Immunology Course

Faculty of Medicine

Lecture 1

2024-2025

Introduction to Immunology

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Learning objectives

Definitions
History highlights

Define and describe the characteristics of:
Antigen
Immunogen
Hapten
Epitope
adjuvant

Identify the factors that affect the immunogenicity

Differentiate between active, passive, and adoptive immunity

What is immunology?

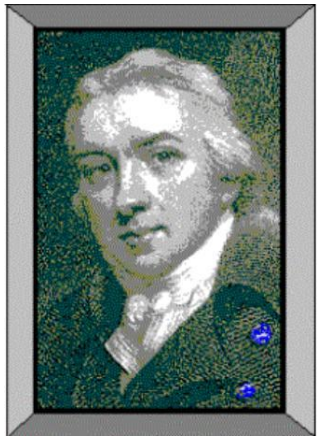
- **Immune** (Latin- “immunus”)
  - To be free
- **Immunity:** The state of protection from infectious disease
- **Immune System**: Molecules, cells, tissues and organs which provide non-specific and specific protection against
  - Bacteria- Viruses- Fungi- Parasites- Toxins

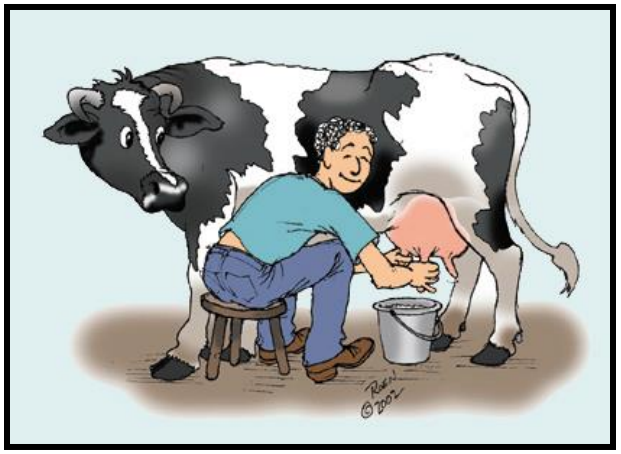
Historical Events in Immunology

The earliest known reference to immunity was during the plague of Athens in 430 BC

- 1796-Edward Jenner (smallpox)
- 1881-Loius Pasteur (vaccines)
- 1884-Elie Metchnikoff (phagocytes)
- 1890-Emil von Behring (antibodies)
- 1895-Jules Bordet (complement)
- 1960-McFarlane Burnet (tolerance)
- 1975-Cesar Milstein (monoclonal Ab)
- 1996-Peter Doherty Rolf Zinkernagel (MHC)

1796 Edward Jenner





Observation:

Milkmaids who contracted cowpox (a mild disease) were subsequently immune to small pox

