kind of direct contact such as syringes or body fluids
   b. examples are hepatitis, HIV
How are Diseases Spread?

3. Contaminated **food** and **water**
   a. examples giardia, coxsackievirus (hand-foot-mouth disease)

4. Animal contact (**zoonosis**)  
   a. usually need a vector  
      - organism that transport pathogen  
   b. examples Lyme disease, West Nile disease
Lyme Disease Transmission

1. Eggs hatch into spirochaete-free larvae.
2. Larva feeds on first host.
3. Larva drops to ground and molts to nymph.
4. Nymph feeds on second host.
5. Nymph drops to ground and molts to adult.
6. Replete female drops to ground and lays eggs.
7. Adult feeds on third host.
8. Incidental or dead-end host.

Reproductive Cycle of the Blacklegged Tick
35.2 – Defenses Against Infection

**HOW DO WE FIGHT OFF DISEASE?**

The body has **nonspecific** and **specific** defenses against infection.
Defenses Against Infection

• Two types of defenses
  – Non-specific Defense
  – Specific Defense (immunity)
Nonspecific Defenses:

• general defense

• provide protection against many different pathogens

• involve physical and chemical barriers, fever, inflammation, phagocytosis
FIRST LINE OF DEFENSE

1) mechanical barriers / physical barriers include:
   - skin (and associated hairs)
   - mucous membranes
   - fluid (sweat and mucus)

- as long as they remain intact, they can keep out many pathogens
2) Chemical Barriers

- **gastric juice**: contains HCl
- **tears**: contain the enzyme **LYSOZYME**
- the salt in **perspiration**
SECOND LINE OF DEFENSE

1) INFLAMMATORY RESPONSE

- a tissue response to injury or infection
- produces: localized redness, swelling, heat and pain
- chemicals released by damaged tissues attract white blood cells to the site
2) **INTERFERONS**: chemicals released by virus-infected cells; “interfere” with viral growth – *slow down viral reproduction!*
3) FEVER

• higher body temperature increases the rate of some white blood cells

• also lowers iron levels in the blood (bacteria and fungi require iron, so this slows their growth)
Specific Defenses:

- very precise
- target certain pathogens
- also known as **Immunity**
- involve specialized lymphocytes (T cells and B cells) that recognize and respond to specific pathogens

**Non-specific defenses are quick to respond; specific defenses are slower-to-respond**
ANTIGENS...

- **ANTIGENS**: specific foreign molecules that trigger an immune response; usually located on a cell’s surface
• Immune system responds to antigens by increasing the number of cells that attack pathogen or produce proteins called **ANTIBODIES**

• Shape of antibody allows it to bind to specific antigen.
LYMPHOCYTES (T and B Cells)

- originate in the **red bone marrow**
- released into the blood before they differentiate (specialize)
- some reach the **THYMUS**, where they mature into **T CELLS**
- others, the **B CELLS**, mature in the **RED BONE MARROW**
- both T cells and B cells reside in lymphatic tissues and organs (lymph nodes, spleen, etc.)
Specific immunity has two main actions:

1. Humoral Immunity
2. Cell-mediated Immunity
HUMORAL IMMUNITY

• Depends on antibodies circulating in blood and lymph

• Activated when antibodies on B cells bind to antigens on surface of pathogen

• When bind with antigens 2 types of B cells are formed: plasma cells and memory B cells
PLASMA CELLS

- produces and release antibodies
- antibodies respond to antigens on surface of pathogen
- antibodies will then either disable or destroy the pathogen
MEMORY B CELLS

• Once infection is gone, plasma cells die
• some B cells remain dormant as MEMORY CELLS
• if antigen returns, memory B cells are reactivated and destroy pathogen much more rapidly
CELL-MEDIATED IMMUNITY

• Depends on actions of different types of T cells and macrophages
• Protects against viruses, fungi, single-celled organisms, and cancer cells
FUNCTIONS of T-CELLS

- some secrete toxins that kill their antigen-bearing target cells
- some interact with antigen-bearing cells directly
FUNCTIONS of T-CELLS

● some puncture cell membrane of pathogen and initiate apoptosis (cell death)

● some engulf the pathogen

● some suppress the immune response once infection under control
Organ/Tissue Rejection

- **T** cells can also be responsible for organ transplant rejections.
- Body recognizes transplanted tissue/organ as a nonself and the immune system will attack.
• To prevent rejection, doctors match up cell markers with donor and recipient.

• Recipient will have to take immunosuppressive drugs also to reduce rejection.
35.3 – Fighting Infectious Disease

- PRIMARY IMMUNE RESPONSE
- SECONDARY IMMUNE RESPONSE
PRIMARY IMMUNE RESPONSE

- **PRIMARY IMMUNE RESPONSE**: the first exposure to an antigen
- during this response, antibodies are produced for several weeks
- antibodies first show up within 5-10 days
- some B cells remain as **MEMORY CELLS**
SECONDARY IMMUNE RESPONSE

- **SECONDARY IMMUNE RESPONSE:** the second exposure to an antigen

  - **rapid response** due to memory cells produced during the first exposure

  - antibodies produced within a day or two
This graph illustrates the relative amount of specific antibodies in the blood over time after exposure to antigens A and B.

- **Primary immune response**:
  - After the first exposure to antigen A, there is a significant increase in antibody production, peaking around week 3 and fading over the next few weeks.
  - After a longer interval (weeks, months, even years), a second exposure to antigen A results in a secondary immune response, which is also significant but peaks later and may be more robust.

