Immunology

It is a branch of medical science concerned with the study of immune phenomena represented by the way in which any living person can protect himself from infection with diseases or discarding foreign bodies that might enter the body through normal or abnormal openings .So this is, science is concerned with the system responsible for providing this protection , the immune system .

Immunity :

Immunity as a medical term means the body's ability to resist disease in a broad sense it means the body's ability (through the immune system) to naturally or artificially resist pathogens (such as vaccination), either by preventing pathogens from entering the body or by attacking and eliminating or removing pathogens or foreign bodies by prevent growing , reproducing ,or stopping their effects.

Types of Immunity

A- Natural immunity (Innate or non-specific):

It is an immunity that an organism inherts from its parents and naturally develops as its life evolves and begins to function from birth ,in resisting invasions of foreign bodies , pathogenic microorganisms , and other harmful organisms, their mechanism does not depend on specific cellular or mixing factors , and does not require specific identification of invading foreign bodies to do its immune function . Natural immunity can be defined as mechanical , chemical , and cellular defense lines.

Natural immunity is consist of :

1- Mechanical barriers : which include the following

a- The skin : is the first line of defense in the host body to protect it from injury by microorganisms and foreign bodies .

b- Mucous membranes : which are found in all organs that have external contact , such as the digestive and respiratory systems, where it secretes

mucus that prevents the adhesion of foreign bodies and microbes to the cells of this organs.

c- Hair : is a mechanical barrier that prevents microorganisms from sticking to the skin and mucous membranes .

d- Ciliated epithelial cells : such as those found in the respiratory tract , that trap and release microbes and solid molecules attached to the mucosa by movement of cilia.

e- Acid and enzymatic secretions of stomach: have an adverse effect on many microorganisms that enter the mouth.

f- Saliva and sweat : have an cleaning role.

g- Tears : they work to remove hard molecules and foreign bodies that may enter the eye , as well as the enzymes released by the eye are able to eliminate many microbes.

h- Urinary pathways : they help to remove microbes and other things during the urination .

i- Sneezing ,coughing , vomiting , and diarrhea : they all have an cleaning role by removing microbes and foreign bodies into the outside of the body.

j- Normal flora : they reduces the possibility of sticking and growing of pathogenic bacteria in the cellular membrane of the intestine .

2- The chemical barriers :

a- Perspiration and product of sebaceous gland : gives the skin's surface an acidic medium act as inhibitor for the growth of several microbes such as lactic acid , which is sweat contents, and lysozyme as

well as fatty acids which excreted from skin and be poisoned for several pathogenic microbes.

b- Tear : contains bacteriostatic and bacteriocidal enzymes, especially for gram positive microbes.

c- Hydrochloric acid : secreted by the stomach and is able to kill the majority of microbes that may enter the mouth.

d- Urine : a growth inhibitor acid medium for many microbes , as well as , the presence of certain enzymes in the urine eliminate the microbes that can be found in the urinary tract.

e- Lysozymes : these are lyses enzymes which are excreted by many cells in the body such as white blood cells , mucous membrane cells , spleen cells , and they are found in many body secretions such as tears , sweat , urine , salivary gland secretions , and body fluids other than spinal cord fluid . These enzymes have an antibacterial effect by splintering sugar in the cell wall of gram positive and negative microbes , resulting in wall disintegration and death of the microbe .

f- Cytokines : They are proteins secreted by various activated immune cells and also non immune cells . Cytokines act as intercellular messenger proteins affect the functioning of the immune system and associated it with other body physiological systems , where they stimulate, inhibit or regulate the functions of other immune system cells. Also , they are an important mediator for host defenses against infection , injuries and acute or chronic inflammation . In addition , cytokines are important for development and differentiation of Stem cells ,that from which Myeloid cells and Lymphoid cells are create .

g- Properdins : They are γ-globulin proteins which work on activating of the alternate route of the complement system leading to kill the microbes that invade the body by activating the complement system.

h- β-lysine : A substance has antibacterial activity is found in the serum of many animals , including human ,where excreted from platelets during the coagulation. This material has a defensive role , in the body natural immunity, against gram positive pathogenic bacteria except Streptococci.

i- Natural antibodies : Are those antibodies that found in the body without previous exposure to specific antigen. There are several hypotheses to explain their existence , including genetic factors and the cross linkage with an antigens has the same specific sites for this antibodies , or the antigens have entered the body without realizing them by the host and have led to the formation of these antibodies.

j- Acute phase proteins: A protein collections often arise in the liver , such as Antitrypsin , C-Reactive protein , Ceroloplsma , and fibrinogen …etc. which their concentration rises sharply in the serum when acute inflammations or tissue accidents occur for any reason such as microbial infection or other tissue damage.

