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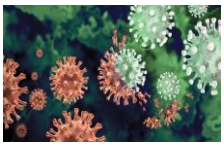
An introduction to immunology



What the immune system does

The immune system consists of a series of biological processes designed to protect the body from diseases and infectious organisms. It acts to detect and respond to a wide variety of entities, including pathogens and cancer cells, and is intended to distinguish self-molecules (healthy endogenous cells) from foreign material in order to avoid attacking the body's own healthy tissue.

The innate and adaptive components

The human immune system consists of the innat e immune system and the adaptive immune system. The innate immune system provides a pre-existing response to broad groups of stimuli and often invokes natural killer cells (NKCs). The adaptive immune system develops responses to stimuli after learning to recognise foreign molecules after an initial exposure.

In general, the adaptive immune system provides a stronger immune response and establishes the immunological memory, where a part of a pathogen's characteristic structures can be 'learned' and 'remembered', leading to robust defensive responses after subsequent exposures.

Humoral immunity within the adaptive system

The adaptive immune response consists of two main mechanisms (humoral and cellular) and is trained by two types of white blood cells (WBCs), B-lymphocytes and T-lymphocytes. B-lymphocytes are responsible for the humoral immune response, which involves the production of antibodies that can recognise and lead to the elimination and/or targeting of undesired material. There are five main classes of antibodies (IgG, IgA, IgD, IgE and IgM). When antibody responses are formed by the humoral system, IgM and IgA antibodies develop relatively early in an infection and then subside as IgG takes on a larger role in the immune response. IgG levels can stay elevated for months or even years, depending on the infection.

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'Treatments aiming to modulate the immune system when it is unnecessarily attacking the body underpin a global market valued at over $100bn', Pooya Hemami, analyst

The components of cellular immunity

The T-lymphocytes provide the 'cellular immunity' axis of protection whereby sub-classes of T-lymphocytes and other forms of WBCs work in a coordinated and networked context to attack undesired or foreign material through processes that can include cytotoxic T cells, macrophages and natural killer T-cells (not to be confused with NKCs employed by the innate immune system).

Antigens and their specificity

Adaptive immunity depends heavily on the recognition of antigens, which themselves are molecular structures that are or can become bound (or 'recognised') by specific antibodies or immune T-cell receptors in circulating blood.

Antigen receptors are tailored to the specific molecular structure of the presented antigens, such that in general, each T-cell receptor or antibody will only react with (ie will only be bound by) the structure of one specific antigen. Upon future exposure to an antigen, only the lymphocytes that recognise that specific antigen are activated and expanded. Similarly, most antibodies will only bind and react to one specific antigen (although some antibodies may cross-react and bind more than one).

How the immune system distinguishes self-proteins from foreign material to avoid attacking itself

Antigens may originate from within the body (self-protein) or from the external environment (non-self). When working properly, the immune system should only identify and attack 'non-self' external antigens and avoid reacting to self-proteins (self-antigens) due in part to central tolerance or negative selection (which eliminates any developing T or B lymphocytes that would become reactive to self-protein). Tolerance involves the elimination of autoreactive (self-reactive) lymphocytes to ensure that the immune system does not recognise self-antigens as foreign material and does not attack the body's own healthy tissue.