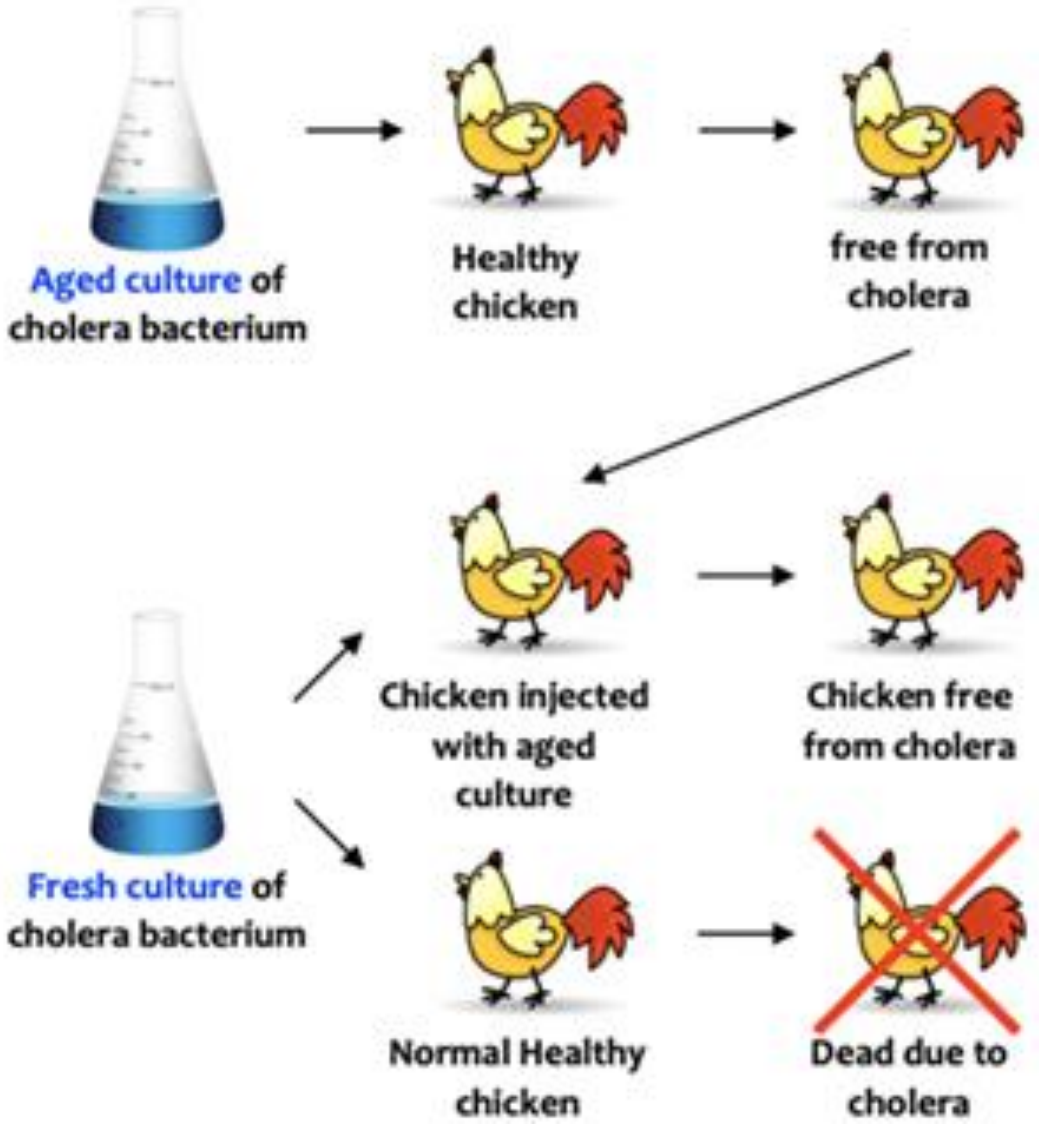
Profound results:

(1) Jenner's technique of inoculating with cowpox to protect against small pox spread quickly throughout Europe.

(2) Began the science of Immunology, the study of the body's response to foreign substances.

1881-Loius Pasteur (vaccines)

Aging had weakened the virulence of the pathogen and that such an attenuated strain (called vaccine)
might be administered to protect against disease.



Immunology definitions

- **Antigen (Ag):** any substance (usually foreign) that binds specifically to a component of adaptive immunity.
- **Immunogen:** any substance capable of eliciting an immune response**.** All immunogens are antigen, but some antigens are not immunogens.
- **Antibody (Ab)**
  - Secreted immunoglobulin from plasma
- **Vaccination:** induction of protective immunity to a pathogen
- **Immunization:** the ability to resist infection

Immunology definitions

- **Allergen**: noninfectious antigens that induce hypersensitivity reactions.
- **Innate immunity**: nonspecific host defenses that exist prior to exposure to Ag.
- **Adaptive Immunity**: host defenses that are mediated by T & B cells following exposure to Ag with antibody production.
- **Epitope (antigenic determinant)**: the portion of Ag that is recognized and bound by an antibody (Ab) or T cell receptor.
- **Pathogen**: a disease causing organism

