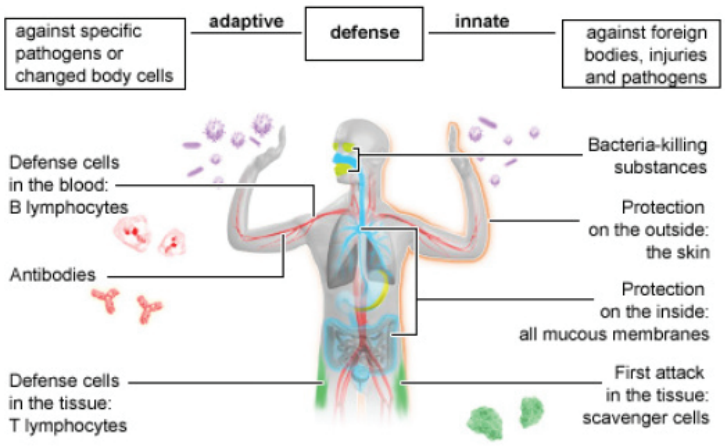
THE INNATE & ADAPTIVE IMMUNE SYSTEMS

The immune system fights germs and foreign substances on the skin, in the tissues of the body and in bodily fluids such as blood. The immune system is made up of two parts: the innate, (general) immune system and the adaptive (specialized) immune system. These two systems work closely together and take on different tasks.



The Innate Immune System: Fast and General Effectiveness

The innate immune system is the body's first line of defense against germs entering the body. It responds in the same way to all germs and foreign substances, which is why it is sometimes referred to as the "nonspecific" immune system. It acts very quickly: For instance, it makes sure that bacteria that have entered the skin through a small wound are detected and destroyed on the spot within a few hours. The innate immune system has only limited power to stop germs from spreading, though.

The innate immune system consists of

- Protection offered by the skin and mucous membranes
- Protection offered by the immune system cells (defense cells) and proteins

Protection Offered by the Skin and Mucous Membranes

All outer and inner surfaces of the human body a key part of the innate immune system. The closed surface of the skin and of all mucous membranes already forms a physical barrier against germs, which protects them from entering. Additionally, chemical substances like acid, enzymes or mucus prevent bacteria and viruses from gaining a foothold. Movements created, for example, by hair-like structures in the bronchi (cilia) or bowel muscles stop germs from settling in the body. Tear fluid, sweat and urine (which flushes the organs of the urinary tract) have a similar effect.

Protection Offered by the Immune System Cells (Defense Cells) and Proteins

The innate immune system activates special immune system cells and proteins if germs get past the skin and mucous membranes and enter the body.

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What happens during an inflammation?

When a part of the skin is infected, immune system cells move to the area or immune system cells that are already there are activated. Specific immune system cells release substances into the immediate area that make the blood vessels wider and more permeable. This causes the area around the infection to swell, heat up and redden, and inflammation results. A fever may develop as well. Then the blood vessels expand further, and even more immune system cells arrive.
Certain proteins (enzymes) are also activated to help in the immune response (see below).

Scavenger cells: Neutralizing germs

Bacteria or viruses that enter the body can be stopped right away by scavenger cells (phagocytes). Scavenger cells are special kinds of white blood cells (leukocytes). These cells enclose germs and "digest" them. The remains of these germs move to the surface of the scavenger cells to be detected by the adaptive immune system.
There are also other types of immune system cells that release substances to kill bacteria and various germs. Both germs and body tissue and immune system cells die and decay during an immune system response. Their remains form pus, a yellowish fluid.

The role of proteins

Several proteins (enzymes) help the cells of the innate immune system. A total of nine different enzymes activate one another in a process similar to a chain reaction: One enzyme in the first stage alerts several enzymes of the second stage, each of which again activates several enzymes of the third stage, and so on. This allows immune system responses to escalate very quickly.

The tasks of these enzymes include:

- Marking germs as targets for scavenger cells,
- Attracting other immune system cells from the bloodstream,
- Destroying bacteria cell walls to kill them, and
- Fighting viruses by destroying the viral envelope (the outermost layer of a virus) or cells that have been infected with viruses.