k- Complement system : A one of natural components of plasma , consisting of 20 proteins or glycoprotein and they plays a key role in the body's various defenses against microorganisms .

l- Interleukins : They are a member of the vast cytokines family , and they act as a communication tool between the different cells of the immune system and , on the other hand , between the immune system and other cells of the body . In addition , interleukins assisting the immune

system in performing of its defense functions . Interleukins are produced by various immune cells such as macrophages , B and T lymphocytes .

m- Interferons (IFN) : A group of proteins or glycoproteins secreted by virus infected cells and act to protect the non-infected neighboring cells from viral infection by blocking the intracellular replication of the virus RNA(V-RNA) as reaction from infected cells against virus. In addition , interferons has a role in immunoregulation such as inhibiting B-lymphocytes activation , activating the cellular poisoning ability of natural killer cells , and growth inhibiting of the cellular parasites. Interferons are not affected by temperature or acidity and they recognized to several important types :

1- α-Interferon : Is made by white cells and it activates antiviral substances and the natural killer cells . Its also called Leukocyte interferon.

2- β-Interferon : This interferon is implanted by Fibroblasts , Epithelial cells , and Macrophages . The essential role of this interferon is the antiviral activity. It's also called Fibroepithelial interferon.

3- γ-Interferon : Is a major interferon secreted by lymphocytes , especially T- lymphocytes , and its role is immunoregulation. Its also called Immune-interferon

n- Tumer Necrosis Factor (TNF) : Is an essential mediator for host responsibility against gram negative bacteria and may play other roles in response to infection with other microorganisms . The main source of TNF is lipo-polysaccharide of activated mononuclear macrophages , Antigen-stimulated T- lymphocytes , and Activated Natural Killer cells.

3- Cellular barrier or factors involved in natural immunity (natural cellular immunity) :

Various white blood cells are consider as cellular barriers for organism defenses , represent the second essential defense line in the body. Many microbes are able to penetrate the mechanical and chemical barriers in the in the host body, so, the various cellular barriers intervene to prevent damage of this invasive microorganisms by eliminating it through phagocytosis or producing of specific globulins (lymphocytes) active against this microorganisms , and producing of an factors are contribute in the body resistance for microorganisms.

* Factors influencing in natural immunity :

First : Factors that associated with host

1- genetic factor (gender and species)

2- ethnic differences

3- age influence

4- individual differences

5- hormonal effect

6- effect of psychological factors

Second : Factors that associated with environment

1- influence of nutritional factors

2- level of living

3- exposure rate to pathogens

B- Acquired or Specific Immunity

When foreign bodies and microbes can penetrate through the barriers of natural defenses , the body builds additional immunity defenses that takes on the body's defense role , called acquired immunity . The tools that contributes in this immunity are :

1- cellular components include B and T lymphocytes and plasma cells.

2- mix components include antibodies .

The nature of acquired and natural immunity action is a continuous and complementary relationship . Natural immune action provides the primary means for resistance of foreign bodies and microbes that attempt to invade the body , while acquired immunity provides a strong and effective specific immunity to develop and enhance the activity of natural immunity and provide immune memory to male foreign bodies if they repeatedly attack the body. So specialization , diversity and memory are the most important features of acquired immunity , as well as the ability to distinguish between self and non self.

Types of specific or acquired immunity :

1- Active acquired immunity :

It's the immunity that an individual develops it after direct exposure to foreign antigens (bacteria or viruses) or their products . This direct contact to foreign antigens may be due to :

a- clinical or subclinical injury .

b- injection of microorganisms or dead organisms or their antigens .

c- absorption of bacterial products such as toxins .

A disadvantage of this type of acquired immunity is that it is not as immediate as passive immunity ; rather , it takes a long time to develop. However , its advantages are that it remains for a long time and can be induced again upon exposure to a second infection with the same infection or by re-injecting the foreign antigen to boost it (a booster dose) as occurs with vaccination . Active acquired immunity is divided into two types :

A- Natural active acquired immunity :

Is the immunity that an individual acquired it after a disease that has been cured , such as a bacterium or its products or a virus , where the body forms specific antibodies or specific immune cells to resist these pathogens if the infection recurs . The duration of this immunity varies depending on the type of infection .

B- Artificial active acquired immunity :

Is the immunity that can be introduced in the body by injecting different types of vaccines such as the polio vaccine and the bacterial triple vaccine (diphtheria , tetanus and whooping cough).