Basic definitions

Antigens

Immunogens

Haptens

Epitope

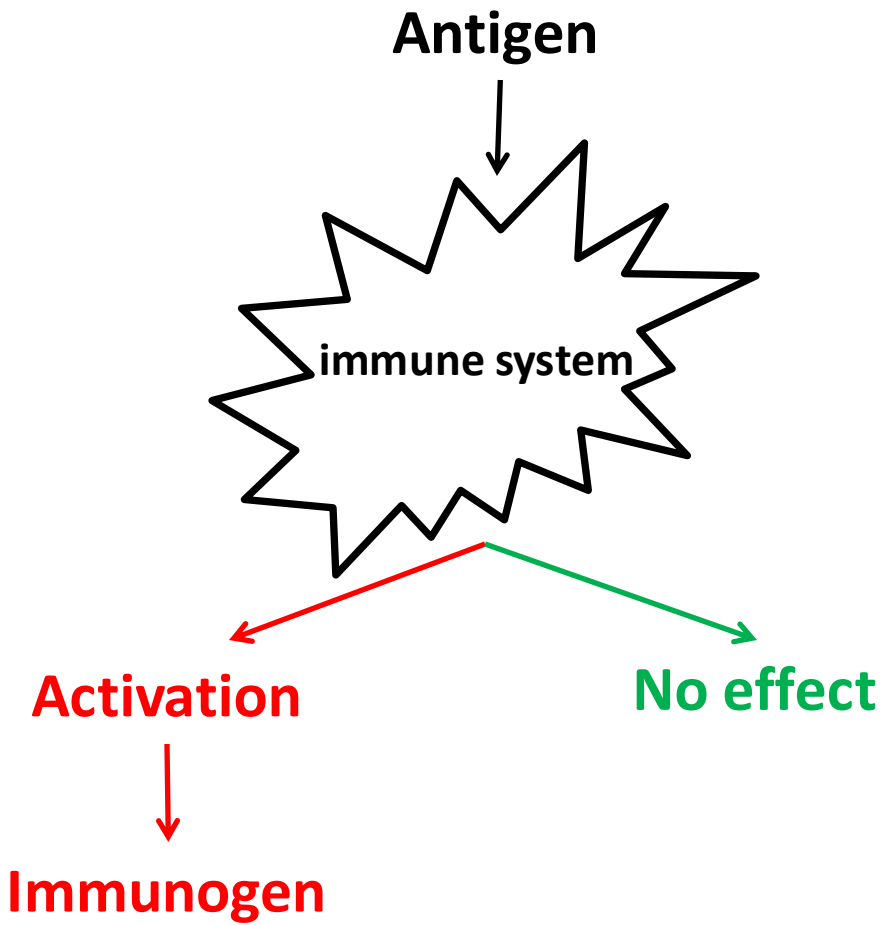
Adjuvant

Antigens

Antigen

- Antigens are carbohydrate or proteins found on the surface of all types cells.
- Antigens can be
  - Endogenous,
  - Exogenous.
- An antigen capable of inducing a specific immune response is called immunogen (immune response generating antigen).

Antigens vs. Immunogens



Immunogen: is a substance capable of inducing a specific immune response, resulting in the formation of antibodies or immune lymphocytes.

