UNIT IV- IMMUNOLOGY

Immunology is a branch of biology. It is concerned with immunity. It is resistance of living organisms to infection of microorganisms.

Immunity

Immunity is defined as the resistance to infection. This is carried out by the process of recognition and disposal of non-self or foreign material that enters the body.

Immunity is broadly classified into two types, namely innate immunity and acquired immunity.

Innate Immunity

All living organisms are naturally gifted with the resistance to certain infections from birth and this natural defense mechanism is known as innate immunity or native immunity or natural immunity.

As the innate immunity includes the general protective reactions of organisms against any invasion and not against any particular microorganism, it is also known as non-specific immunity. The mechanism is effective against a wide range of infectious agents and it operates through many factors such as,

a. Physical and Mechanical factors
b. Biochemical factors
c. Cellular factors
d. Genetic factors and
e. Other factors

a. Physical and Mechanical Factors

The physical and mechanical factors of innate immunity include

1. Skin
2. Mucous membrane
3. Cilia
4. Coughing and Sneezing
5. Peristalsis
6. Tear, Saliva, etc

b. Biochemical Factors

The following biochemical factors are employed to fight against infectious organisms:

1. Secretions of the skin
2. Secretions of gut
3. Human milk
4. Nasal secretion
5. Lysozyme
6. Interferons
7. Complement
8. Properdin
9. Secretions of bacteria
10. Semen
11. Acute phase proteins

C. Cellular Factors

Natural immunity is provided by the following cellular factors:

1. Phagocytosis
2. NK cells

Phagocytosis

Phagocytosis is a process of *cell eating*" (GK – phagia – eating, cytos – cell).

The phagocytic cells discovered by ***Metchnikoff*** (1838) are of two types, namely ***microphages*** and ***macrophages***. These are the professional phagocytes but on occasions, other cells also perform the function of phagoctosis.

The microphages are nothing but the ***polymorphonuclear leucocytes (PMN).*** It includes ***neutrophils***, ***eosinophils*** and ***basophils***. These are the dominant ***white cells*** in the blood stream. These cells possess multilobed nuclei, do not divide and are short lived.

The macrophages are long lived and are usually found engulfing bacteria, viruses and protozoans which are capable of living within the cells of the host.

Process of Phagocytosis

The process of phagoctosis includes the following stages : ***Chemotaxis, attachment, ingestion, intracellular killing*** and ***digestion.***

1. ***Chemotaxis*** involves the movement of the phagocytes to the site of infection or inflammation in response to the chemotatic factors produced by the foreign particles (microbial organisms) or damages or dead tissues.

The next stage is the ***attachment*** of phagocytes to the foreign particles.

2.The attachment is promoted by opsonins (like antibodies or activated complement factors) which form a coating around the particles.

Once the attachment is made, the process of ***ingestion*** starts. The cell membrane of the phagocytes produce pseudopodia around the particle and thus the particle is completely enclosed in the vacuole which is known as a phagosome. The phagosome soon fuses with the lysosome of the phagocytic cell and the fusion results in the formation of a ***phagolysosome"*** also known as "secondary lysosome".

3.The next stage is the ***intracellular killing***. This is done by the antimicrobial substances produced by the lysosomes of the phagocytes, namely lysozyme, hydrogen peroxide and myeloperoxide.

In addition, polymorphs (PMN) have cationic proteins and lactoferritin which also have an antibacterial action.

5.Finally the killed organisms and cells are ***digested*** by the hydrolytic enzymes of the lysosomes followed by the elimination of the product of digestion to the exterior.

Phagocytes can also kill neoplastic cells and other cells directly without ingesting them but just by membrane contact which is known as ***"contactual*** cell injury.

Natural Killer Cells (NK Cells)

These are non-phagocytic lymphoid cells having large granules. Hence, these cells are also known as large ***granular lymphocytes.***

D. Genetic Factors

Natural immunity is also due to genetic factors

1.Species Immunity

2.Racial Immunity

3. Individual Immunity

E. Other Factors

1. Temperature

2 .Inflammation

3. Fever

Acquired Immunity

The resistances developed by man during his life is known as ***acquired immunity*** or ***adaptive immunity***.

This is distinct from innate immunity in that it is due to specific antibodies or sensitised lymphocytes produced in response to specific antigens. Hence, this immunity is also known as ***specific immunity.***

This acquired specific immunity is of two types namely active and passive. Both active and passive immunity may be ***natural*** or ***artificial.***

A. Active Immunity

Active immunity is the resistance developed by an individual in response to an antigenic stimulus. The antigen may again entrance either by natural infection or through any other sources such as artificial immunization by vaccination.

