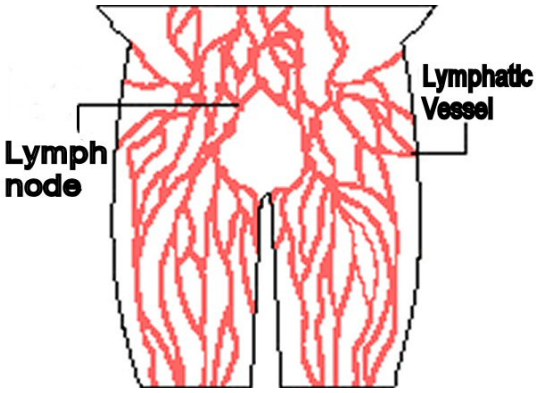
Immune System

THE BODY'S FIRST LINE OF DEFENSE

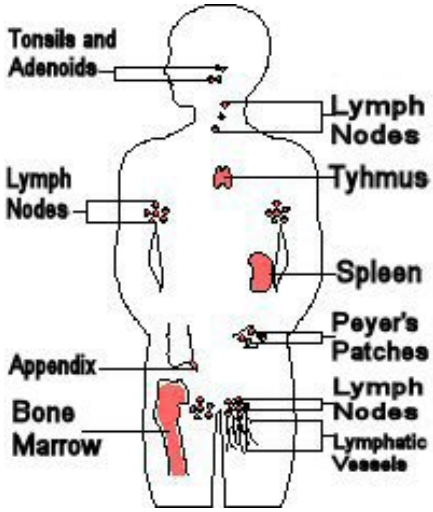
The immune system is a complex of organs - highly specialized cells and even a circulatory system separate from blood vessels - all of which work together to clear infection from the body.



The organs of the immune system, positioned throughout the body, are called lymphoid organs. The word “lymph” in Greek means a pure, clear stream - a good description considering its appearance and purpose.

Lymphatic vessels and lymph nodes are the parts of the special circulatory system that carries *lymph*, a transparent fluid containing white blood cells, chiefly *lymphocytes*.

Lymph bathes the tissues of the body, and the lymphatic vessels collect and move it eventually back into the blood circulation. Lymph nodes dot the network of lymphatic vessels and provide meeting grounds for the immune system cells that defend against invaders. The spleen, at the upper left of the abdomen, is also a staging ground and a place where immune system cells deal with foreign microbes.

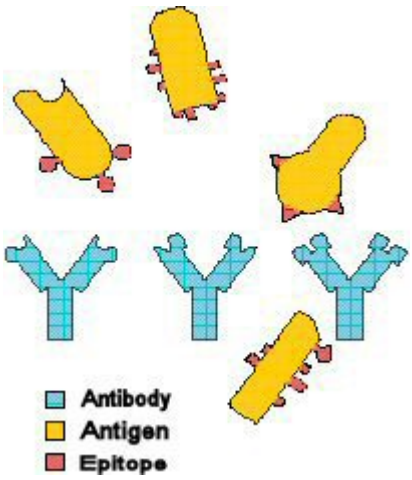


Pockets of lymphoid tissue are in many other locations throughout the body, such as the bone marrow and thymus. Tonsils, adenoids, Peyer's patches, and the appendix are also lymphoid tissues.

Both immune cells and foreign molecules enter the lymph nodes via blood vessels or lymphatic vessels. All immune cells exit the lymphatic system and eventually return to the bloodstream. Once in the bloodstream, lymphocytes are transported to tissues throughout the body, where they act as guards on the lookout for foreign *antigens* (substances that cause an immune reaction).

HOW THE IMMUNE SYSTEM WORKS

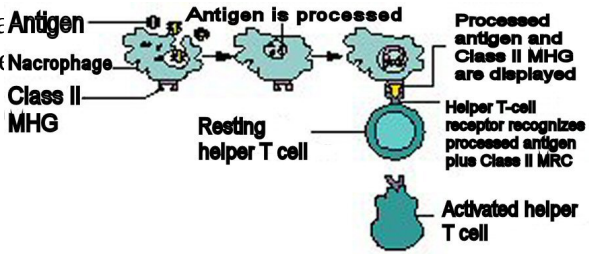
Cells that will grow into the many types of more specialized cells that circulate throughout the immune system are produced in the bone marrow. This nutrient-rich, spongy tissue is found in the center shafts of certain long, flat bones of the body, such as the bones of the pelvis. The cells most relevant for understanding vaccines are the lymphocytes, numbering close to one trillion.



The two major classes of lymphocytes are B cells, which grow to maturity in the bone marrow, and T cells, which mature in the thymus, high in the chest behind the breastbone.

B cells produce antibodies (Epitopes) that circulate in the blood and lymph streams and attach to foreign antigens to mark them for destruction by other immune cells.

