


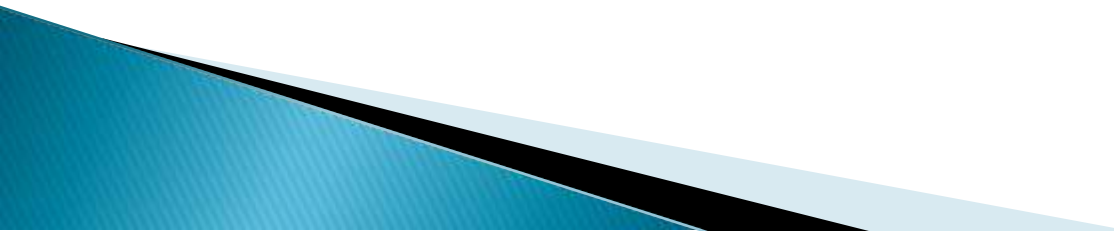
Department of Biotechnology

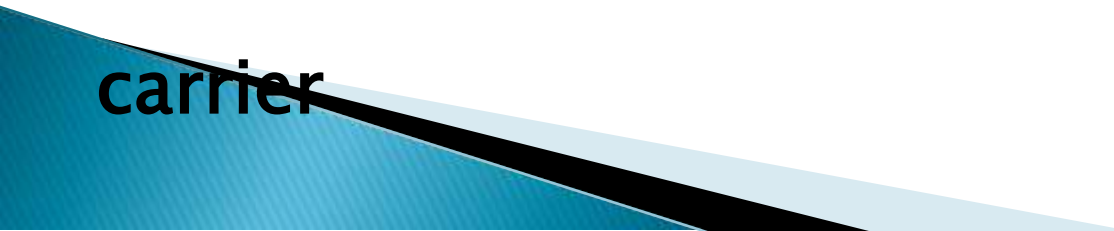
Antigen or Immunogen

By
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- ▶ **Antigen**– In simple words, antigens can be anything that doesn't belong to the body and are foreign.
 - ▶ **Substance that can generate immune response**
 - ▶ **Immunogen** –Molecule that is capable of eliciting immune response
 - ▶ **Antigens are indicated by the term 'Ag', and these can occur in different forms like pollen, viruses, chemicals, or bacteria.**
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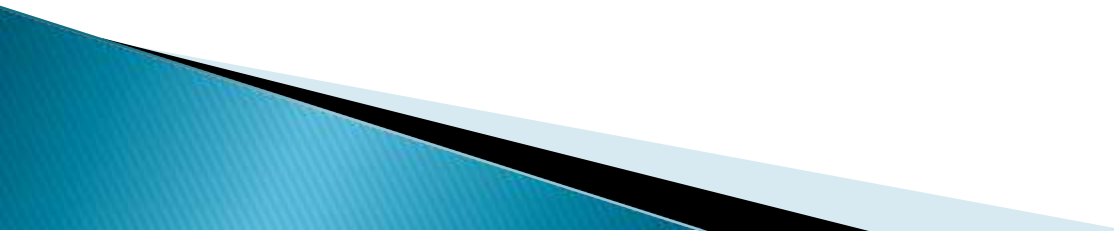
- ▶ **The concept of antigen arose from the fact that our body can distinguish between the components of the body and foreign particles.**
- ▶ **In response to these antigens, the body induces the production of antibodies that act against the said antigens.**
- ▶ **Most antigens in humans are proteins, peptides, or polysaccharides; however, lipid and nucleic acids can also act as antigens when combined with proteins or polysaccharides.**

- ▶ **In addition, antigens might also be intentionally introduced into the body in the form of vaccines in order to induce the adaptive immune system of the body against the antigen.**
 - ▶ **All immunogens are antigens but not all antigens are immunogens**
 - ▶ **Some very small molecules called haptens can bind to Ab's or TCR's but they cannot initiate an immune response**
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- **Immunogen:** a stimulus that produces a humoral or cell-mediated immune response
 - **Antigen:** any substance that binds specifically to an antibody or a T-cell receptor
 - **Epitope:** the portion of an antigen that is recognized and bound by an Ab or TCR/MHC complex (aka antigenic determinant)
 - **Hapten:** a low molecular weight molecule that can be made immunogenic by conjugation to a suitable carrier
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- ▶ Paratope: “The site in the variable (V) domain of an antibody or T-cell receptor that binds to an epitope on an antigen

Properties of Antigen

- Foreignness
 - Molecular size
 - Chemical composition and heterogeneity
 - Degradability
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Foreign Nature

- ▶ All antigens that induce an immune response in the host are foreign to the body of the recipient.
- ▶ The host body recognizes the antigen to be different from the normal body components.
- ▶ The immunogenicity of the antigen increases with the increase in the degree of foreignness. In the case of biological antigens, the foreignness increases with the increase in the phylogenetic gap between the two species.
- ▶ However, there are some exceptions in that some proteins occurring within the host might also induce an immune response, as in the case of autoantigens.
- ▶ Similarly, proteins and other molecules from other species might also not induce an immune response if they lack antigenic determinants or epitopes.

