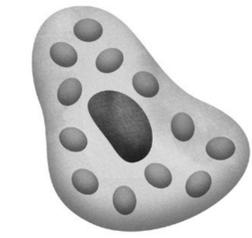


# The immune response

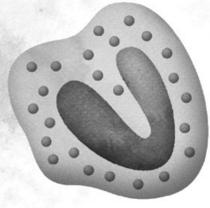
# BigPicture

## Non-specific (innate) immune system

Includes chemical and physical barriers (the first line of defence) and responses such as inflammation (the second line of defence). Its effects are rapid, short-lived and non-specific. Found in all multicellular organisms.



**Mast cell**  
Cells involved in allergic responses, releasing histamine and other inflammatory molecules. Mast cells sit within skin and mucosal tissues.

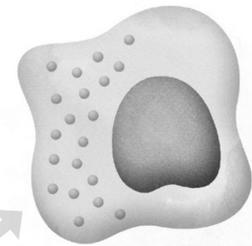


**Basophil**  
Cells involved in allergic and inflammatory responses. Basophils release histamine like mast cells, but unlike mast cells they circulate in the blood.

**INFLAMMATION**  
Invading microbes trigger inflammation. This involves an increase in blood flow to the affected part of the body, which leads to swelling, pain and an increase in temperature. **Mast cells and basophils** are involved in inflammation.

## PHYSICAL AND CHEMICAL BARRIERS

- Physical barriers include the skin and the mucous membranes of the airways, guts, and urinary and reproductive systems.
- Chemical barriers include hydrochloric acid secreted by the stomach lining.



## NATURAL KILLER (NK) CELLS

NK cells kill pathogen-infected cells and cancer cells. They also release chemicals called cytokines, which alert and attract other immune cells.

## IF BREACHED

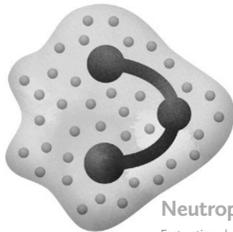
## COMPLEMENT

A set of around 30 proteins in the blood plasma that can be activated by the presence of microbes or antibody-antigen complexes. **Complement** can destroy pathogens and activate phagocytic cells.



## LEUKOCYTES

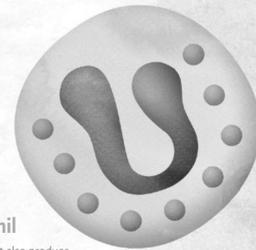
Made in the bone marrow, leukocytes, or white blood cells, are an important part of the immune system. There are two main types: granulocytes, which have granular cytoplasm and a lobed nucleus, and agranulocytes, which have smooth cytoplasm and a non-lobed nucleus. Leukocytes include **mast cells, basophils, macrophages, dendritic cells, neutrophils, eosinophils, B cells and T cells.**



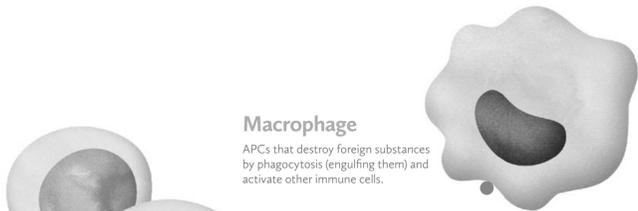
**Neutrophil**  
Fast-acting phagocytes that flock to the site of inflammation.

## PHAGOCYTOSIS

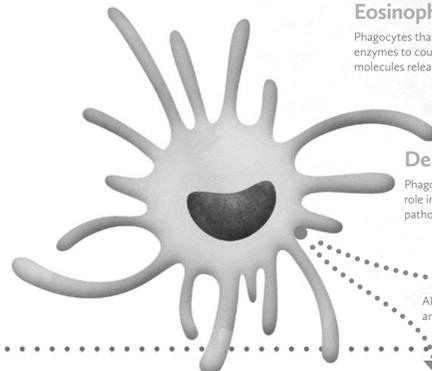
White blood cells including **dendritic cells, macrophages** and granulocytes such as **eosinophils and neutrophils** engulf (or phagocytose) microbes or cells that are infected, damaged or dying. They enclose the particle or cell with a phagosome and then break down the contents with hydrolytic enzymes. Some cells then become antigen-presenting cells (APCs), which present the digested remains to other immune cells.



