What is Immunity?

Whatever happened to plenty of rest, lots of fluids, and call me in the morning?!?

CITIZEN TIMES
40 MILLION BIRDS DESTROYED; FLU RAMPANT

Injections being administered.
Immunity

- **Immunity**
  - The ability of the body to fight infection and/or foreign invaders by producing antibodies or killing infected cells.

- **Immune System**
  - The system in the body consisting of numerous components that are responsible for maintaining homeostasis by recognizing harmful from non-harmful organisms and produces an appropriate response.
Foreign Invaders

• Called *Pathogens*
  – Viruses, bacteria or other living thing that causes disease/immune response.

• Antigens
  – Any molecule, particle, or entity that can elicit an immune response.
Parts of the Immune System

2. Lymph nodes
3. Thymus Gland – Produces T Lymphocytes
4. Bone Marrow – Produces B Lymphocytes
5. First Line Defenses – Skin, mucus, cilia, sweat, etc...
How does the body fight infection/foreign invaders?

There are both Non-specific and Specific Lines of defense.

The Body’s THREE lines of Defense

First Line of Defense – The Skin (Non-Specific)

• Provides Physical and Chemical barriers
  • *Physical* – hard to penetrate, made of indigestible keratin
  • *Chemical* – tears, sweat
Second Line of Defense - Nonspecific Immune Response

These are defenses the body uses no matter what the invader may be. These defenses include:

- **Phagocytosis** – done by Macrophages
- **Natural Cell Killers** – White blood cells that carry out phagocytosis
- **Inflammation** - caused by release of Histamine from leukocytes
- **Fever** – caused by histamines. The fever (high temp) kills invaders by denaturing their proteins.

**Macrophage**: A phagocytic cell found in the liver, spleen, brain and lungs. Travels to all areas of the body to find and eat pathogens.
Inflammatory Response

• 1. Non-phagocytic leucocytes arrive at the infection site and release histamine.
• 2. Histamine causes dilation of blood vessels making them more permeable to fluid and other blood cells.
• 3. Increased blood flow causes redness, swelling and heat. (Increased temperature alone can ‘burn’ off the infection.)
Inflammatory Response

Bacteria
Chemical alarm signals
Blood vessel
Phagocytes
Third Line of Defense - Specific Immune Response

This is a specific response to a specific pathogen/antigen.

- The response involves the creation of Antibodies.
Antibodies

- **Y-shaped** protein molecule.
- Made up of *variable* and *constant* regions.
- Made up of **Heavy** and **Light** chains.
- Produced by B-Lymphocytes

**Function:** Recognize antigens, bind to and deactivate them.
- **Note:** Variable region recognizes the antigens.
How an antibody operates/works?

Deactivation of a bacterium by an antibody.
The Pathway of Specific Immune Response

**Step 1**
Pathogens eaten by Macrophage

**Step 2**
Displays portion of Pathogen on surface

**Step 3**
Helper-T cell recognizes Pathogen
Activates Cytotoxic T-Cell

Kills Infected Cells

Memory T-Cell

Activated helper T cell

Activates B-Cell

B-cell

Plasma cell

Memory B-Cell

Antibodies
# Cellular Immunity vs. Antibody Immunity

<table>
<thead>
<tr>
<th>Cellular Immunity</th>
<th>Antibody or Humoral Immunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Carried out by T-Cells</td>
<td>• Carried out by B-cells</td>
</tr>
<tr>
<td>• Infected cells are killed by Cytotoxic T –Cells.</td>
<td>• Antibodies are produced and dumped into blood stream.</td>
</tr>
<tr>
<td></td>
<td>• Antibodies bind to antigens and deactivate them.</td>
</tr>
</tbody>
</table>
Immune Response Explained

1. Antigen infects cells.
2. Macrophage ingests antigen and displays portion on its surface.
3. Helper T-Cell recognizes antigen on the surface of the macrophage and becomes active.
4. Active Helper T-Cell activates Cytotoxic T-Cells and B-Cells.
5. Cytotoxic T-Cells divide into Active Cytotoxic T-cells and Memory T - Cells.
6. Active Cytotoxic T-Cells kill infected cells.
7. At the same time, B-Cells divide into Plasma Cells and Memory B-Cells.
8. Plasma cells produce antibodies that deactivate pathogen.
9. Memory T and Memory B cells remain in the body to speed up the response if the same antigen reappears.
10. Supressor T-Cells stop the immune response when all antigens have been destroyed.
Immune Response Summary

Cellular Immunity
- Active Cytotoxic T-Cell
  - Kills Infected Cells
- Memory T-Cell

Antibody Immunity
- Active B-Cell
- Plasma Cell
  - Antibodies
  - Deactivates Antigens
- Memory B-Cell

Antigen
- Displays copy of antigen on surface of cell

Helper T-Cell

Macrophage
Primary vs. Secondary Immune Response

- **Primary Immune Response**
  - This is a response to an invader the First time the invader infects the body.
    - No measurable immune response for first few days.
    - Next 10 – 15 days antibody production grows steadily

- **Secondary Immune Response**
  - A more rapid response to an invader the 2\textsuperscript{nd} time it invades the body.
    - Antibody production increases dramatically and in a much shorter time period.
Primary vs. Secondary Immune Response

- First exposure to antigens
- Second exposure to same antigens

Graph shows the relative amount of antibodies produced over time (weeks).
Passive vs. Active Immunity

1. **Active Immunity**
   This is immunity where the body is “actively” producing antibodies to fight infection.
   Ex: You have a throat infection and you are actively creating antibodies to fight it.

   **Vaccination:** An injection of a *weakened strain* of an infectious microbe (pathogen) that causes the body to undergo active immunity (produce antibodies).

2. **Passive Immunity**
   This is immunity where antibodies are given to a person from the blood of another person or animal.
   This immunity only lasts for a short period of time.
   ex: Breastfeeding mothers pass antibodies to their children through the milk.
Autoimmune Disease

- Autoimmune diseases are diseases where the immune system begins to attack itself.
  - Ex:
    - **Rheumatoid Arthritis** – crippling disease of the joints.
    - **Lupus** – disease of blood and organs.
    - **Multiple Sclerosis** – disease of nervous system

- **Cause(s):** unknown
- **Cures/Treatments:** No known cures. Usually treated with drugs.
Allergies

**Allergy**
- An exaggerated response by the immune system to an allergen.

**Allergen**: a normally harmless substance that causes an allergic reaction.

ex: dust, pollen, mould, food, insect stings

**Types of Allergic reactions**
There are two types of allergic reactions.

a. **Immediate** – occurs within seconds and normally lasts for about 30 mins.

b. **Delayed** – takes longer to react and can last for a much longer time.
What happens during an allergic reaction?

- During an allergic reaction antibodies cause histamines to be released from certain cells.

Histamines cause:
  a. Swelling of tissues
  b. Release of fluids (runny noses and eyes)
  c. Muscle spasms (some cases)

Anaphylaxis or anaphylactic shock:
  This is the sudden and severe allergic reaction to a substance that can cause death.

Treatments for Allergies
1. Avoidance of material – especially food.
2. Epinephrine – “epi – pen”
3. Antihistamines -- benadryl