Introduction to Immunity

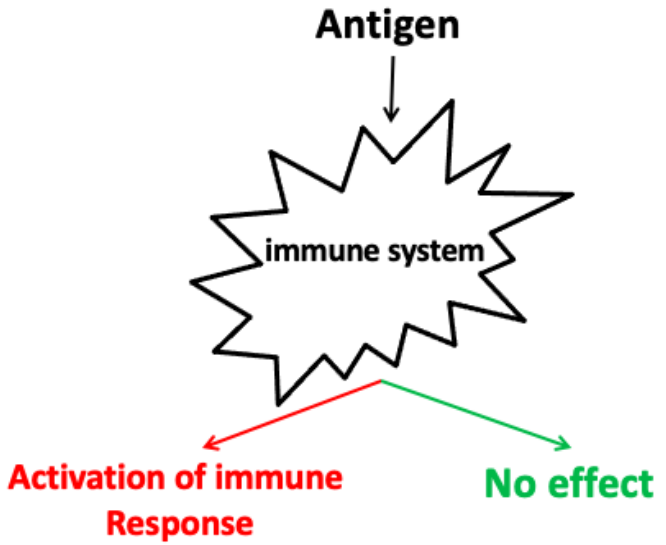
MEDEMIA ACADEMY

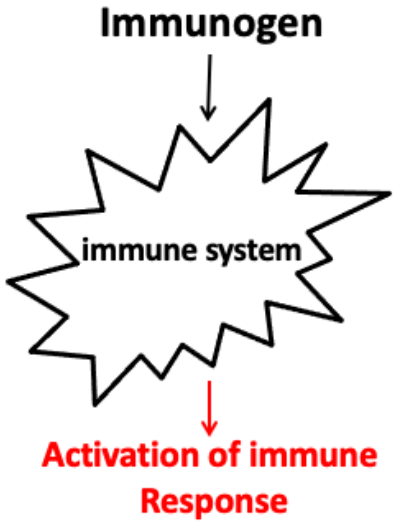
Introduction

- The earliest known reference to immunity was during the plague of Athens in 430 BC.
- In the 18th century, scientists made experiments with scorpion venom and observed that certain dogs and mice were immune to this venom.
- **Immunology:** the study of the components and function of the immune system.
- **Immune system:** molecules, cells, tissues and organs which provide non-specific and specific protection against microorganisms, microbial toxins, and tumor cells.

Antigen Vs Immunogen

- **Antigen:** any molecule that can react with the immune system (without the necessity of inducing an immune response).
- **Immunogen:** is a substance capable of inducing a specific immune response, resulting in the formation of antibodies or active white blood cells.
- All immunogens are antigens, but not all antigens are immunogens.
- The distinction between antigen and immunogen is functional.
  - Example:
    - A person with **blood group A** accidentally receiving a **type B blood** unit from a donor (homologous/ allogenic donation), is going to have an immune response (blood antigens from donor are immunogens).
    - A person with **blood group A** receiving a unit from his own blood that was previously stored for him in the blood bank (autologous donation), isn't going to have an immune response.





Factors Affecting Immunogenicity

I. Nature of the immunogen

i. Foreigness (compounds that are part of self are not immunogenic to the individual).

ii. Molecular weight

- A minimal molecular weight is required for a compound to be immunogenic.
- **< 1000 Daltons:** not immunogenic (penicillin, progesterone, aspirin).
- **1000-6000 Daltons:** may or may not be immunogenic (insulin).
- **> 6000 Daltons:** are immunogenic (albumin, tetanus toxin).

iii. Chemical structure complexity

- Immunogens that are homopolymers (all monomers are identical) (e.g starch) are less immunogenic compared to heteropolymers (the monomers are not identical/ containing two or more different monomers).
- Amino acids (least immunogenic) → Haptens → Lipids → Steroids → Carbohydrates → Proteins (the most immunogenic).

Factors Affecting Immunogenicity Cont.

II. Biological factors

i. **Dosage**

ii. **Route of administration** (subcutaneous > intravenous > intragastric)

