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Group – A

Topic: Immunity

Immunity

Immunity is the balanced state of multicellular organisms having adequate biological defenses to fight infection, disease, or other unwanted biological invasion, while having adequate tolerance to avoid allergy, and autoimmune diseases.

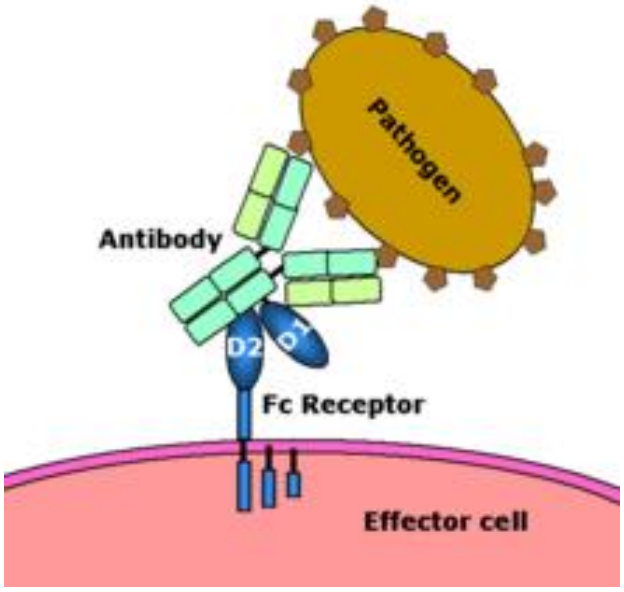


Fig: Scheme of a Fc receptor

Immunity is the capability of multicellular organisms to resist harmful microorganisms from entering it. Immunity involves both specific and nonspecific components.

The nonspecific components act as barriers or eliminators of a wide range of pathogens irrespective of their antigenic make-up. Other components of the immune system adapt themselves to each new disease encountered and can generate pathogen-specific immunity.

An immune system may contain innate and adaptive components.

The innate system in mammalians, for example, is composed of primitive bone marrow cells that are programmed to recognize foreign substances and to react.

The adaptive system is composed of more advanced lymphatic cells that are programmed to recognize self-substances and not to react. The reaction to foreign substances is etymologically described as inflammation, meaning to set on fire.

The non-reaction to self-substances is described as immunity, meaning to exempt or as immune tolerance.

These two components of the immune system create a dynamic biological environment where "health" can be seen as a physical state where the self is immunologically spared, and what is foreign is inflammatorily and immunologically eliminated.

"Disease" can arise when what is foreign cannot be eliminated or what is self is not spared.

Innate immunity:

It is also called native immunity, exists by virtue of an organism's innate constitution that is its genetic make-up, without an external stimulation or a previous infection.

It is divided into two types:

(a) **Non-Specific innate immunity**, a degree of resistance to all infections in general.

(b) **Specific innate immunity**, a resistance to a particular kind of microorganism only. As a result, some races, particular individuals or breeds in agriculture do not suffer from certain infectious diseases.

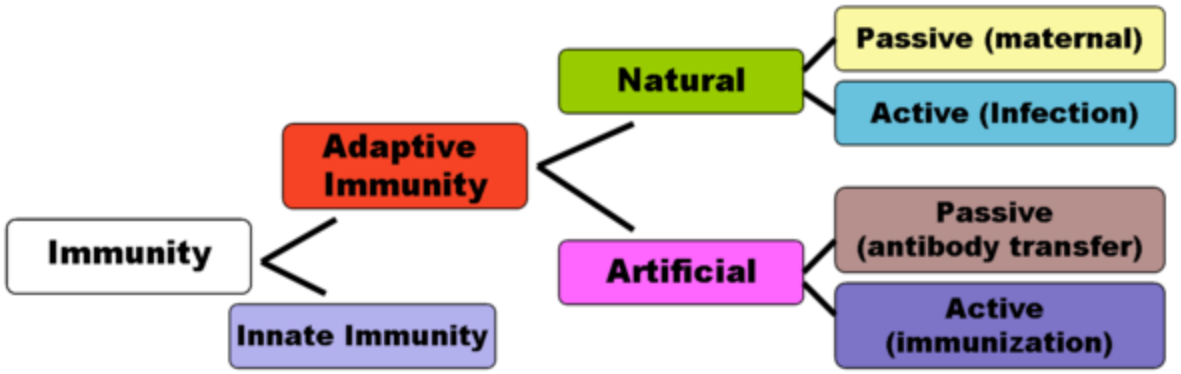
Adaptive immunity:

Adaptive immunity can be sub-divided depending on how the immunity was introduced in 'naturally acquired' through chance contact with a disease-causing agent, whereas 'artificially acquired immunity' develops through deliberate actions such as vaccination.