Chemical Nature

- ▶ The most potent and commonly encountered antigens are proteins followed by polysaccharides.
- ▶ However, other molecules like lipids and nucleic acids can also act as antigens when complex with proteins and polysaccharides.
- ▶ In the case of proteins, the antigen should contain immunogenic regions with at least 30% of amino acids like lysine, glutamine, arginine, glutamic acids, asparagine, and aspartic acid, along with a high number of hydrophilic or charged groups.
- ▶ The level of immunogenicity also increases with the heterogeneity of the molecules.
Homopolymers are usually less immunogenic than heteropolymers.


Molecular Size

- The molecular size of the antigens is also crucial in the immunogenicity of the molecules.
- It has been established that antigens should have a minimum size of greater than 5000 Da before they can be considered immunogenic.
- However, low molecular weight substances can demonstrate immunogenicity when coupled with large-sized carriers.
- The low molecular weight substances are termed haptens that are considered 'partial antigens' with at least one antigenic determinant.

4. Molecular Rigidity and Complexity

- The rigidity and complexity of molecules are essential factors that determine immunogenicity.
- In general, rigid molecules are good antigens as they can raise antibodies to certain structures when compared to the less rigid ones.
- The complexity of the structure is also an essential factor as a peptide antigen with a repeating unit of a single amino acid is less immunogenic than a molecule with two or more repeating amino acids units.

Antigenic Determinants and Cross-reactivity

- Antigenic determinants are regions in an antigen molecule that is involved in the reaction with antibodies.
 - Usually, antigens with two or more antigenic determinants can induce antibody production. Thus, a smaller antigen usually doesn't induce antibody production as it is not possible for a small molecule to have more than one antigenic determinant.
 - Cross-reactivity of antigens is also an essential factor where antibodies induced by a different antigen can interact with another antigen.
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Types of Antigens

Antigens can be grouped into different types based on different factors. Some of the common classifications are based on the origin of the antigen and its immunogenicity.

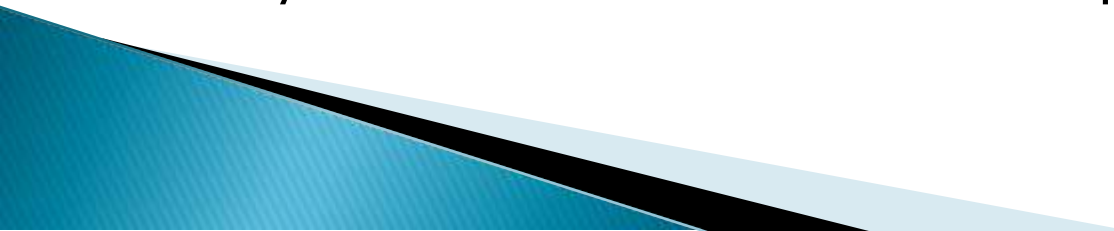
1. Types of antigen–based on their origin

Antigens can be classified into two groups on the basis of their origin;

a. Exogenous Antigens

- Exogenous antigens are the antigens that are originated outside the body of the host and, thus, are foreign to the host.
- These antigens might enter the body through inhalation, ingestion, or injection and then circulate throughout the body via bodily fluids.
- The uptake of exogenous antigens is primarily mediated by phagocytosis via Antigen Processing Cells (APCs) like macrophages, dendritic cells, etc.
- Many antigens like intracellular viruses might begin as exogenous antigens and later become endogenous.


b. Endogenous Antigens

- Endogenous antigens are antigens that originate within the body of the host during metabolism or as a result of intracellular viral or bacterial infection.
 - Endogenous antigens are usually the cells of the body or fragments, compounds, or antigenic products of metabolism.
 - These are usually processed in the macrophages and are later detected by cytotoxic T-cells of the immune system.
 - Endogenous antigens include antigens that are xenogenic or heterologous, autologous, and idiotype or allogenic.
 - Endogenous antigens might result in autoimmune diseases as the host immune system detects its own cells and particles as immunogenic.
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Autoantigens