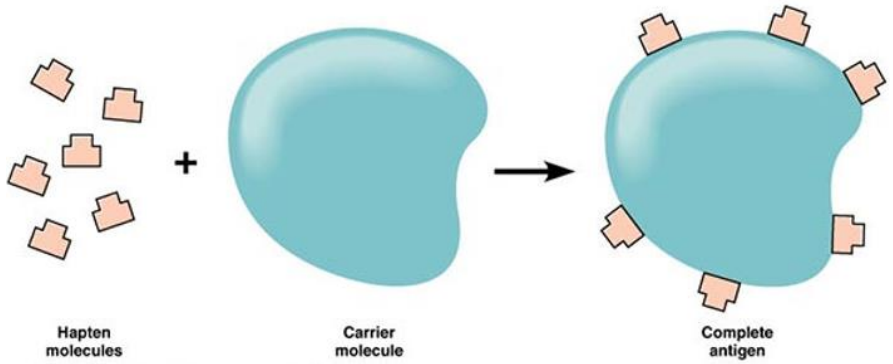
iii. **Individual genetic difference**

iv. **Adjuvants**

- Substances that when mixed with an immunogen (usually added to vaccines) enhance the immune response against the immunogenwithout altering their chemical composition (Immunopotentiator/ Immuno-booster).
- **Examples:** inorganic compounds (alum, aluminum hydroxide), mineral oil (paraffin oil), bacterial products (killed bacteria Bordetella pertussis, Mycobacterium bovis, toxoids), Freund's complete adjuvant and incomplete adjuvant.
- **They potentiate the immune response by:**
  - Extending the presence of Ag in the blood.
  - Helping the Ag uptake by macrophages.
  - Activating macrophages and lymphocytes.
  - Supporting the production of cytokines.

Haptens

- **Haptens** are partial antigens with very low MW, that themselves cannot cause the activation of an immune response (lymphocytes or antibodies) (too small to be immunogenic), but does react with products of that response.
- **Examples:** antibiotics, analgesics, and other low MW compounds.
- If a hapten is coupled to a larger carrier molecule (albumin, globulins, or synthetic polypeptides) it becomes immunogenic (a complete Ag).
- Certain haptens possess the ability to form spontaneous covalent bonds with self proteins to create new antigens in vivo called **auto-coupling haptens.** These bonds are the basis for autoimmune diseases and drug allergy.

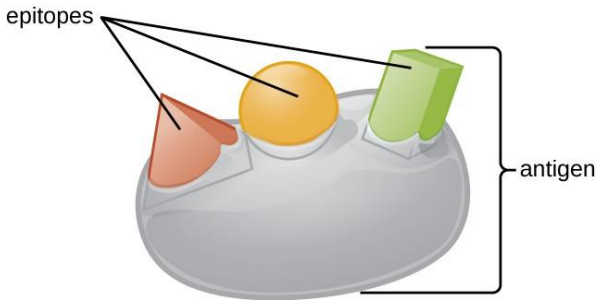


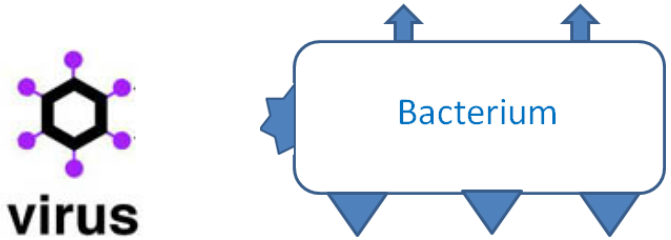
Haptens Cont.

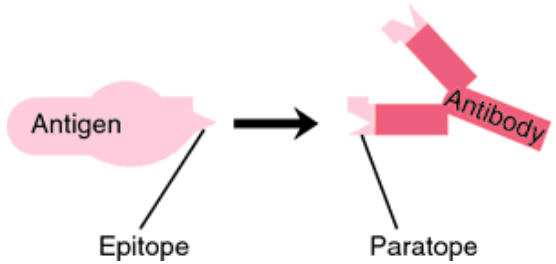
- **Drug allergy:** adverse immunological reactions to certain antigens, particularly antibiotics, can be a significant medical problem (e.g. people die from anaphylactic reactions to penicillin).
- In clinical medicine haptens such as penicillin can cross react with self-proteins causing an **allergic response.**
- Penicillin can form a hapten-carrier conjugate with self-protein that can then act as an immunogen and generate an IgE antibody. IgE antibodies will bind to mast cells. During the second exposure, penicillin will bind directly to IgE and activate mast cell degranulation.
- IgE cross reactivity: unfortunately, some anti-penicillin IgE antibodies also cross-react with other antibiotics with similar structures as cephalosporins and carbapenems. This can complicate the treatment of bacterial infections in these patients since they are unable to take the antibiotics necessary to combat the infection.

Epitopes

- **Epitopes:**
  - The smallest part of an antigen that is seen by immune cells, or antibodies.
  - Called antigenic determinants.
  - Are very small (e.g. just 4 or 5 a.a or monosaccharide residues)
  - Epitopes and haptens are similar, but while a hapten is artificially added to a molecule, an epitope is an integral part of the native molecule.
- **Paratope**
  - Also known as an antigen-binding site, is the part of an antibody which recognizes and binds to an antigen.