Both naturally and artificially acquired immunity can be further subdivided depending on whether the host built up immunity itself by antigen as 'active immunity' and lasts long-term, sometimes lifelong.

Passive immunity:

Passive immunity is acquired through transfer (injection or infusion) of antibodies or activated T-cells from an immune host; it is short lived—usually lasting only a few months. The diagram below summarizes these divisions of immunity.



Adaptive immunity can also be divided by the type of immune mediators involved; humoral immunity is the aspect of immunity that is mediated by secreted antibodies, whereas cell mediated immunity involves T-lymphocytes alone.

Humoral immunity:

Humoral immunity is called active when the organism generates its antibodies and passive when antibodies are transferred between individuals or species. Similarly, cell-mediated immunity is active when the organisms' T-cells are stimulated and passive when T cells come from another organism.

History of theories:

The modern word "immunity" derives from the Latin immunis, meaning exemption from military service, tax payments or other public services.

In 1798, Edward Jenner introduced the far safer method of deliberate infection with cowpox virus, (smallpox vaccine), which caused a mild infection that also induced immunity to smallpox.

By 1800 the procedure was referred to as vaccination. To avoid confusion,

smallpox inoculation was increasingly referred to as variolation, and it became common practice to use this term without regard for chronology.

The success and general acceptance of Jenner's procedure would later drive the general nature of vaccination developed by Pasteur and others towards the end of the 19th century.

In 1891, Pasteur widened the definition of vaccine in honour of Jenner and it then became essential to qualify the term, by referring to polio vaccine, measles vaccine etc.

Passive Immunity:

Passive immunity is the transfer of active immunity, in the form of readymade antibodies, from one individual to another. Passive immunity can occur naturally, when maternal antibodies are transferred to the foetus through the placenta, and can also be induced artificially, when high levels of human (or horse) antibodies specific for a pathogen or toxin are transferred to non-immune individuals.

Passive immunization is used when there is a high risk of infection and insufficient time for the body to develop its own immune response, or to reduce the symptoms of ongoing or immunosuppressive diseases.

Passive immunity provides immediate protection, but the body does not develop memory, therefore the patient is at risk of being infected by the same pathogen later.

Naturally acquired passive immunity:

Maternal passive immunity is a type of naturally acquired passive immunity, and refers to antibody-mediated immunity conveyed to a fetus by its mother during pregnancy.

Maternal antibodies (MatAb) are passed through the placenta to the fetus by an FcRn receptor on placental cells. This occurs around the third month of gestation.

IgG:

IgG is the only antibody isotype that can pass through the placenta. Passive immunity is also provided through the transfer of IgA antibodies found in breast milk that are transferred to the gut of the infant, protecting against bacterial infections, until the newborn can synthesize its antibodies.

Colostrum present in mother's milk is an example of passive immunity.

Artificially acquired passive immunity:

Artificially acquired passive immunity is a short-term immunization induced by the transfer of antibodies, which can be administered in several forms; as human or animal blood plasma, as pooled human immunoglobulin for intravenous (IVIG) or intramuscular (IG) use, and in the form of monoclonal antibodies (MAb).

Passive transfer is used prophylactically in the case of immunodeficiency diseases, such as hypogammaglobulinemia. It is also used in the treatment of several types of acute infection, and to treat poisoning.

Immunity derived from passive immunization lasts for only a short period of time, and there is also a potential risk for hypersensitivity reactions, and serum sickness, especially from gamma globulin of non-human origin.

Transfer of activated T-cell:

Passive or "adoptive transfer" of cell-mediated immunity, is conferred by the

transfer of "sensitized" or activated T-cells from one individual into another. It is rarely used in humans because it requires histocompatible (matched) donors, which are often difficult to find.

In unmatched donors this type of transfer carries severe risks of graft versus host disease. It has, however, been used to treat certain diseases including some types of cancer and immunodeficiency. This type of transfer differs from a bone marrow transplant, in which (undifferentiated) hematopoietic stem cells are transferred.

