Antigens and Immunogens

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Antigen

Antigens (Ag) are substances that the immune system recognizes and responds to Antigen means **foreign particles** (cells, soluble substances) and diversity in size and chemical composition .

Antigens can be proteins, glycoproteins, viruses, bacteria, parasites, etc., substances of various chemical that have the ability to alert the body's immune system to produce a specific immune response .

Immunogen

Immunogen : is a specific type of antigen; it is capable to induce an immune response and binds to the products of the immune response

The distinction between the terms is necessary because there are many compounds that are incapable of inducing an immune response, yet they are capable of binding with components of the immune system that have been induced specifically against

Although, All immunogens are antigens but not all antigens are immunogens because all immunogens can stimulate and binds to the components of immune system but not all antigens can induce the immune response.

The foreign substances that induce an immune response possess two properties:-

1- **Antigenicity** refers to the ability of a substance to bind specifically to antibodies or T cell receptors. An antigen is any molecule or molecular structure that can be recognized by the immune system, particularly by antibodies, B cells, or T cells. Antigenicity is a property of the antigen itself, indicating its capacity to be recognized by the immune system.

2-**Immunogenicity**, on the other hand, is the ability of a substance to provoke an immune response. This means that an immunogenic substance not only can bind to immune receptors (as an antigen) but also can trigger the immune reactions, including the activation of B cells and T cells, leading to the production of antibodies, memory cells, and other immune responses.

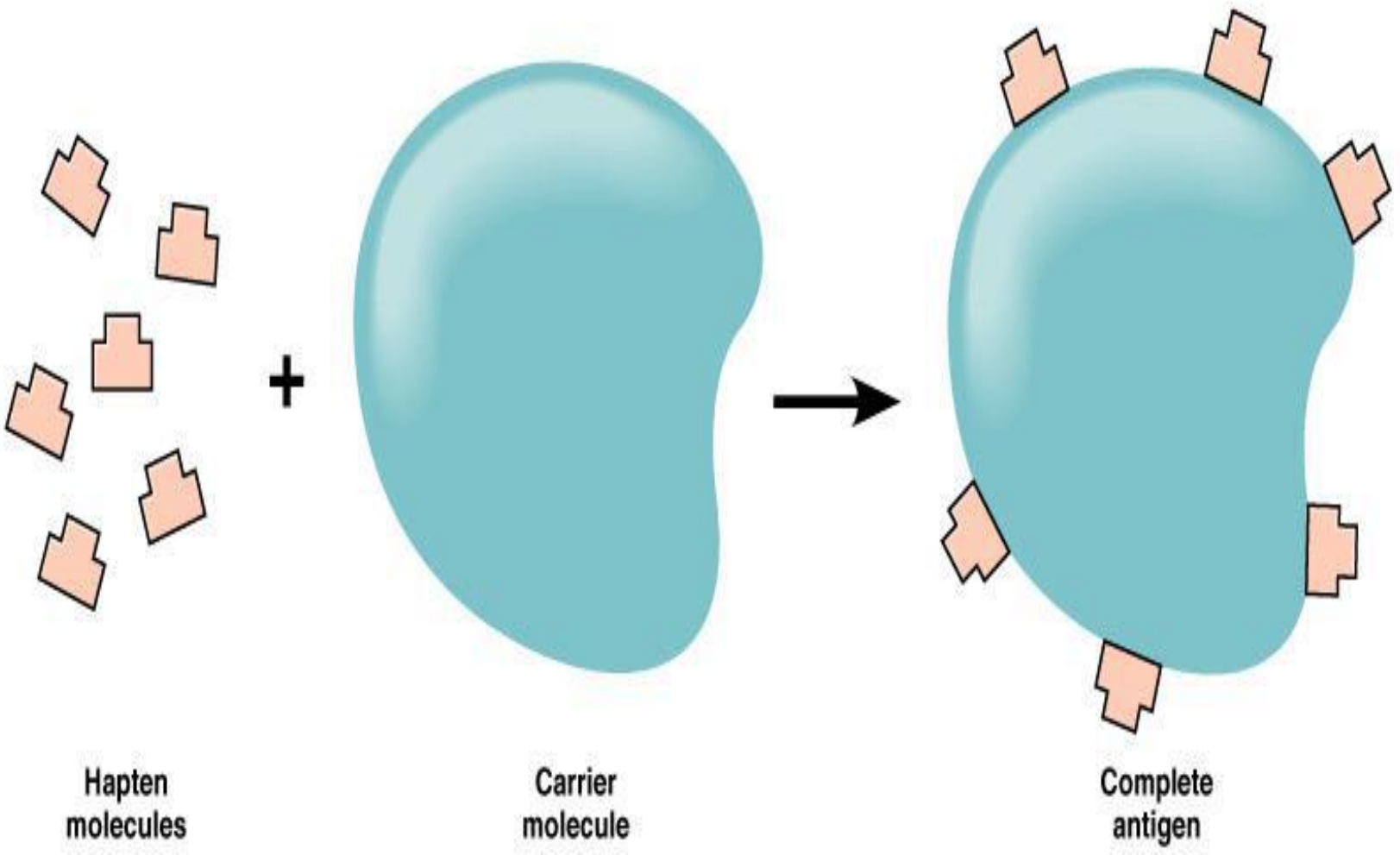
- All molecules that have the property of immunogenicity also have the property of antigenicity.

Hapten (Incomplete antigen)

- **Hapten** is a molecule or substance with low molecular weight (Non-immunogenic) that cannot induce an immune response on its own.
- However, if a hapten is combined with larger macromolecules (usually proteins) which serve as carriers then a response can be induced.

