

# Basic terms of the immune system

Immunity or defensibility ensures the protection of the body from extraneous and own harmful organisms and substances. The human organism reacts to antigens and pathogens.

**An antigen** is a particle which is able to induce an immune redeficiencies, antigens are for example **parasites**, **chemical substances** (venoms of plants and animals, chemicals...), possibly **own body cells**, which are dysfunctional or do the damage to the body (dead or tumor cells) and **transplanted parts**. The body fights the antigens with help of antibodies (proteins from the group of the immunoglobulins).

**A pathogen** is a germ which causes a disease in humans (viruses, bacteria, protozoa, molds...).

## Non-specific immunity

It is an inborn phylogenetically older type of immunity, which does not distinguish the pathogen. It is a set of mechanisms that prevent the entry of the substances into the body and ensure the primary defense response:

- **Skin** – represents a natural mechanical barrier for the entry of pathogens into the body. In addition, the skin is covered with a layer of substances (lactic acid, urea in the sweat,...), which are toxic to some organisms.
- **Hair, earwax** – restrain the entry of the bigger particles inside the body (in the nose, ears, eyelashes,...).
- **Mucous membranes** – make the mechanical barrier, in addition, they have developed their own immune system – they contain the areas of accumulated lymphatic tissue.
- **The stomach** – contains an acidic environment (pH 2), where most of the organisms are not able to survive.
- **Gut microbiota** – inside the intestines there are symbiotic bacteria which produce the defensive substances and support the digestion.
- **Temperature** – many of the bacteria are not able to survive the high temperatures. Unfortunately, own body cells cannot survive as well.
- **Phagocytes** – white blood cells that ingest the extraneous particles.
- **Interferons** – proteins which are produced by the attacked cells – send signals that they have been attacked, other cells receive these proteins and may become resistant to the pathogen.
- **Activation of the complement system** – complement is a complex of 30 serum and membrane proteins; after contact with the antigen activates the complement cascade. The complement system has 3 functions:
  1. Opsonization – binding of some antibodies to the antigen surface, which causes the recognition and destruction by the phagocytes.
  2. Chemotaxis – is the movement of the white blood cells to the area of inflammation.
  3. Osmotic lysis – the cell is destroyed directly.
- **Lysozyme** – this enzyme occurs in saliva, tears, mucus, blood plasma and breast milk. It has an ability to destroy the wall of the bacteria cell.

## Specific immunity

It specializes in certain substances and organisms - cells respond only to a certain antigen with help of their antibodies and are activated only after encountering the antigen. It's also important that cells of the specific immunity have a so-called immunological memory – they are able to remember a specific antigen and respond faster the next time they meet again (the principle of vaccination is based on this).

Cells which are involved in specific immunity are white cells and leukocytes. Leukocytes are divided into granulocytes and agranulocytes.

**Granulocytes** contain differently colored granules and act in allergic redeficienciess. **Agranulocytes** are divided into monocytes and lymphocytes.

### Monocytes

They are the biggest leukocytes and belong to the mononuclear phagocyte system – they have the ability to penetrate through the capillary walls to the tissues and transform into macrophages. Macrophages move in the interstitium, engulf and digest the extraneous particles. Phagocytosis is a process, when a cell "hugs" the absorbed particle with its protrusions, engulfs and enzymatically decomposes it. We can find these cells for example in pulmonary alveoli of the lungs, where they digest the airborne dust particles (so-called dust cells), then also in the liver (Kupffer cells), bones (osteoclasts) and others.

### Lymphocytes

Lymphocytes can be divided into T-lymphocytes and B-lymphocytes, according to their place of maturation. Here also belong the NK-cells (however functionally they belong to the naturally acquired immunity).

- **T-lymphocytes** – these cells ensure cell immunity. They mature in the thymus (that's why they're called T-cells). They have specific receptors on their surface – after the antigen recognition they start to divide and after several stages, they finally transform into the effector cell:

1. helper cell (Th) – products the substances, which stimulate T and B lymphocytes and lead the macrophages to the inflammation area,
  2. suppressor cell (Ts) – behaves in the opposite way, reducing the activity of T and B lymphocytes with help of its substances. This serves as protection against an excessive allergic redeficiencies and autoimmune disease. (During the transplantation of an organ they are stimulated because otherwise the body would attack and refuse the foreign organ.),
  3. cytotoxic cell (Tc) – produces the substances, which kill the pathogenic cell directly, eventually destroy the antigen enzymatically,
  4. memory cell – this cell plays an important role when the organism encounters the same infection for the second time – memory cells allow the fast response to the pathogen and increase the chance of recovery.
- **B-lymphocytes** – these cells mature in the bone marrow and in the intestine. They are responsible for humoral, or antibody-mediated immunity. It means that after stimulation they produce the antibodies (immunoglobulins). If it comes to the B-lymphocytes stimulation, it begins to divide (like T-cells do) and then turns into a plasma (effector) cell, which produces the antibodies.

**Immunoglobulins** are proteins, which are bound to the cell membrane of the B-lymphocytes and represent the antigen receptors. They have a specific structure of the letter Y – they are composed of 2 light and 2 heavy chains. Antigen falls into Y "shoulders" on the principle of lock and key. Every immunoglobulin is specific for a certain antigen – it can bind up only one and no other. According to the type of heavy chain, immunoglobulins can be divided into 5 groups: IgA, IgG, IgD, IgE, and IgM.

- the most important is **IgG** – it is the only one that can pass through the placenta and protect the fetus from the pathogens even before its own immune system is formed. It can bind to viruses, bacteria and fungi.
- the next important one is **IgA** – it penetrates to digestive tract, it can be found in milk, tears and saliva.

#### **NK cells = „natural killer cells“**

This cell is ranked among the lymphocytes, but functionally it belongs to the naturally acquired immunity – it can kill the tumor cells or cells attacked by the virus – these cells were marked for liquidation by the plasmocytes, NK cells can recognize it and destroy the marked cell.