

The Immune System – Important Concepts

The body, working as a whole, protects itself from invading pathogens (disease causing agents) through three cooperating lines of defense.

FIRST LINE OF DEFENSE: *nonspecific* against *all* potential enemies

- skin: cells tightly bound to keep out invaders
- mucous membranes: release mucous which has antimicrobial chemicals like lysozyme.
- cilia, small hairlike structures lining nasal passages, sweep out mucus with trapped microbes
- stomach acid kills microbes that are swallowed

Microbes that get past 1st line of defense encounter

SECOND LINE OF DEFENSE (also nonspecific): that limits spread of invaders in advance of *specific* immune responses

- **INFLAMMATORY RESPONSE**

1. Histamine, secreted by basophils, a type of circulating white blood cell, and mast cells

triggers vasodilation, enlargement of blood vessels, which increases blood supply to area of invasion

(also responsible for common cold symptoms: sneezing, coughing, redness, itchy eyes, and runny nose)

- 2. Prostaglandins further promote blood flow to area

3. Chemokines secreted by blood vessel endothelium and monocytes attract phagocytes (cells that eat bacteria and viruses) to area

4. Pyrogens, chemicals released by some leukocytes (white blood cells) increase body temperature. This speeds up immune action and slows microbial growth.

5. Phagocytes: move to affected site, in response to above, to eat invading microbes

These are:

- macrophages – large white blood cells that eat bacteria,
- neutrophils – white blood cells that engulf bacteria and then release chemicals that kill the bacteria and themselves also, and
- natural killer cells – large white blood cells that ingest and kill pathogens

Natural killer cells can also detect cancer cells and kill them in much the same way.

6. Interferons, proteins released by infected cells, block viruses by causing nearby cells to produce an enzyme that prevents them from making proteins and RNA.

7. Natural killer (NK) cells destroy body cells infected by viruses. They also destroy cancer cells. They punch a hole in the cell membrane, causing it to lyse (burst open).

SPECIFIC IMMUNE DEFENSES: LYMPHOCYTES

Two Kinds: T lymphocytes and B lymphocytes

Although both originate in *bone marrow*, T lymphocytes mature in the thymus gland. B lymphocytes mature in the blood.

They are the 3rd line of defense working against a *specific* type of invader -

- There are also two kinds of T-cells: helper T-cells and cytotoxic T-cells

Helper T-cells recognize of molecular markers produced by "foreigners" (eg a virus or bacteria) These markers are called **ANTIGENS**. Helper T-cells bind to cells which have these markers on their surface. They activate cytotoxic (this word means "poisonous to cells") T cells and B cells.

For example -

1. When a macrophage eats a body cell infected by a virus, the virus' antigens are displayed on the cell membrane of the macrophage

2. Receptor proteins on helper T-cells recognize these antigens as foreigners (not "self") and bind to them.

3. The macrophages then release a protein called Interleukin-1, which activates the helper T-cells.

4. The activated helper T-cells don't kill the pathogens directly, but they activate cytotoxic T-cells and B-cells.

5. Activated Helper T-cells also release another protein called Interleukin-2, which stimulates them to divide rapidly into more helper T-cells.

6. Interleukin-2 also causes B-cells to divide rapidly and differentiate into two types of cells:

- plasma cells, which kill the microbes, and

- memory cells, which have the antibody on their surface. These memory cells stay in the body for many years, so that in a second attack by the microbe, the immune system will mount a much more rapid attack against the invader

7. The Plasma cells release Y-shaped antibodies. These are protein molecules, also called immunoglobins, shaped to bind to the specific antigen of the invader, and thus to deactivate the invader.

8. Activated Plasma cells **DIVIDE QUICKLY**, each releasing thousands of antibodies and thus incapacitating the invader.

The binding of antibodies cause invading microbes to stick together and they are marked for destruction.

Any of your body's cells bearing traces of an invader will be destroyed by cytotoxic T cells with receptor proteins that bind to the antigen of that microbe.

IMMUNITY

The specific immune response is very powerful and long lasting. Some memory cells can provide protection for many years against any subsequent attack by that specific microbe.

Unfortunately there are thousands of pathogenic viruses, bacteria and protists, but the immunity established by fighting off one is for that one only.

VACCINATION is a medical procedure used to produce immunity. A vaccine is a preparation of a dead or weakened pathogen that is usually injected under the skin. This triggers the immune response described above without having symptoms of the infection.

The first vaccination was developed by Edward Jenner in 1796 – against smallpox. This was the beginning of the science of immunology.

There are many kinds of cold and flu viruses. The average person could get a couple every year.

In 1918 a deadly form of flu spread rapidly around the earth causing an epidemic that killed 20 million people. Flu viruses often mutate, causing differences in their antigens that aren't recognized by memory cells.

IMMUNE SYSTEM DISORDERS

1. AUTOIMMUNE DISEASE (auto "self" in Greek) The immune system can't distinguish between the body's antigens and foreign antigens. It attacks body cells as if they were foreign cells.

- A. Graves' disease affects the thyroid gland.**
Weakness, irritability, heat intolerance, increased weight loss, insomnia sweating,
- B. multiple sclerosis (MS) affects nervous system**
weakness, loss of coordination, problems with speech vision and
- C. rheumatoid arthritis affects the joints.**
Severe pain, fatigue, disabling inflammation of joints joints
- D. lupus affects connective tissue, joints and kidneys**
facial skin rash, painful joints, fever, fatigue, kidney problems, weight loss
- E. type 1 diabetes affects the pancreas gland**
high blood glucose level, excessive urine production, problems with vision, weight loss, fatigue, irritability

2. AIDS (acquired immunodeficiency syndrome) is caused by the HIV (human immunodeficiency virus)

HIV virus invades helper-T cells and hijacks their DNA, forcing them to produce more HIV viruses. It takes 10 or more years between the infection and disease symptoms. During this time, a person unknowingly infected with HIV can spread the disease to many other people, despite the fact that there is a blood test for HIV.

As helper-T cells die, the immune system gradually weakens. The body cannot fight off other diseases

3. ALLERGIES The immune system responds inappropriately to antigens of normally harmless particles, such as pollen, dust and pet dander.

Respiratory cells release histamine, causing red eyes and runny nose. Others are allergic to bee venom, antibiotics, and foods. Severe allergic reactions such as asthma can be life threatening.