- **Secondary immune response**:
  - Following the first exposure to antigen B, there is a secondary response marked by peak antibody production at week 1, which then decreases but remains elevated compared to the primary response.

- **Comparison**:
  - The primary response after antigen A exposure is compared to the secondary response after antigen B exposure, highlighting the differences in antibody production patterns.
35.3 FIGTHING INFECTIOUS DISEASE

1) ACTIVE IMMUNITY

- when the person produces an immune response (including memory cells) to the antigen

- a result of direct exposure to the antigen

- long-lasting (memory cells)
ACTIVE IMMUNITY…

➔ NATURALLY ACQUIRED
ACTIVE IMMUNITY: person is directly exposed to the pathogen, develops a disease, and acquires immunity

➔ ARTIFICIALLY ACQUIRED
ACTIVE IMMUNITY: person receives a vaccine
VACCINES...

**A VACCINE consists of bacteria or viruses that have been weakened or killed so they cannot cause a serious infection; or could include a toxoid or toxin that has been chemically altered to destroy its toxic effects.

-includes antigens that stimulate a primary immune response but does not produce the severe symptoms of disease.
How Vaccines Work

1. A weakened or nonliving form of the germ is introduced through the skin.

2. B cells in the body make antibodies to kill the germs.

3. If exposed to the germ in the future. The antibodies will effectively kill or neutralize the germs.
2) PASSIVE IMMUNITY

- person receives antibodies produced by another individual
- since the person does not produce the immune response themselves, this is short-term only (as long as the antibodies remain in the blood)
- the person remains vulnerable to the antigen if exposed at a later date
PASSIVE IMMUNITY

- **NATURALLY ACQUIRED PASSIVE IMMUNITY**: fetus acquires limited immunity from mother through placenta and/or breast milk (colostrum)

- **ARTIFICIALLY ACQUIRED PASSIVE IMMUNITY**: person receives an injection of antiserum collected from a person who has already developed immunity against a particular disease (rabies)
Public Health Prevention of Diseases Spreading

1) Regulating food and water supplies
   - Cholera, Typhoid, Guinea worm
Public Health Prevention of Diseases Spreading

2) Promoting vaccinations

- Herd Immunity
- Not immunized but still healthy
- Immunized and healthy
- Not immunized, sick, and contagious

No one is immunized.

Contagious disease spreads through the population.

Some of the population gets immunized.

Contagious disease spreads through some of the population.

Most of the population gets immunized.

Spread of contagious disease is contained.
Public Health Prevention of Diseases Spreading

3) Promoting behaviors that avoid spread of infection
New and Re-Emerging Diseases

• Many diseases were eliminated or were under control in the 1980s
  – e.g. polio and smallpox

• Over the past decade, we have had a resurgence of old diseases and introduction of new diseases
  – Ebola, SARS, hantavirus

• Why has this happened??
Reasons for New and Re-Emerging Diseases

1. Changing interactions with Animals
   - Human and animal habitats combine
   - Trade of exotic animals
Reasons for New and Re-Emerging Diseases

2. Misuse of Antibiotics and medications
   - Not following instructions on medication
   - Overuse of antibiotic causing resistance
35.4 – Immune System Disorders

- Allergies
- Autoimmune Diseases
- Attack on the Immune System (HIV / AIDS)
ALLERGIC REACTIONS

• triggered by antigens known as **ALLERGENS**

• the immune system attacks a nonharmful substance, such as **pollen, pet dander, peanuts**

Some common asthma triggers: animal dander, ragweed pollen, and the microscopic house dust mite. When breathed into the lungs of susceptible individuals, the dander, pollen, or waste products of the dust mite can cause an allergic reaction that leads to an asthma attack.

Photos courtesy of the American Academy of Allergy, Asthma, and Immunology.
# Allergic Reactions

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<thead>
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<th>Skin Contact</th>
<th>Injection</th>
<th>Ingestion</th>
<th>Inhalation</th>
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<tbody>
<tr>
<td>poison plants</td>
<td>bee sting</td>
<td>medication</td>
<td>pollen</td>
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<td>animal scratches</td>
<td></td>
<td>nuts &amp; shellfish</td>
<td>dust</td>
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<tr>
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<td></td>
<td></td>
<td>mold &amp; mildew</td>
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<tr>
<td>latex</td>
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<td>animal dander</td>
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*ADAM.*
The first time the allergy-prone person comes in contact with an allergen such as ragweed, he or she makes large amounts of ragweed IgE antibody.

These IgE molecules attach themselves to the mast cells.

When that person has another brush with ragweed, the IgE antibodies are cross-linked, causing the IgE-primed mast cells to release their powerful chemicals.

These chemical mediators cause the person to suffer the wheezing and/or sneezing, runny nose, watery eyes, and itching of allergy.
AUTOIMMUNITY / AUTOIMMUNE DISORDERS:

- the immune system fails to properly “self” & attacks the body’s own cells
Examples of Autoimmune Disorders:

- Lupus
- Rheumatoid arthritis
- Type I diabetes
- Multiple sclerosis
AIDS

- caused by retrovirus: **HIV**
- HIV infects **HELPER T CELLS**
- Without $T_H$ cells, the patient’s immune system stops functioning
- AIDS patients become very susceptible to other infections
Preventing HIV Infection:

- **Abstinence** from sexual activity / use safe practices
- Don’t do **intravenous drugs**