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DEPARTMENT OF BIOTECHNOLOGY
FACULTY OFENGINEERING & TECHNOLOGY

LT.5 Nature of antigen, immunogenicity, antigenicity

Content Outline

1. Nature of antigen
2. Immunogenicity
3. Test your understanding
4. References & Further reading

LT.5 Nature of antigen

➢**Antigen** is a substances usually protein in nature and sometimes polysaccharide, that generates a specific immune response and induces the formation of a specific antibody or specially sensitized T cells or both.

➢An **immunogen** is any antigen that is capable of inducing humoral and/or cell-mediated immune response rather than immunological tolerance. This ability is called immunogenicity. Sometimes the term **immunogen** is used interchangeably with the term antigen. But only an **immunogen** can evoke an immune response.

Antigen Vs Immunogen

Immunogen is a stimulus that produces a humoral or cell-mediated immune response, whereas **antigens** are any substance that binds specifically to an antibody or a T-cell receptor.

Epitope is immunologically active regions of an immunogen (or antigen) that binds to antigen-specific membrane receptors on lymphocytes or to secreted antibodies. It is also called **antigenic determinants.**

Autoantigens, for example, are a person's own self antigens. Examples: Thyroglobulin, DNA, Corneal tissue, etc.

Alloantigens are antigens found in different members of the same species (the red blood cell antigens A and B are examples).

Heterophile antigens are identical antigens found in the cells of different species. Examples: Forrssman antigen, Cross-reacting microbial antigens, etc.

Adjuvants are substances that are non-immunogenic alone but enhance the immunogenicity of any added immunogen.

Chemical Nature of Antigen

Chemical Nature of Antigens (Immunogens)

A. Proteins

The vast majority of immunogens are proteins. These may be pure proteins or they may be glycoproteins or lipoproteins. In general, proteins are usually very good immunogens.

B. Polysaccharides

Pure polysaccharides and lipopolysaccharides are good immunogens.

C. Nucleic Acids

Nucleic acids are usually poorly immunogenic. However, they may become immunogenic when single stranded or when complexed with proteins.

D. Lipids

In general lipids are non-immunogenic, although they may be haptens.

Types of Antigen

Types of Antigen On the basis of order of their class (Origin)

1. Exogenous antigens

These antigens enters the body or system 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

Some antigens start out as exogenontigens, and later become endogenous (for example, intracellular viruses)

2. Endogenous antigens

These are body's own cells or sub fragments or compounds or the antigenic products that are produced.

The endogenous antigens are processed by the macrophages which are later accepted by the cytotoxic T – cells.

Endogenous antigens include xenogenic (heterologous), autologous and idiotypic or allogenic (homologous) antigens.

Examples: Blood group antigens, HLA (Histocompatibility Leukocyte antigens), etc.

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.

On the basis of immune response

1. Complete Antigen or Immunogen

Posses antigenic properties denovo, i.e. ther are able to generate an immune response by themselves.

High molecular weight (more than 10,000)

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)

•Haptens can react specifically with its corresponding antibody.

•Examples: Capsular polysaccharide of pneumococcus, polysaccharide “C” of beta haemolytic streptococci, cardiolipin antigens, etc.

Determinants of Antigenicity

The whole antigen does not evoke immune response and only a small part of it induces B and T cell response.

The small area of chemical grouping on the antigen molecule that determines specific immune response and reacts specifically with antibody is called an ***antigenic determinant.***

Property of antigens/ Factors Influencing Immunogenicity

Immunogenicity is determined by:

1. Foreignness

An antigen must be a foreign substances to the animal to elicit an immune response.

2. Molecular Size

The most active immunogens tend to have a molecular mass of 14,000 to 6,00,000 Da.

Examples: tetanus toxoid, egg albumin, thyroglobulin are highly antigenic.

Insulin (5700) are either non-antigenic or weakly antigenic.

3. Chemical Nature and Composition

•In general, the more complex the substance is chemically the more immunogenic it will be.

•Antigens are mainly proteins and some are polysaccharides.

•It is presumed that presence of an aromatic radical is essential for rigidity and antigenicity of a substance.

5. Antigen Specificity

Antigen Specificity depends on the specific actives sites on the antigenic molecules (Antigenic determinants).

Antigenic determinants or epitopes are the regions of antigen which specifically binds with the antibody molecule.

6. Species Specificity

Tissues of all individuals in a particular species possess, species specific antigen.

Human Blood proteins can be differentiated from animal protein by specific antigen-antibody reaction.

7. Organ Specificity

•Organ specific antigens are confined to particular organ or tissue.

•Certain proteins of brain, kidney, thyroglobulin and lens protein of one species share specificity with that of another species.

8. Auto-specificity

The autologous or self antigens are ordinarily not immunogenic, but under certain circumstances lens protein, thyroglobulin and others may act as ***autoantigens.***

9. Genetic Factors

•Some substances are immunogenic in one species but not in another .Similarly, some substances are immunogenic in one individual but not in others (i.e. responders and non-responders).

•The species or individuals may lack or have altered genes that code for the receptors for antigen on B cells and T cells.

•They may not have the appropriate genes needed for the APC to present antigen to the helper T cells.

10. Age

Age can also influence immunogenicity.

Usually the very young and the very old have a diminished ability to elicit and immune response in response to an immunogen.

11. Degradability

Antigens that are easily phagocytosed are generally more immunogenic.

This is because for most antigens (T-dependant antigens) the development of an immune response requires that the antigen be phagocytosed, processed and presented to helper T cells by an antigen presenting cell (APC).

12. Dose of the antigen

The dose of administration of an immunogen can influence its immunogenicity.

There is a dose of antigen above or below which the immune response will not be optimal.

13. Route of Administration

Generally the subcutaneous route is better than the intravenous or intragastric routes.

The route of antigen administration can also alter the nature of the response.

Antigen administered intravenously is carried first to the spleen, whereas antigen administered subcutaneously moves first to local lymph nodes.

14. Adjuvants

Substances that can enhance the immune response to an immunogen are called adjuvants.

The use of adjuvants, however, is often hampered by undesirable side effects such as fever and inflammation.

Example: aluminum hydroxide.

References & Further reading

References

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