Active Immunity:

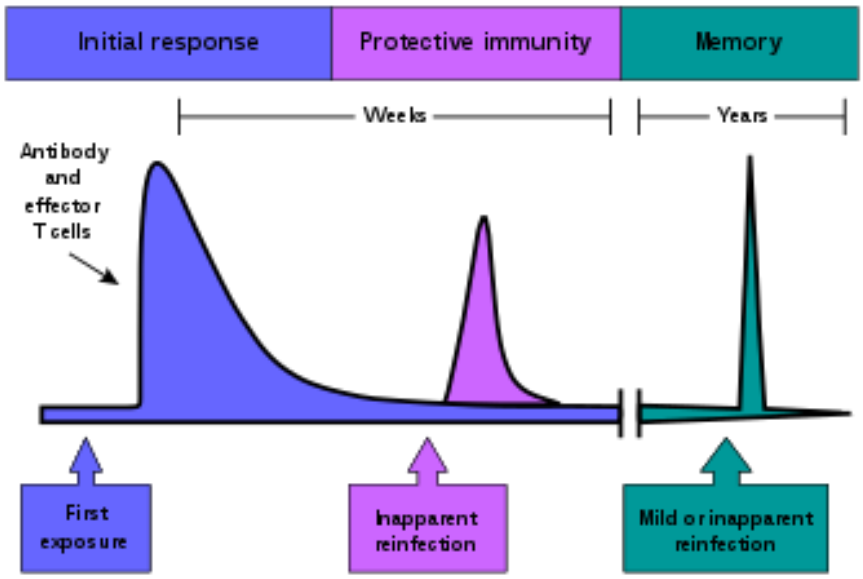


Fig: The time course of an immune response. Due to the formation of immunological memory, reinfection at later time points leads to a rapid increase in antibody production and effector T cell activity. These later infections can be mild or even unapparent.

When B cells and T cells are activated by a pathogen, memory B-cells and T- cells develop, and the primary immune response results. Throughout the lifetime of an animal, these memory cells will "remember" each specific pathogen

encountered, and can mount a strong secondary response if the pathogen is detected again.

The primary and secondary responses were first described in 1921 by English immunologist Alexander Glenny, although the mechanism involved was not discovered until later.

This type of immunity is both active and adaptive because the body's immune system prepares itself for future challenges.

Active immunity often involves both the cell-mediated and humoral aspects of immunity as well as input from the innate immune system.

Naturally acquired active immunity:

Naturally acquired active immunity occurs when a person is exposed to a live pathogen and develops a primary immune response, which leads to immunological memory.

This type of immunity is "natural" because deliberate exposure does not induce it. Many disorders of immune system function can affect the formation of active immunity such as immunodeficiency (both acquired and congenital forms) and immunosuppression.

Artificially acquired active immunity:

Artificially acquired active immunity can be induced by a vaccine, a substance that contains antigen. A vaccine stimulates a primary response against the antigen without causing symptoms of the disease.

Richard Dunning coined the term vaccination, a colleague of Edward Jenner, and adapted by Louis Pasteur for his pioneering work in vaccination.

The method Pasteur used entailed treating the infectious agents for those diseases, so they lost the ability to cause serious disease. Pasteur adopted the name vaccine as a generic term in honor of Jenner's discovery, which Pasteur's work built upon.

There are four types of vaccines:

- **Inactivated vaccines**

Inactivated vaccines are composed of micro-organisms that have been killed with chemicals and/or heat and are no longer infectious.

Examples are vaccines against flu, cholera, plague, and hepatitis A. Most vaccines of this type are likely to require booster shots.

- **Live, attenuated vaccines**

Live, attenuated vaccines are composed of micro-organisms that have been cultivated under conditions which disable their ability to induce disease.

These responses are more durable; however, they may require booster shots. Examples include yellow fever, measles, rubella, and mumps.

- **Toxoids**

Toxoids are inactivated toxic compounds from micro-organisms in cases where these (rather than the micro-organism itself) cause illness, used prior to an encounter with the toxin of the micro-organism.

Examples of toxoid-based vaccines include tetanus and diphtheria.

- **Subunit vaccines**

Subunit vaccines are composed of small fragments of disease-causing organisms. A characteristic example is the subunit vaccine against Hepatitis B virus

Most vaccines are given by hypodermic or intramuscular injection as they are not absorbed reliably through the gut.

Live attenuated polio and some typhoid and cholera vaccines are given orally in order to produce immunity based in the bowel.