Natural killer cells: Searching for changed body cells

The natural killer cells are the third major part of the innate immune system. They specialize in identifying cells that are infected by a virus or that have become tumorous. To do this, they search for cells that have changes in their surface, and then destroy the cell surface using cell toxins.

The adaptive immune system: Fighting the germs directly

The adaptive immune system takes over if the innate immune system is not able to destroy the germs. It specifically targets the type of germ that is causing the infection. But to do that it first needs to identify the germ. This means that it is slower to respond than the innate immune system, but when it does it is more accurate. It also has the advantage of being able to "remember" germs, so the next time a known germ is encountered, the adaptive immune system can respond faster.
This memory is also the reason why there are some illnesses you can only get once in your life, because afterwards your body becomes “immune.” It may take a few days for the adaptive immune system to respond the first time it comes into contact with the germ, but the next time the body can react immediately. The second infection is then usually not even noticed or is at least milder.

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The adaptive immune system is made up of:

- T lymphocytes in the tissue between the body's cells
- B lymphocytes, also found in the tissue between the body's cells
- Antibodies in the blood and other bodily fluids

T Lymphocytes

T lymphocytes (also called T cells) are produced in bone marrow and then move to the thymus through the bloodstream, where they mature. The "T" in their name comes from "thymus."
T cells have three main jobs:

- They use chemical messengers to activate other immune system cells in order to start the adaptive immune system (T helper cells).
- They detect cells infected by viruses or tumorous cells and destroy them (cytotoxic T cells).
- Some T helper cells become memory T cells after the infection has been defeated. They can "remember" which germs were defeated and are then ready to activate the adapted immune system quickly if there is another infection.

T cells have detection features on their surfaces that can attach to germs – like a lock that one particular key will fit. The immune system can produce a matching T cell type for each germ in an infection within a few days.
Then if a germ attaches to a matching T cell, the T cell starts to multiply – creating more T cells specialized to that germ. Because only the cells that match the germ multiply, the immune response is customized.

B Lymphocytes

B lymphocytes (B cells) are made in the bone marrow and then mature there to become specialized immune system cells. They take their name from the "B" in "bone marrow." Like the T cells, there are many different types of B cells that match particular germs.

The B cells are activated by the T helper cells: T helper cells contact B cells that match the same germs that they do. This activates the B cells to multiply and to transform themselves into plasma cells. These plasma cells quickly produce very large amounts of antibodies and release them into the blood. Because only the B cells that match the attacking germs are activated, only the exact antibodies that are needed will be produced.

Some of the activated B cells transform into memory cells and become part of the "memory" of the adaptive immune system.

The various cells of the adaptive immune system communicate either directly or via soluble chemical messengers such as cytokines (small proteins). These chemical messengers are mostly proteins and are produced by different cells in the body.

Antibodies

Antibodies are compounds of protein and sugar that circulate in the bloodstream. They are created by the immune system to fight germs and foreign substances. Antibodies can quickly detect germs and other potentially harmful substances, and then attach to them. This neutralizes the "intruders" and attracts other immune system cells to help. Antibodies are produced by the B lymphocytes. Germs and other substances that can provoke the creation of antibodies are also referred to as "antigens."

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Antibodies continued

An antibody only attaches to an antigen if it matches exactly, like a key in the lock of the antibody. That is how antibodies detect the matching germs to initiate a fast response from the adaptive immune system.

Antibodies have three main functions:

- They neutralize germs, e.g. by directly attaching to the cell surfaces of viruses or bacteria, or by attaching to their toxins. This prevents the germs from latching onto the regular cells of the body and infecting them.
- They activate other immune system cells by attaching to their surfaces. Scavenger cells are better able to fight off germs that are loaded with antibodies, too.
- They activate proteins that help in the immune system response.

The antibodies of the adaptive immune system also support the innate immune system.

Sources

- Brandes R, Lang F, Schmidt R (Ed). Physiologie des Menschen: mit Pathophysiologie. Berlin: Springer; 2019.
- Menche N (Ed). Biologie Anatomie Physiologie. München: Urban und Fischer; 2016.
- Pschyrembel. Klinisches Wörterbuch. Berlin: De Gruyter; 2017.
- IQWiG health information is written with the aim of helping people understand the advantages and disadvantages of the main treatment options and health care services.

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*Taken from the National Library of Medicine