**Eosinophil**  
Phagocytes that also produce enzymes to counteract the inflammatory molecules released by mast cells.



**Macrophage**  
APCs that destroy foreign substances by phagocytosis (engulfing them) and activate other immune cells.



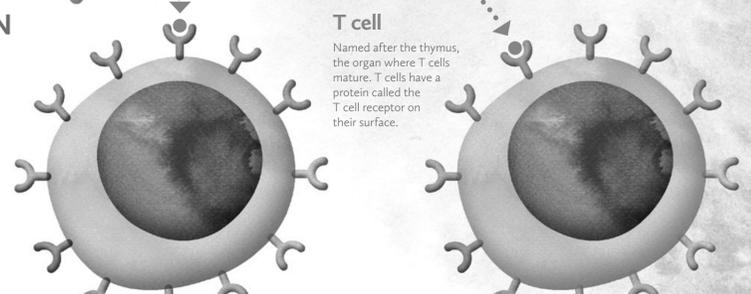
**Dendritic cell**  
Phagocytic APCs with an important role in alerting T cells to new pathogens.

## Specific (adaptive) immune system

The third line of defence against invading pathogens. In vertebrates, it provides long-lasting protection against specific pathogens or foreign substances.

## ANTIGEN PRESENTATION

Antigen-presenting cells (APCs) break up invading or non-self particles and cells and display parts of them – antigens – for other immune cells to inspect. They include macrophages and dendritic cells.



**T cell**  
Named after the thymus, the organ where T cells mature. T cells have a protein called the T cell receptor on their surface.

**Helper T cell (CD4<sup>+</sup>)**

**Cytotoxic T cell (CD8<sup>+</sup>)**

## LYMPHOCYTES

Agranulocyte white blood cells. Types include **B cells and T cells.**

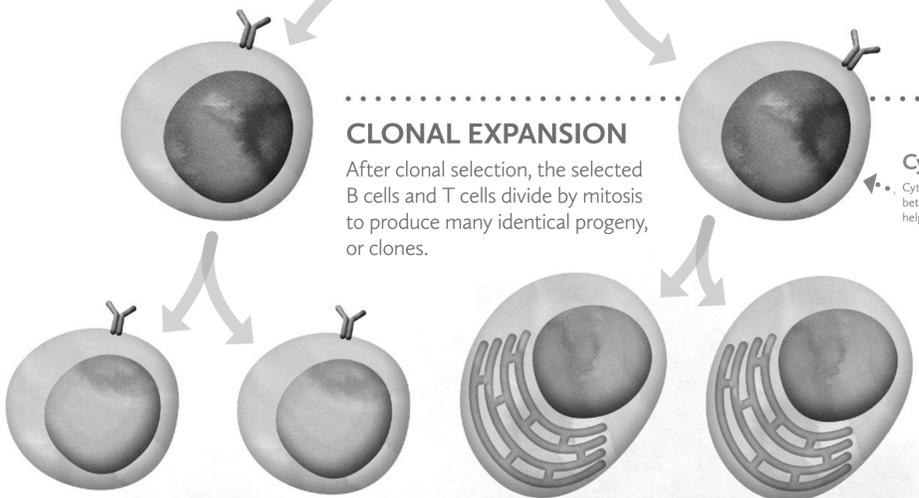
## CLONAL SELECTION

The process by which a B cell and T cell specific to the antigen are selected for clonal expansion by an APC.

## CLONAL EXPANSION

After clonal selection, the selected B cells and T cells divide by mitosis to produce many identical progeny, or clones.

**Cytokines activate**  
Cytokines are proteins that act as messengers between cells. Released by immune cells, including helper T cells to signal danger or damage.