Antigens & Immunogens

Blood antigens in this case are considered Non-immunogens

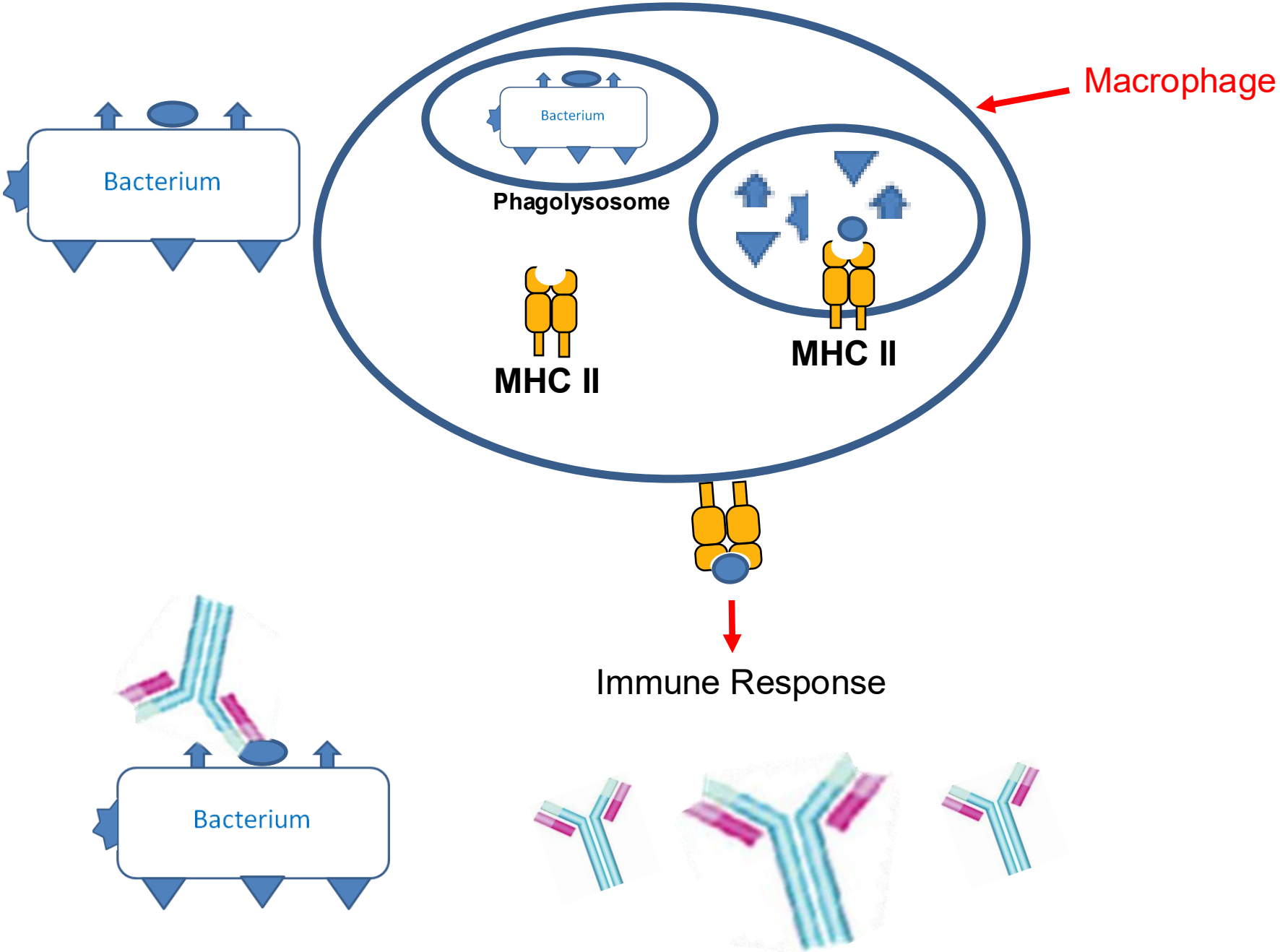
Blood group A

Blood group B

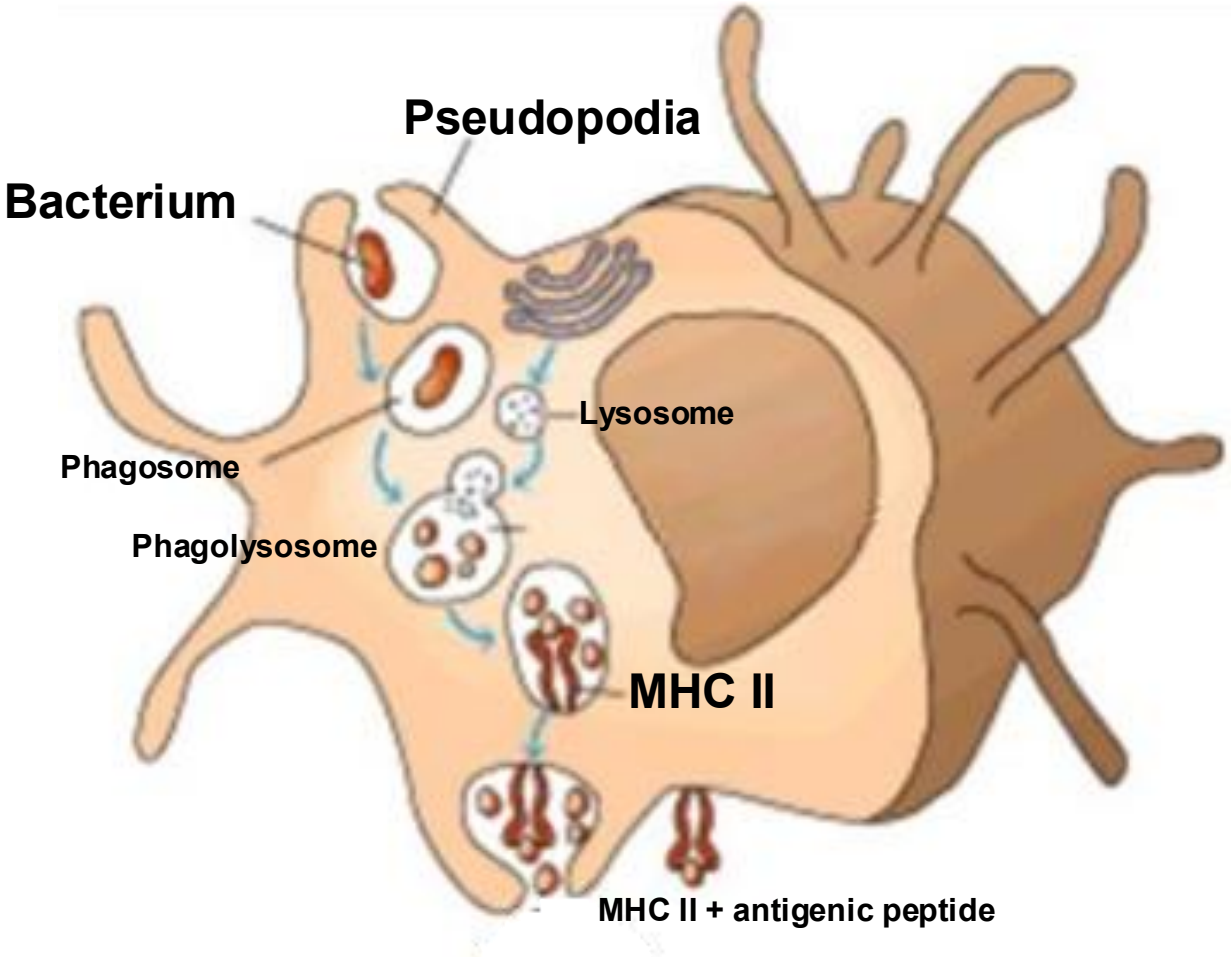
Blood antigens in this case are considered immunogens