B cells are part of what is known as antibody-mediated or humora circulate in blood and lymph, which the ancient Greeks called, the

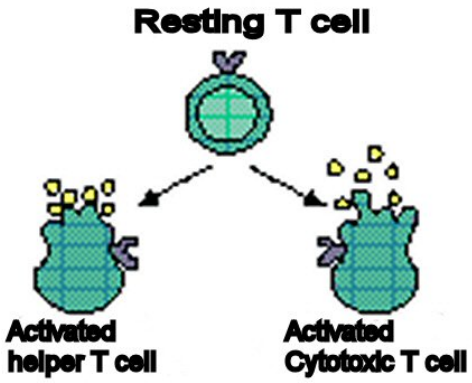


Certain T cells, which also patrol the blood and lymph for

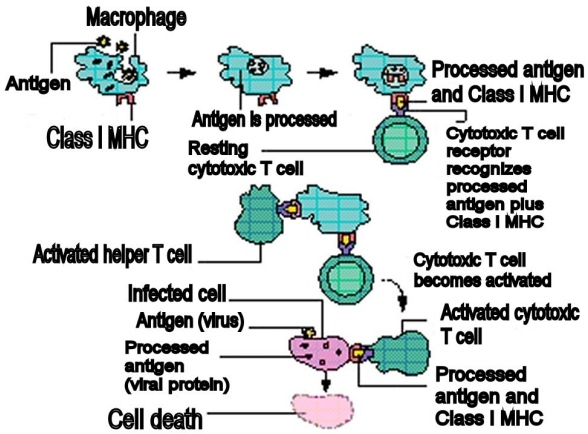
foreign invaders, can do more than mark the antigens; they attack and destroy diseased cells they recognize as foreign. T lymphocytes are responsible for cell-mediated immunity (or cellular immunity). T cells also orchestrate, regulate and coordinate the overall immune response. T cells depend on unique cell surface molecules called the major histocompatibility complex (MHC) to help them recognize antigen fragments.

ANTIBODIES

The antibodies that B cells produce are basic templates (patterns or models) with a special region that is highly specific to target a given antigen. Much like a car coming off a production line, the antibody's frame remains constant, but through chemical and cellular messages, the immune system selects a green sedan, a red convertible or a white truck to combat this particular invader.



However, in contrast to cars, the variety of antibodies is very large. Different antibodies are destined for different purposes. Some coat the foreign invaders to make them attractive to the circulating scavenger cells, *phagocytes*, that will engulf an unwelcome microbe.



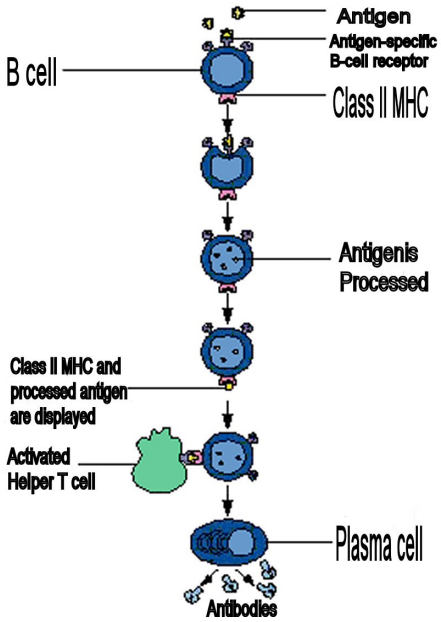
When some antibodies combine with antigens, they activate a cascade of 9 proteins, known as complement, that have been circulating in inactive form in the blood. Complement forms a partnership with antibodies, once they have reacted with antigen, to help destroy foreign invaders and remove them from the body. Still other types of antibodies block viruses from entering cells.

T CELLS

T cells have two major roles in immune defense. Regulatory T cells are essential for orchestrating the response of an elaborate system of different types of immune cells.

Helper T cells, for example, also known as CD4 positive T cells (CD4+ T cells), alert B cells to start making antibodies; they also can activate other T cells and immune system scavenger cells called *macrophages* and influence which type of antibody is produced.

Certain T cells, called CD8 positive T cells (CD8+ T cells), can become killer cells that attack and destroy infected cells. The killer T cells are also called cytotoxic T cells or CTLs (cytotoxic lymphocytes).



IMMUNE SYSTEM PROCESS SUMMARY

Activation of helper T cells

After it engulfs and processes an antigen, the macrophage displays the antigen fragments combined with a Class II MHC protein on the macrophage cell surface. The antigen-protein combination attracts a helper T cell, and promotes its activation.

Activation of cytotoxic T cells

After a macrophage engulfs and processes an antigen, the macrophage displays the antigen fragments combined with a Class I MHC protein on the macrophage cell surface. A receptor on a circulating, resting cytotoxic T cell recognizes the antigen-protein complex and binds to it. The binding process and a helper T cell activate the cytotoxic T cell so that it can attack and destroy the diseased cell.

Activation of B cells to make antibody

A B cell uses one of its receptors to bind to its matching antigen, which the B cell engulfs and processes. The B cell then displays a piece of the antigen, bound to a Class II MHC protein, on the cell surface. This whole complex then binds to an activated helper T cell. This binding process stimulates the transformation of the B cell into an antibody-secreting plasma cell.

Information courtesy of NIH & National Institute of Allergy and Disease.

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