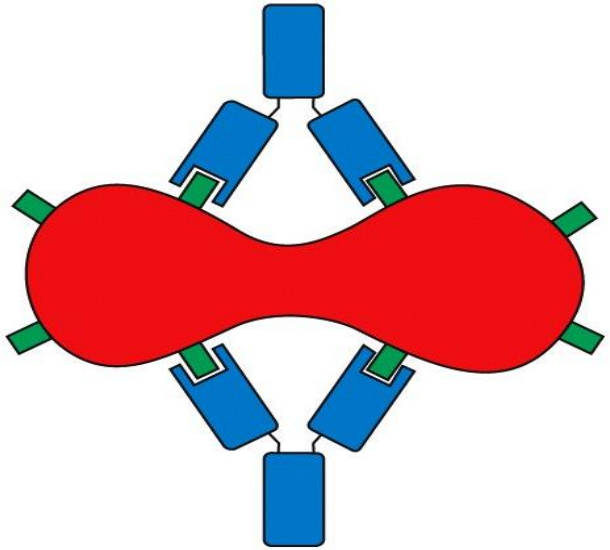




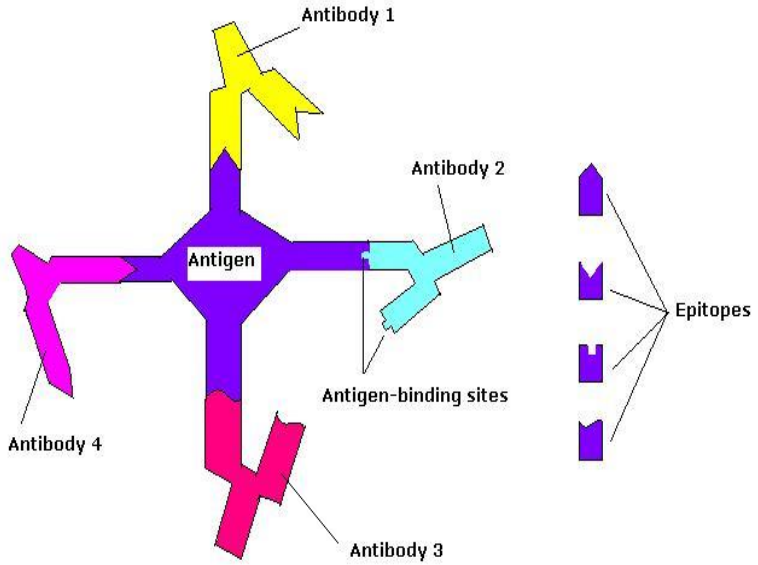


Epitopes Cont.

- **Polyvalent antigens:** antigens with many epitopes of different specificities.
- **Multivalent antigens:** antigens with many epitopes of the same specificities.
- An antigen molecule carries a number of different epitopes that specify different antibodies



Multivalent Ag with similar epitopes



Polyvalent Ag with different epitopes

Characteristics of The Immune Response

- **Specificity:** the ability to discriminate among different molecular entities rather than making a random, undifferentiated response.
- **Discrimination** between “self” and “non-self” antigens.
- **Memory:** the ability to recall previous contact with a foreign molecule and respond to it in a learned manner (more rapid and larger response).

Routes of Acquiring Immunity

Acquired Immunity			
Naturally acquired		**Artificially acquired**	
Active	**Passive**	**Active**	**Passive**
Ags enter the body naturally, then the body induces Abs and specialized lymphocytes (e.g. infection) Provide long term protection	Abs pass from mother to fetus (via placenta) or to the infant (via milk) Provides intermediate short term protection	Ags are introduced in vaccines, then the body produces Abs and specialized lymphocytes (e.g. Hepatitis B vaccine) Provide long term protection	Preformed Abs in immune serum are introduced by injections (e.g. Hepatitis B immunoglobulin) Provides intermediate short term protection

- **Active immunity**: a rection of your own immune system.
- **Passive immunity**: borrowed immune agents from another person.
- **Adoptive Immunity**: refers to the transfer of immunity by the transfer of immune cells

MCQ

❖Active artificially acquired immunity is a result of :

a. Vaccination.
b. Contact with a pathogen.
c. Antibodies passed on from mother to fetus through the placenta.
d. Injection of an immune serum.
e. Antibodies passed on from mother to baby through breast milk.

MCQ

- Which of the following foreign body characteristics lead to immune response?
  a. High biodegradability
  b. Haptens
  c. Low biodegradability
  d. Additive food
  e. Low molecular weight