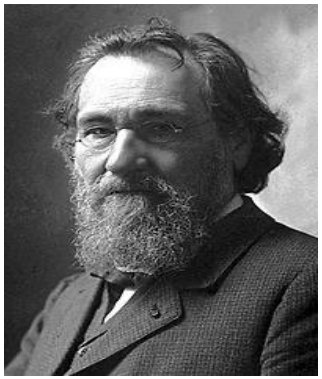
Antigenic Determinants (Epitopes)

Antigenic Determinants (Epitopes)



Phagocytosis





Ilya Ilyich Mechnikov who discovered macrophages and the phenomenon of phagocytosis.
Was awarded the 1908 Nobel Prize in Medicine
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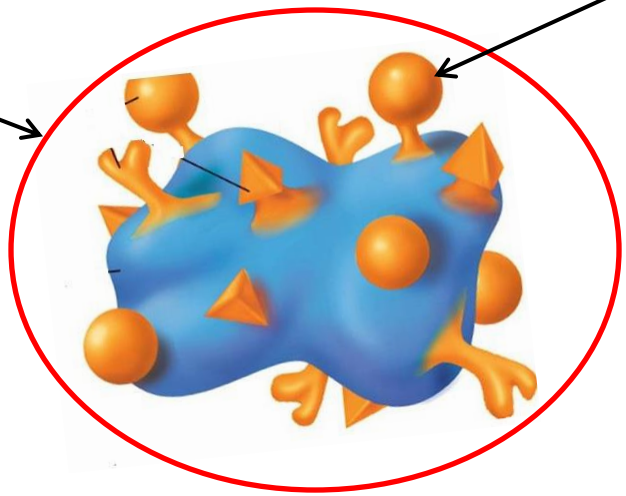
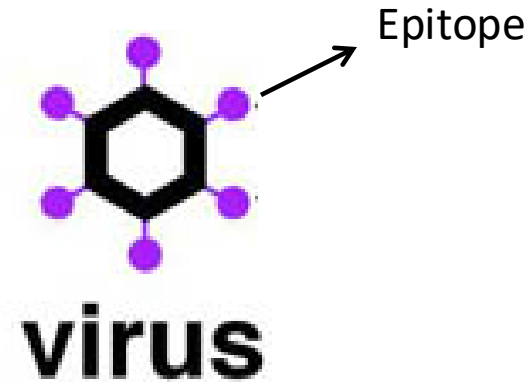
Antigenic Determinants (Epitopes)

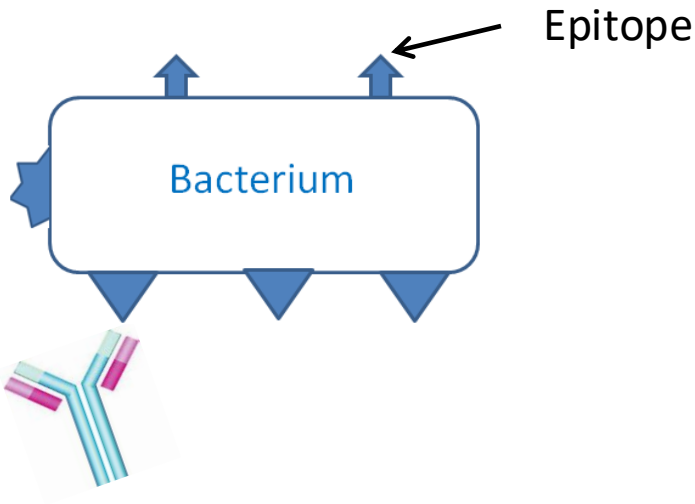
Bacteria
(Whole Antigen)



Antigenic Determinants (Epitope)