2- Passive Acquired Immunity :

It is immunity in which the host body has no role but is obtained by transferring protective antibodies (serums) in a natural or artificial way from another source (human or animal) in which they are created or stimulated . This form of immunity is given immediate but temporary protection , where it lasts for a limited period (3-4 weeks) , and it is usually used for prophylactic or therapeutic purposes in cases of epidemics or injuries. There are two types of passive acquired immunity :

A- Natural passive acquired immunity

It is immunity that a baby or fetus gains from the mother through the placenta when he present in the womb or through breastfeeding from his mother after birth ; for example , if the mother was vaccinated against tetanus or rubella , the antibodies against these vaccines are passed on to the fetus or child via the placenta or the lactation , providing protection against these diseases . Furthermore , the other antibodies that child obtains from the mother provide protection against many infections during the early stages of his development, such as the IgA antibody that gets it from the mother's milk.

B- Artificial passive acquired immunity

It is immunity that an individual acquired by transfusing or injecting protective serums contain antibodies ready for different diseases , such as the serum given for prevention or treatment of tetanus .

• Immunity and the elderly

Impairment of immunity in the elderly is due to :

1- thymus gland atrophy

2- decreased rate of T-cells synthesis

3- changes in the functions of T-cells

4- changes in the lymphocytes of blood

5- changes in the humeral immunity

6- changes in the functions of phagocytosis

Vaccines

These are substances that contain more than one living weakened , dead bacterium or weakened toxin as antigens that induce the body to form antibodies against it without the bacteria or their toxins having the ability to cause disease. This process is called immunization .

* **Ways to weaknesses bacteria for obtaining vaccines :**

1- Use of chemicals such as formalin

2- Exposing bacteria to high temperatures where their pathogenicity is driven .

3- Frequent bacteria culture (frequent subculturing) .

4- Drying the bacteria where the virus is less infectious and the paddle can be used as vaccine .

* **Features of weakened vaccines**

1- Gives strong ,long-acting immunity

2- Given in low doses

3- Low incidence of allergies occurs

* **Characteristics of dead vaccines**

1- Has no possibility of developing disease due to so called residual virulence .

2- Stable during storage

Vaccine's mechanism of action

1- The immune system recognizes the foreign material (antigen) that present in the vaccine.

2- By special receptors , the macrophages will recognize the antigens and swallowed , digested then they reappeared on the surface of cells as simple proteins for recognized and treated by the lymphocytes to completes the process of appropriate immune response.

The immune system response against any vaccine is differed between the first and second dose. In the first dose , an initial response has obtained in which the antibodies are produced after a period of several days to two weeks from vaccine administration .Usually , the antibodies are of IgG type and reach their highest level at the fifth week then gradually declined.

At the second dose , a secondary immune response occurs which characterized by the rapid appearance of large amounts of IgG antibodies , during several days of vaccine administration , and remains longer period in the body or may be permanently.

Immunological response to vaccine

A number of factors are affect the amount and quality of immune response to vaccines . These factors can be divided into two main categories :

1- The nature of vaccinated person : include several respects

a- Age of the vaccinated child (vaccination time)
b- Immune ability of the person
c- Acquired antibodies against the vaccine

2- The vaccine used : include several respects

a- Nature and dose of the antigen used in the vaccine

b- using of immunological Co-factors in vaccine synthesis

c- Method of vaccine administration

d- Vaccine activity

Classification of vaccines

According to substance prepared from or preparation method, vaccines are classified as follows :

1- Live attenuated vaccines : vaccines that contain suspensions of bacteria or viruses that have been weakened by heat or repeated cultivation (sub-cultivation) , so they have lost their ability to cause disease , but have retained their ability to provoke the formation of active immunity. The most important of these vaccines are :

* Viral attenuated vaccines such as Mump , Smallpox , Rubella and Measles .

* Bacterial attenuated vaccines such as tuberculosis vaccine

2- Dead (killed) vaccines : vaccines that contain suspensions of bacteria or viruses that have been killed by heat , chemotherapy , radiation and so on.

* Viral dead vaccines such as Rabies and Influenza.

* Bacterial dead vaccines such as Typhoid and Whooping cough.

3- Vaccines of reduced toxins : these are external toxins excretes by some bacteria, which have been weakened by heat or chemotherapy (by formalin) so they lost their toxicity and retained their ability to build

immunity. The examples of these vaccines are Diphtheria and Tetanus, this vaccine has been administrated at two doses to form active immunity and may be followed by third booster dose.

4- Bacterial derivatives vaccines : these are vaccines in which certain bacterial parts contain bacterium antigens are used , such as bacterial pili that causes Syphilis disease , Meningitis vaccine , and Polio vaccine.

5- Protozoa and Helminthes vaccines: the primary and helminthic animals are complex parasites that produce many antigens on their surface as well as through their metabolic products. In addition , different antigens appear during the stages of their development , so it's difficult to make a vaccine against them .

Vaccine administration methods :

1- By scratching the skin , such as Smallpox vaccine.

2- By subcutaneous injection , such as Cholera and Typhoid vaccine.

3- By injection into the skin , such as Tuberculosis vaccine.

4- By oral , such as Polio vaccine.