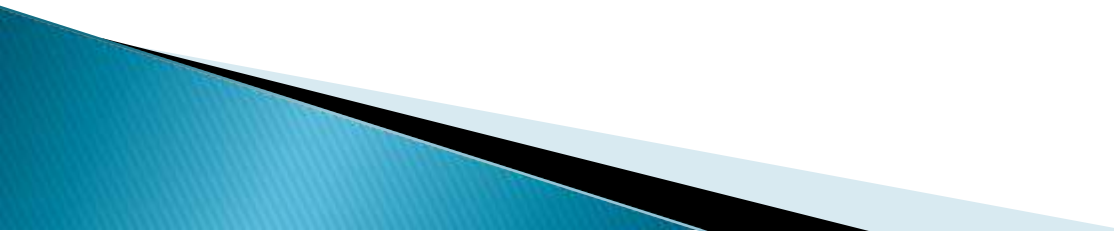
- Autoantigens are proteins or protein complexes of the host that are attacked by the host's immune system, resulting in autoimmune disease.
- Autoantigens can be deadly to the host as the body's own cells should not be targeted by the immune system.
- The immunological tolerance to such antigens is lost as a result of genetic and environmental factors.

Tumor Antigens (Neoantigens)

- Tumor antigens or neoantigens are presented by Major Histocompatibility Complex (MHC) I and II on the surface of tumor cells.
 - The antigens are produced as a result of a tumor-specific mutation during the malignant transformation of normal cells.
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- These antigens usually do not induce an immune response as the tumor cells develop ways to evade antigen presentation and immune defense.

Native Antigens

- Native antigens are antigens that are not processed by any antigen-presenting cells (APC), and thus immune cells like T-cells cannot bind to these antigens.
 - However, B-cells can be activated such antigens even without any processing.
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. **Types of antigens on the basis of immune response**

Antigens can be classified into two distinct groups on the basis of immune response;

a. Complete antigens/ Immunogens

Complete antigens or Immunogens are antigens that elicit a specific immune response.

These antigens can induce an immune response by themselves without any carrier particles.

These are usually proteins, peptides, or polysaccharides with high molecular weight (greater than 10,000 Da).

b. Incomplete antigens/ Haptens


Incomplete antigens or haptens are antigens that cannot generate an immune response by themselves.

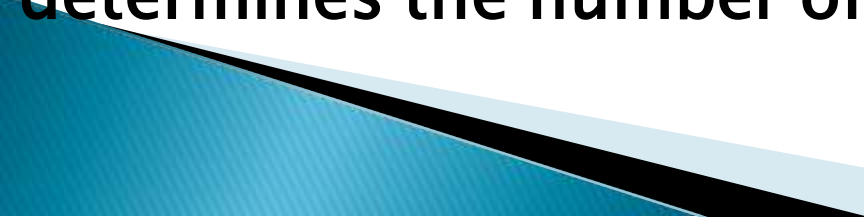
These are usually non-protein substances that require a carrier molecule to form a complete antigen.


Haptens have a low molecular weight (usually less than 10,000 Da) and fewer antigenic determinant sites.

The carrier molecule bonded to the hapten is considered a non-antigenic component and is a protein or a polysaccharide molecule.

Antigen Structure

- The molecular structure of an antigen is characterized by its ability to bind to the antigen–binding site of an antibody.
 - Antibodies differentiate between different antigens on the basis of the specific molecular structures present on the surface of the antigen.
 - Most antigens are proteins or polysaccharides. These can include coats, capsules, flagella, toxins, and fimbriae of bacteria, viruses, or other microorganisms. Besides, secretions and other chemicals of the same nature can also act as antigens.
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- Lipids and nucleic acids of these microorganisms are only antigenic when these are combined with proteins or polysaccharides.
 - The structure of antigens might be different depending on the nature of the antigen, their size, and immunogenicity.
 - All immunogenic antigens have a specific structural component called epitope or antigenic determinant.
 - The number of epitopes differs in different antigens and determines the number of antibodies
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- The number of epitopes differs in different antigens and determines the number of antibodies a single antigen can bound to.
 - The structural components of interaction in antigens are different, which determines the classes of antibodies they bound to.
 - The region on antibodies that interacts with antigens is called a paratope. It has been established that the structure of epitope and paratope can be defined with a lock and key metaphor as the structures are specific and fit with one another.
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Thank You