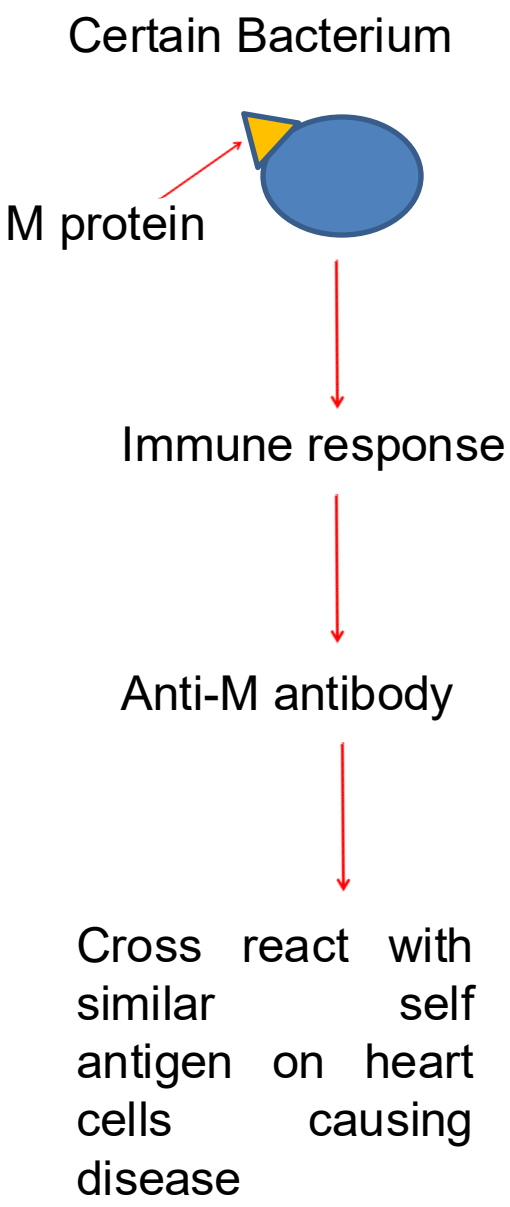
specific regions on an antigen (a foreign substance) that are recognized by and bind to the immune system's receptors, such as Ab or T cells





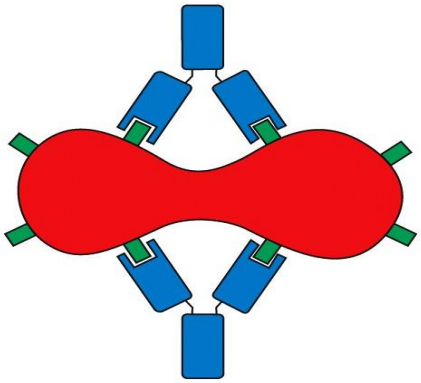
Antigenic Determinants (Epitopes)

- Composition of antigenic determinants may consist of:
  - several amino acids of a protein molecule
  - Or several monosaccharide units of a polysaccharide.
- Types of antigens.
  - **Autoantigens**: are the self antigens.
  - **Alloantigens** are different genetic forms of the same antigen within a species (eg, blood group antigens).
  - **Heterophile** antigens are identical antigens found in the cells of different species.



Antigenic Determinants (Epitopes)

Antigens with many epitopes of different specificities are called polyvalent while antigens with many epitopes of the same specificities are called multivalent



multivalent antigen with similar epitopes

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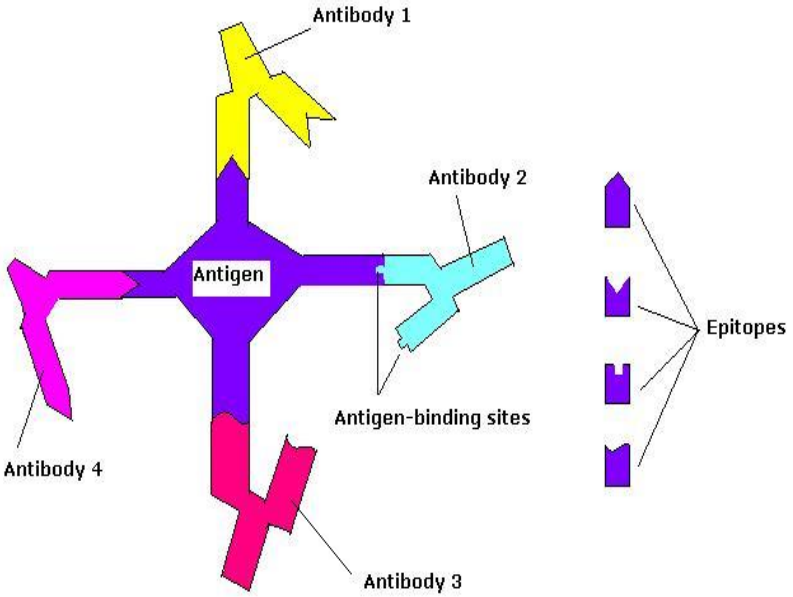
One type of antibody



polyvalent antigen with different epitopes

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More than one type of antibody

