ACQUIRED IMMUNITY

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The immunity acquired during the lifetime of an individual is known as acquired immunity or adaptive immunity, it is differs from innate immunity in the following :

1. It is not inherent in the body but is acquired during life.
2. It is specific for a single type of microorganism (specific antigen).

Acquired immunity may be:

1. Active.
2. Passive.

Active immunity: It is the resistance developed by immune system as a result of antigenic stimulus.

Active immunity may be:

Natural active immunity: This is acquired after one infection or recovery from disease or subclinical infection after repeated exposure to small doses of the infecting organism.

Artificial active immunity: It may be acquired artificially by inoculation of bacteria, viruses or their products as under:

a. **Living organisms**: After proper attenuation, e.g. smallpox, BCG. Attenuation may be obtained as under:

i. Subjecting the organism to drying, e.g. rabies virus vaccine.

ii. Growing the organism at temperature higher than optimum, e.g. anthrax vaccine is prepared by cultivating the organism at 42°C.

iii. By passage through animals of different species, e.g. through rabbit and calf.

iv. By continued cultivation in presence of antagonistic substance, e.g. BCG vaccine is prepared by prolonged cultivation of tubercle bacillus in medium containing bile.

v. By repeated subculture in artificial media, e.g. streptococci.

b. Organisms are killed by heat or phenol without changing the antigenic structure of bacteria, e.g. typhoid vaccine, cholera vaccine.

c. Toxoid: Bacterial inactivated toxin (not toxigenic but still antigenic) is injected repeatedly in increasing doses, e.g. diphtheria and tetanus toxoid.

Passive Immunity: the individual is immunized by prepared antibodies , body cells do not take any active part in the production of immunity, types:

1. ***Natural passive immunity***
2. ***Artificial passive immunity***

Natural passive immunity:

- During intrauterine life transmission of antibodies from the mother to fetus can occur through placenta.

- It may be by way of colostrum of mother and milk during first few months of life.

- Breast-fed infants resist enteroviruses in alimentary tract.

- These antibodies last for few weeks and protect infants from diphtheria, tetanus, measles, mumps, smallpox, etc.

Artificial passive immunity: Immunization in this case is passive and produced by injection of serum of animals that have been immunized actively. Antibodies remain in effective quantity for 10 days only. Following serum may be used:

a. *Antitoxic serum:* It is produced by injection of toxoid into horse in increasing doses till the blood is rich in circulating antibodies . e.g. diphtheria, tetanus, etc.

b. *Antibacterial serum:* Antibodies are produced by injection of bacteria into animals and serum is collected, e.g. *pneumococcal,meningococcal*, anthrax, dysentery, etc.

c. *Convalescent serum*: It is obtained from convalescent patient. It is also called convalescent serum. Such serum is used in the treatment of measles, poliomyelitis , infective hepatitis, etc.

DIFFERENCES BETWEEN ACTIVE AND PASSIVE IMMUNITY

Active immunity	Passive immunity
1. Produced actively by host's immune system	Received passively by the host. No participation by host's immune system
2. Induced by infection or by contacts with antigene	Conferred by introduction of readymade antibody
3. Afford durable and effective protein	Temporary and less effective protection
4. Immunity effective after lag phase	Immunity effective immediately
5. Immunological memory present	No immunological memory
6. Not applicable to immunodeficient hosts	Application to immunodeficient hosts
7. Used as prophylaxis to increase resistance of body	Used for treatment of acute infection
8. Both cell mediated and humoral immunity take part	Exclusively humoral immunity is involved
9. No inheritance of immunity	May be acquired from mother

ANTIGEN

- **Antigen** is a substance which, when introduced into the body, stimulates the production of an antibody.
- Antigenic determinant is that portion of antigen molecule that determines the specificity of antigen-antibody reaction. It is also called epitope.
- Antibody recognizes epitope present on the surface of an antigen in solution, which may be proteins or polysaccharides.
- T cell receptors bind to peptide fragment → antigen presenting cells → proteolytic degradation of antigen .

