The Immune System and Pathology
The **Immune System** in Action

When a mosquito bites
When you breathe
When you have allergies
When you get a blood transfusion
When you die

....also called the **Lymphatic System**
The Lymphatic System contains lymph, which is a clear liquid that circulates through the lymph vessels to protect from injury and illness.

Edema (swelling) occurs if this fluid builds up in areas.
Edema and
Pitting edema
Lymphatic Organs

Produce lymph and white blood cells

Red Bone Marrow
Thymus Gland
Lymph Nodes
Spleen
Tonsils
Defenses

Nonspecific - barriers to entry (skin), inflammatory response, phagocytes (general white blood cells for consuming pathogens)

Specific – special “memory” white blood cells B Lymphocytes and T lymphocytes (B cells and T cells)
Typical Immune Response

From *Biology* by Campbell and Reece © 2008 Pearson Education, Inc.
Antigen Presentation

dendritic cell

1. A phagocyte "eats" a bacteria.

2. Parts of the bacteria (antigen) goes to the surface of the phagocyte

3. The phagocyte presents the antigen to a helper T cell

4. The helper T cell is activated.

activated helper T cell

helper T cell
1. The B-cell finds an antigen which matches its receptors.

2. It waits until it is activated by a T-helper cell.

3. Then the B-cell divides to produce plasma and memory cells.

4. Plasma cells produce antibodies that attach to the current type of invader.
5. “Eater cells,” prefer intruders marked with antibodies and “eats” loads of them.

6. If the same intruder invades again, memory cells help to activate the immune system to activate much faster.
Another Look

1. Virus infects body, cells display viral antigens
2. Macrophages engulf virus and display viral antigen.
3. Macrophages activate helper T Cells
4. Helper T Cells activate Cytotoxic T and B Cells
5. B Cells form plasma cells
6. Plasma cells make antibodies which bind to viral antigen
7. Antibodies attach to the virus and infected body cells, signals for their destruction.
8. Cytotoxic T Cells destroy infected body cells

Animation of the process from McGraw Hill
How Do Vaccines Work?

Vaccines contained a killed or weakened part of a virus (or other pathogen) to stimulate your specific immuninity to react to the antigen. Once you have antibodies for that microbe, the real one will not make you sick.
What if your immune system works TOO well? What if it starts attacking your own cells?
Some people already have boosted immune systems..... they suffer from **AUTOIMMUNE DISORDERS** (overreactive immunity or immunity against their own cells) such as:

- lupus
- allergies
- arthritis
- psoriasis

Lupus is a widespread and chronic autoimmune disease that, for unknown reasons, causes the immune system to attack the body’s own tissues and organs, including joints, kidneys, heart, lungs, brain, blood, and skin. - See more at:
Autoimmune disorders are often treated with steroids, which suppress the immune system.
Haiti was devastated by an earthquake in 2010 and lost most of its infrastructure.

6 months later, people began suffering from diarrhea and dehydration.

How can health care workers identify the source of the illness so that it can be prevented and treated?
Pathology - the scientific study of the nature of disease and its causes

A PATHOGEN is any disease causing agent (virus, bacteria, eukaryotic parasite, etc).

Quick Exercise: How many diseases can you think of?

Video: "The A to Z of Germs..."
some diseases are communicable (contagious), such as:

anthrax, swine flu, herpes, common cold, malaria, salmonella, AIDS

Other diseases are not contagious:

cancer, lupus, arthritis, allergies

This unit will focus on the first type: the disease, its agents, treatment and history and will cover three main areas of pathology

1. Viruses (virology)
2. Bacteria (bacteriology)
3. Parasites (parasitology)
Definitions

Host - organism which provides nutrients, etc. to another organism

Parasite - organism which lives at the expense of its host; the parasite is metabolically dependent upon it

Disease - an upset in the homeostasis of the host, resulting in observable changes and/or damage to host

Infectious disease - disease that can be transmitted by the host to another host or vector
Symptom - evidence of damage to the host (headache)

**Virulence** - a measure of pathogenicity, which is the ability to cause disease (a microorganism that causes disease is **virulent**).
Epidemic - when a disease affects a community

Pandemic - when a disease affects the world

Play Pandemic 3 or Plague Inc
Disease Categories

Food and Waterborne - pathogen is in a food or water source (Cholera)

Blood Borne - carried in blood or other bodily fluids (HIV)

Sexually Transmitted - transmitted by sexual contact (Syphilis)

Zoonotic - carried by animals (Rabies)

Airborne - carried by the air, often affect respiratory tract (Influenza)
Organizations Dealing with Health -

Centers for Disease Control (CDC)

World Health Organization (WHO)

U.S. Department of Health and Human Services (HHS)

U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID)
And now...

Great Moments in Medical History!!!!
Koch's Postulates

If a microorganism is the causative agent of an infectious disease, it must be:

- Present in every case of the disease, but absent from the healthy host
- Isolated and grown in pure culture
- Able to cause the disease when a pure culture is inoculated into a healthy host
- Re-isolated from the host that was inoculated with the pure culture
1. Microorganisms are isolated from a dead animal.

2a. The microorganisms are grown in pure culture.

2b. The microorganisms are identified.

3. The microorganisms are injected into a healthy animal.

4. The disease is reproduced in the second animal; microorganisms are isolated from this animal.

5a. Pathogenic microorganisms are grown in pure culture.

5b. Identical microorganisms are identified.
Steps in Pathogenesis

To cause disease, a pathogen must:
- Contact the host - be transmissible
- Colonize the host - adhere to and grow or multiply on host surfaces
- Infect the host - proliferate in host cells or tissues
- Evade the host defense system - by avoiding contact that will damage it
- Damage host tissues - by physical (mechanical) or chemical means

[Image: An emergency hospital ward in Kansas during the 1918 flu]
Edward Jenner (1796)

Noting the common observation that milkmaids did not generally get smallpox, Jenner theorized that the pus in the blisters which milkmaids received from cowpox (a disease similar to smallpox, but much less virulent) protected the milkmaids from smallpox.

Jenner tested his hypothesis by inoculating James Phipps, a young boy of 8 years (the son of Jenner's gardener), with material from the cowpox blisters of the hand of Sarah Nelmes, a milkmaid who had caught cowpox from a cow called Blossom. This became the first vaccine.
Ignaz Semmelweis (1850)

Observed that women in the maternity wards died of childbed fever. He proposed that it was caused by doctors doing autopsies on the deceased women and then carrying the disease causing agent to healthy women who were in labor.

His solution: Wash your hands before delivering babies!

*The Germ Theory did not exist at this time
Louis Pasteur - developed the germ theory and disproved spontaneous generation, in 1885 he developed the rabies vaccine.

Alexander Fleming - discovered penicillin, though it wasn't until much later that it was produced as an antibiotic.
1980 - WHO declared smallpox eradicated
1983 - Discovering and identification of the AIDS virus (HIV)

1985 - First vaccine for *Haemophilus influenzae type b* (HiB)
2006 - First vaccine for *human papillomavirus*

The **Germ Theory** (around 1860)

- Single most important contribution by the science of microbiology to the general welfare of the world's people
- **The theory that microorganisms may be the cause of some or all disease.**
- Key to developing the germ theory of disease was a refutation of the concept of spontaneous generation.
- Specific aseptic techniques are employed to avoid microbial contamination
- Method of prevention of spoilage of liquid foodstuffs - Pasteurization

*Why is this a theory and not a fact?*
Haiti was devastated by an earthquake in 2010 and lost most of its infrastructure.

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Discuss and outline the steps you would take to identify the source of the infection and determine how (or if) it is a communicable disease.