Factors contributing to immunogenicity

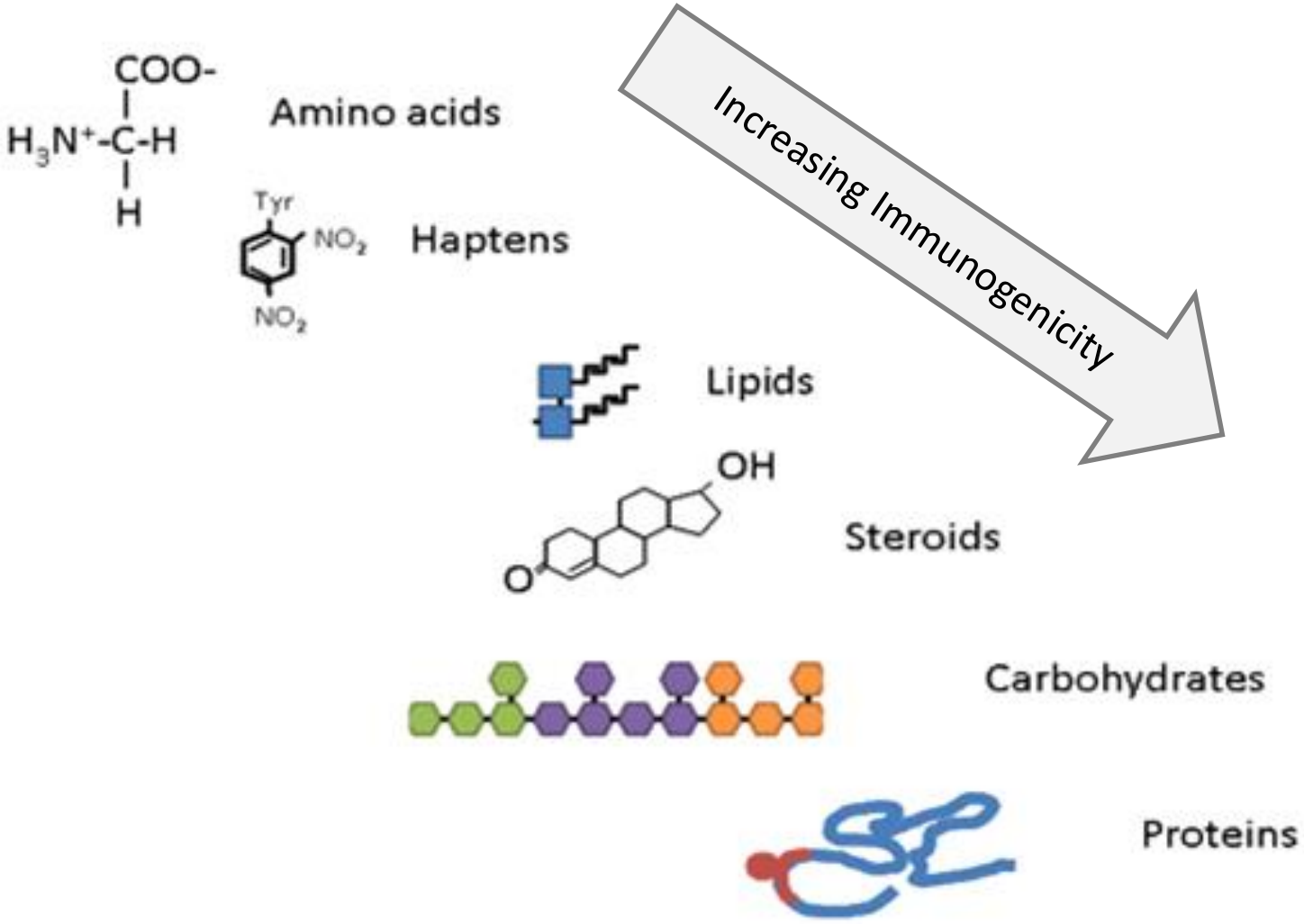
Antigen itself:
Foreignness
Molecular size (Antigen vs hapten)
Chemical composition and heterogeneity
Susceptibility to Ag processing and presentation