- An antigen possesses several epitopes and each epitope induces specific antibody formation

- The determinant groups are:

a. Protein antigen
b. b. Polysaccharide antigen

- A determinant is around 5 amino acid in size

- The site on antibody molecule, which combines with corresponding epitope is known as partope

specificity depends on the following factors:

1. Acid and basic groups are important in regulating the specificity of an antigenic determinant.

2. Spatial configuration is important.

3. Terminal groups in an antigen are often important determinant of specificity.

PROPERTIES OF ANTIGEN

A number of properties have been identified which make a substance antigenic:

1. *Foreignness:*

- Only antigens which are foreign to the individual induce an immune response.

- An individual does not normally give rise to immune response against his own antigen.
- Antigenecity of substance is related to the degree of foreignness.

- Injection of sheep RBC or rat kidney tissue extract in rabbit → production of antibodies. But injection of rabbit RBC or kidney tissue extract into the same rabbit will not → antibody production.

2.Size:

- Antigenecity has a relation to molecular size.
- Very large molecules are highlyantigenic.

- Usually antigens have a molecular weight of 10,000 Dalton or more. Substances of less than 10,000 Dalton molecular weight, e.g. insulin (5700) are either non-antigenic or weakly antigenic.

- Depending on the size of antigen and capacity to induce antibody production antigens can be divided into:

  a. Complete antigen

  b. Partial antigen

a. *Complete antigen:* It is able to induce antibody formation and react with the antibody produced, e.g. proteins,polysaccharide, etc.

b. *Partial antigen* (also called hapten):Haptens are substances which are unable to induce antibody production by themselves, but are able to react specifically with antibodies, e.g. lipids,nucleic acid, sulfonamide, penicillin,etc.

Clinically they are important because a number of hypersensitivity reactions may develop as a complication of drug therapy.

3. *Chemical nature:*

- Most naturally occurring antigens are proteins and polysaccharides.
- Proteins are more effective in stimulating antibody production than polysaccharides.
- Not all proteins are antigenic. Gelatin is a well-known exception.
- Aromatic radical is a must for antigenecity. Gelatin is non-antigenic because of absence of aromatic radical.

4. *Susceptibility to tissue enzymes:*

- Only substances which are metabolized and are susceptible to the action of tissue enzymes behave like antigen.
- Substances insusceptible to tissue enzymes are not antigenic, e.g. D amino acids which are not metabolized in the body are not antigenic.
- Polypeptides composed of L amino acid are antigenic.

5. *Antigenic specificity:*

- Active sites are present at certain places in antigen molecules.
- These active sites are called antigenic determinants.
- The remaining portion of antigen molecule is antigenically inert.
- In antigen-antibody reaction, antigen molecule reacts specifically at determinant site with complementary combining site on antibody molecule.

Antigenic specificity is of following types:

a. *Species specificity*: Tissues of all individuals in species contain species specific antigen. It has been useful in:

i. Tracing of evolutionary relationship.

ii. Forensic application in identification of species.

b. *Isospecificity:* Isoantigens are antigens found in some but not all member of a species, e.g.:

i. Human erythrocytes antigen on which individuals can be classified into group (blood group).

ii. Histocompatibility antigen: HLA (human leukocyte associated antigen system).

It has its application in organ transplantation from one individual to other.

c. Auto-specificity:

A number of tissue antigen may act as auto antigen, e.g. lens protein, thyroglobulin, etc.

These tissues under certain circumstances such as injury, infection or drug therapy alter the molecule so that they become foreign to one's own body and provoke

autoantibody formation.

d. *Organ specificity:*

They are restricted to particular organ or tissue of species. When they are restricted exclusively to an organ they are called organ specific, e.g. thyroglobulin, lens protein, brain, spinal cord and adrenal of one species share specificity with another species.

e. *Heterogenetic specificity*:

This is found in a number of unrelated animals and microorganisms ,e.g.Forssman antigen found in the tissue of guinea pigs, cat, horse, sheep, bacteria, e.g.rickettsiae. It was first described by Forssman in 1911.

SUPERANTIGEN

- Certain proteins that are capable of activating a large number of T-lymphocytes are named as super antigen.

- Superantigen may activate 20% of circulatory T-lymphocytes where as conventional antigenic stimuli can activate not more than 0.0001% of circulating T-lymphocytes.

- This excessive T-lymphocyte activation → ⇑ T-lymphocyte cytokines → multisystem problems.

- The examples are staphylococcal toxic shock syndrome and staphylococcal enterotoxin.