Active immunity involves the synthesis of specific antibodies (humoral immunity) or production of immunologically active cells (cell mediated immunity).

Active immunity may be natural or artificial based on the sources of antigen.

a. Natural ACTIVE Immunity

Here immunity is developed by the host in response to the antigen that enters by ***natural infections***. For example, a person attacked by measles or smallpox develops natural active immunity as he recovers from the diseases.

The immunity acquired by way of such infections is also long lasting in many cases. For example, life time immunity is got following certain viral infections such as smallpox, measles and mumps.

To the contrary, in some bacterial diseases such as bacillary dysentry and influnza, the immunity caused is only short lived. Influenza can reattack an individual a month or an year after the first attack. This is dur to the antigenic variation noticed in the influenza virus.

In diseases like cold, a second attack may occur very soon after the first attack, showing an apparent lack of immunity. This is only because the common cold is caused by various different viruses and a person may not become immune for all these viruses. The immunity attained after the bacterial infections is commonly less permanent than that attained after viral infections.

b. Artificial Active Immunity

In artificial active immunity, immunity is attained by the host in response to the antigen got by vaccination. Vaccines are preparations of live (attenuated) or killed microorganism or their products (toxoids).

Live Vaccine (attenuated)

In this preparation, live microorganisms are attenuated by different methods. ***Attenuation*** results in the loss of pathogenicity without the loss of antigenicity of the microorganisms. Hence, the vaccine products an infection but does not result in disease or injury.

The immunity following live vaccine administration is very similar to that got at the time of natural infections, but may be of a lower level. The immunity that results, lasts for several years but in many cases ***booster dose*** may be necessary. Live vaccine may be administered orally as in the case of Sabin vaccine for poliomyelitis or ***parenterally*** as in the case of smallpox vaccine.

Vaccines Prepared with Killed Microorganisms

In this vaccines, microorganisms are killed in their virulent phase either by heat or antiseptics. Which killing, care is taken not to denature the antigens by excessive heat or strong detergents.

Killed vaccine are generally less immunogenic when compared with live vaccine and immunity lasts for only a short period. Therefore, they have to be administered repeatedly and in many cases twice.

The first dose is called the primary dose and the subsequent dose is known as booster dose.

Killed vaccine may be given orally as in the case of Taboral (TAB) vaccine for typhoid fever parenterally as in the case of Salk vaccine for poliomyelitis (subcutaneous vaccine).

B. Passive Immunity

The immunity that non-immune individual acquires by receiving antibodies or sensitised white blood cells from another immune individual is known as passive immunity.

The immunity caused by passive immunization is less effective and inferior than that caused by active immunisation. The main advantage of passive immunization is that it is immediate in its action of producing immunity and so this method would be used when immediate immunity is needed.

It differs from active immunity in the following:

1. There is no antigenic stimulus and so there is no participation of the recipient's immune system.

2. There is no production of antibodies or sensitised cells in the recipient, but they are transferred from the immune individual (donor) in a readymade form.

3. There is no latent period and protection occur immediately following the passive immunization.

4. There is no negative phase.

5. The protection got is temporary, usually lasting for few days or weeks, till the passively transmitted antibodies are metabolised and eliminated.

6. There is no memory cell formation.

7. In the absence of memory cell formation, there is no secondary immune response. In contrast, passive immunity decreases with repetition of administration of antibodies or sensitised cells.

Passive immunity is also of two types namely ***natural*** and ***artificial***.

a. Natural Passive Immunity

The immunity transferred from the mother to the child passively is known as natural passive immunity.

In human beings, this natural passive immunity occurs mainly by the passage of antibodies from the mother to hr unborn child through the placenta during the later part of pregnancy.

The antibodies that are transferred are entirely IgG as other immunoglobulin sub – types (A,D,E and M) do not pass the placental barrier.

In other primates and in most of the other mammals such as pig the transfer of antibodies from the mother to the young one occurs mainly orally through the ***colostrum***. Human colostrum also offers protection to the newborn as it rich in lgA antibodies.

b. Artificial Passive Immunity

Transfer of immunity from an immunised donor to a non immune recipient by transferring antibodies or immunised lymphocytes is known as artificial passive immunity.

Artificial passive immunity is therapeutically used in the treatment of ***tetanus, diphtheria, gas gangrene, snake bite*** and ***immuno deficiency states***.

Artificial passive immunity is brought about by using anyone of the following sera:

1. Hyperimmune serum of animal or human origin
2. Convalescent serum
3. Pooled sera from different healthy individuals