Hapten + carrier = complete antigen (immunogen)

- Examples of haptens are antibiotics, analgesics, penicillin and other low-molecular weight compounds
- The carrier molecules may be albumins, globulins, or synthetic polypeptides.


Hapten
molecules
Carrier
molecule
Complete
antigen

Types of antigen on the basis of their origin

1. Exogenous antigens

These antigens enter the body and start circulating in the body fluids and trapped by the APCs (Antigen processing cells such as macrophages, dendritic cells, etc.) • The uptakes of these exogenous antigens by APCs are mainly mediated by the phagocytosis. • Examples: bacteria, viruses, fungi etc.

2. Endogenous antigens

Endogenous antigens exist on cells inside the body. • These include cells that are infected with bacteria or a virus that mark themselves to be destroyed by the immune system.

3.Autoantigens

-An autoantigen is usually a normal protein or complex of proteins (and sometimes DNA or RNA) that is recognized by the immune system of patients suffering from a specific autoimmune disease.

• These antigens should not be, under normal conditions, the target of the immune system, but, due mainly to genetic and environmental factors, the normal immunological tolerance for such an antigen has been lost in these patients. •

Examples: Nucleoproteins, Nucleic acids, etc.

Types of antigen according to the functional groups

1. Complete Antigen or Immunogen

-Possess antigenic properties, they are able to generate an immune response by themselves.

-High molecular weight (more than 10,000 Daltons).

-May be proteins or polysaccharides

2. Incomplete Antigen or Hapten

-These are the foreign substance, usually non-protein substances unable to induce an immune response by itself,

-they require carrier molecule to act as a complete antigen.

The carrier molecule is a non-antigenic component and helps in provoking the immune response.

Example: Serum Protein such as Albumin or Globulin. • Low Molecular Weight (Less than 10,000 Daltons)

Epitopes (antigenic determinants)

Epitopes (also known as **antigenic determinant)** are the specific parts of the antigen that are recognized by immune receptors pecifically by **antibodies, B cells**, or **T cells**. Although epitopes are usually **non-self proteins,**

Each antigen can have multiple epitopes.

The epitopes of **protein** antigens are divided into two categories:

conformational epitopes and linear epitope

Factors influencing Immunogenicty

1- **Chemical complexity**

1-Proteins are usually very good immunogens.

2. Pure polysaccharides and lipopolysaccharides are good immunogens.

3. Nucleic acids are usually poorly immunogenic.

4. Lipids are non-immunogenic, although they may be haptens

2- **Foreignness**

- An antigen must be foreign to the host with which it makes contact to serve as an immunogen.

- The degree of immunogenicity is dependent upon the degree of foreignness.

- The greater the phylogenetic difference between species.

3- **Molecular weight**

- There is a correlation between molecular weight of substances and immunogenicity. High molecular weight increase immunogenicty that induces immune response.
- The best immunogens are in the range more than 10000 Dalton (Da.) and the most active immunogen is with 100000 Da., while the small molecules with 5-10,000 Dalton (Da.) are generally poor immunogens.

4- **Degradability**

- The molecules with the ability to biodegrade are the best immunogens to be presented by MHC molecules to activate T-cells (Ag processing by Ag-presenting cells (APC).
- Macromolecules that cannot be degraded and presented with MHC molecules are poor immunogens.
- Example such as polystyrene

5- **Rout of immunization**

The rout of antigen administration plays an important role in immunogenicity. According to high immunogenicity the routs divided as following:-

a- Intravenous (iv): into a vein (non-favorite route because it is minimize the immune response)

b- Intradermal (id): into the skin

c- Subcutaneous (sc): beneath the skin (best route)

d- Intramuscular (im): into a muscle (the best route because it is prolong the period of immune response)

e- Intraperitoneal (ip): into the peritoneal cavity (best route)

6- **Stability**

- The rigid structure of Ag plays an important role in the antigenicity.

- Ag with high stability acts as immunogen due to its ability to activate the immune response while the opposite is not immunogens because they are haven't a rigid structure enough to be stably bound by antibodies such as lipids and gelatin.

7- **Antigen dose**

- Too high or low dose of Ag will fail to activate enough immune response and cause immunologic unresponsiveness state (Tolerance)

- Appropriate dose of Ag cause optimum antigenicity

Adjuvants

in immunology, an **adjuvant** is a substance that increases or modulates the immune response to a vaccine.

The word "adjuvant" comes from the Latin word *adiuvare*, meaning to help or aid.

"An immunologic adjuvant is defined as any substance that acts to accelerate, prolong, or enhance antigen-specific immune responses when used in combination with specific vaccine antigens - Adjuvants are non-immunogenic alone but enhance the immunogenicity of other molecules

Types

1- Inorganic compounds: potassium alum, aluminium hydroxide, aluminium phosphate

2- Oils: paraffin oil,

3- **Organic adjuvants**

Freund's complete adjuvant is a solution of inactivated Mycobacterium tuberculosis in mineral oil developed in 1930.

It is not safe enough for human use. A version without the bacteria, that is only oil in water, is known as Freund's incomplete adjuvant. It helps vaccines release antigens for a longer time

Adjuvant augments the immune response through several ways:-

1- Prolong exposure to Ag: Adjuvants can increase the time of exposure from a few days to a few weeks.

2- Adjuvants also increase the size of the Ag and enhance the efficiency of macrophage processing of antigens (phagocytosis).

3- Increase the proliferation of T, B lymphocytes and macrophages which leads to increase the immune response.