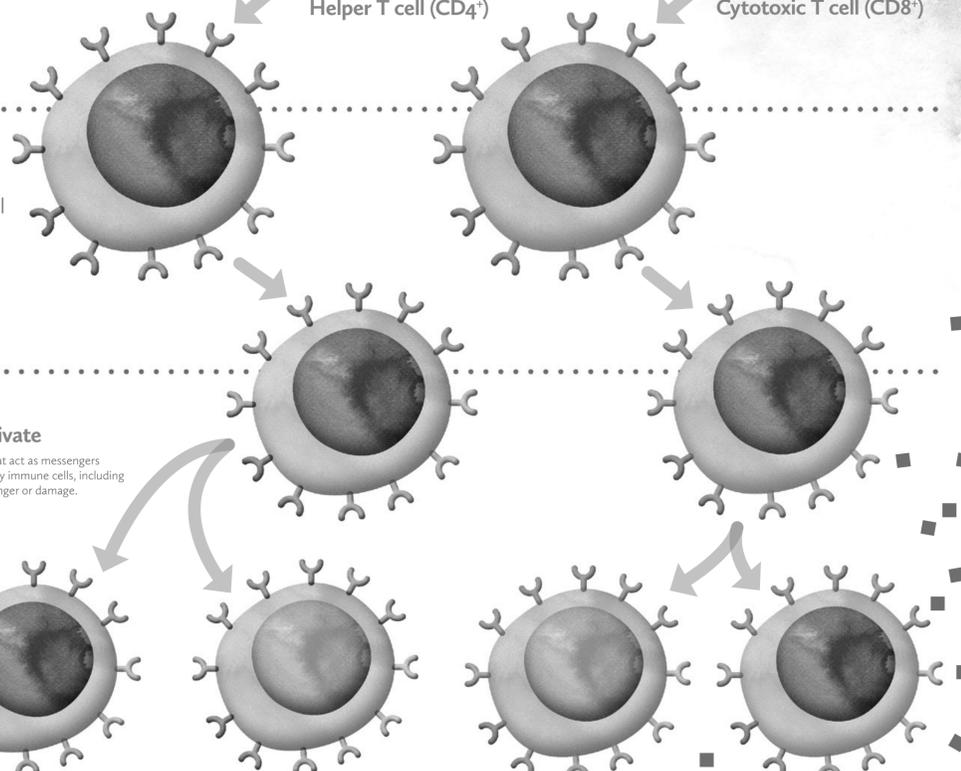
**Memory B cell**  
Long-lived B cells that remember past infections by recognising antigens to provide a secondary immune response.

**Memory B cell**

**Plasma B cell**

B cells that have been activated to produce antibodies. Each B cell makes only one type of antibody.

**Plasma B cell**



**Helper T cell (CD4<sup>+</sup>)**

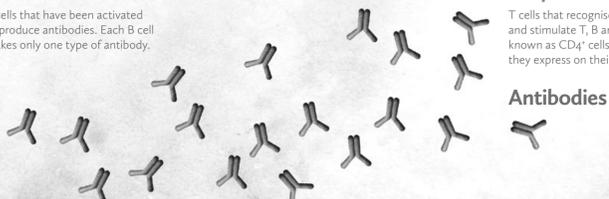
**Memory T cell**

**Memory T cell**

Long-lived T cells that remember past infections to provide a secondary immune response.

**Cytotoxic T cell (CD8<sup>+</sup>)**

T cells that kill virus-infected cells and cancer cells by releasing toxic chemicals. Also known as CD8<sup>+</sup> cells, because of a protein that they express on their cell surface, and as killer T cells.



**Antibodies**

## Perforins

Proteins that cause cells to lyse (burst) by making pores form in the plasma membrane of the cell. Found in the granules of cytotoxic T cells.



## READ MORE

Big Picture is a free post-16 magazine for teachers that explores issues around biology. For more, go to [bigpictureeducation.com/immune](http://bigpictureeducation.com/immune)