

abcam

# The immune system and the antibody response

A coordinated response to prevent infection.

## Overview

The function of the immune system is to protect animals from foreign agents and infectious organisms. It responds in a specific way to pathogens, and can display a long-term memory of exposure to infectious agents. The immune system consists of two functional components:

1. Innate or non-specific immune system
2. Adaptive or specific immune system

### The innate immune system

The components of the innate immune system provide a first line of defense against infection. Physical barriers to infection include skin, which prevents pathogen penetration, and bodily fluids like mucus, which collect and clear pathogens. There are also a number of cellular and biochemical components, including complement proteins, innate leukocytes and phagocytic cells, which identify and eliminate pathogens from the body. Both the function and efficiency of the innate immune system do not change with repeated exposure to foreign pathogens.

### The adaptive immune system

The adaptive immune system is activated when the innate system fails to clear pathogens from the body. It consists of a variety of cells and molecules, among which lymphocytes and antibodies are the key elements. Lymphocytes arise continuously from progenitor cells in the bone marrow. Lymphocytes synthesize cell surface receptors or secrete proteins that specifically bind to foreign molecules. These secreted proteins are known as antibodies. Any molecule that can bind to an antibody is called an antigen. The term antibody is used interchangeably with immunoglobulin. Pathogens bound to antibodies are marked for clearance or destruction.

Most functions of the adaptive immune system can be described by grouping lymphocytes into three basic types:

1. B cells
2. Cytotoxic T cells (TC cells)
3. Helper T cells (Th cells)

The adaptive immune response can be either humoral or cell mediated. The humoral response is mediated by B lymphocytes, which release antibodies specific to the infectious agent. The cell mediated response involves the binding of cytotoxic T lymphocytes to foreign or infected cells, followed by the lysis of these cells. Th cells are involved in both responses through the release of cytokine proteins. All three types of lymphocytes carry cell surface receptors that can bind antigens. All antigen receptors are glycoproteins, and only one type of receptor is synthesized within any one cell.

The specificity of the immune system is imparted by the fact that one cell recognizes only one antigen.

## Antibody generation and production

The interaction of an antibody with an antigen forms the basis of all immunohistochemical techniques, but is also the basis for the immune response. The region of the antibody that reacts with the antigen is called the paratope. The region of an antigen that interacts with an antibody is defined as an epitope. Affinity is the measure of the strength of the binding of an epitope to an antibody. Avidity is a measure of the overall stability of the complex between antibodies and antigens and is often represented by the dissociation constant  $K_d$ .

An antibody response is the culmination of a series of interactions between macrophages, T lymphocytes and B lymphocytes. Infectious agent antigens are engulfed and partially degraded by antigen-presenting cells (APCs), such as macrophages, Langerhans cells, dendritic cells, lymph nodes and monocytes. Fragments of the antigen will appear on the surface of the APC attached to a cell surface glycoprotein known as MHC II (major histocompatibility complex). There are two types of MHC molecules: MHC class I are expressed on the surfaces of APCs and the antigen-MHC II complex allows Th cells to bind to the APC, which leads to a proliferation of Th cells and release of cytokines. T cells then bind to the MHC complex on B cells leading to proliferation and differentiation of B cells. B cells change into plasma cells that secrete large quantities of finely tuned antibodies specific to the foreign agent. Some B cells are changed into memory cells, which can generate a faster antibody-mediated immune response upon future infection.