Biological system:
Genotype:
high/low responder

Route
Dosage
Adjuvant

Route of administration
Subcutaneous > Intravenous > Intragastric

Factors contributing to immunogenicity



Adjuvants

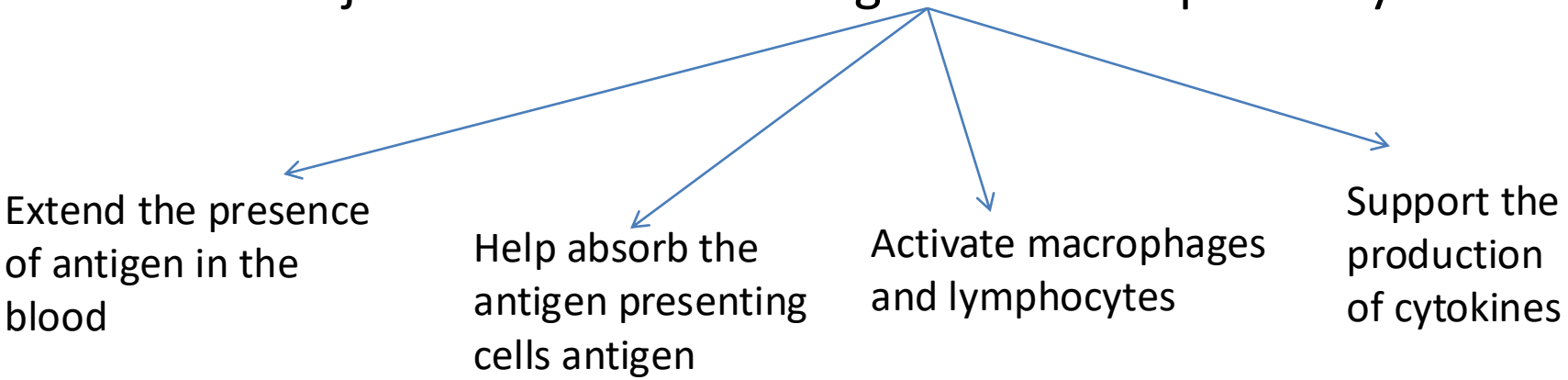
Substances which when mixed with an immunogen enhance the immune response against the immunogen

Examples

a. Inorganic compounds: alum, aluminum hydroxide
b. Mineral oil: paraffin oil
c. Bacterial products: killed bacteria Bordetella pertussis, Mycobacterium bovis, toxoids
d. Freund's complete adjuvant, Freund's incomplete adjuvant

Mode of action

Vaccine + adjuvant = Potentiating immune response by



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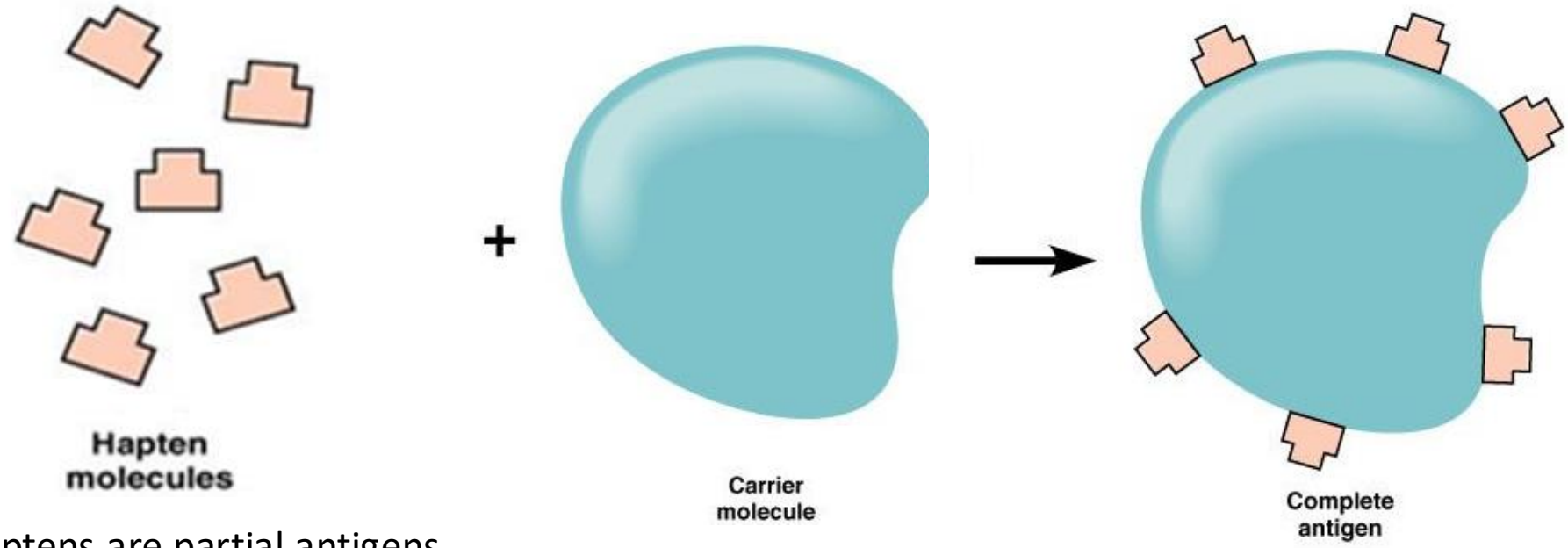
Haptens



Haptens are partial antigens that themselves cannot cause the production of immune lymphocytes or antibodies (too small to be immunogenic).

e.g., antibiotics, analgesics, and other low-molecular weight compounds.

If a hapten is coupled to a larger carrier molecule as albumins, globulins, or synthetic polypeptides it becomes immunogen

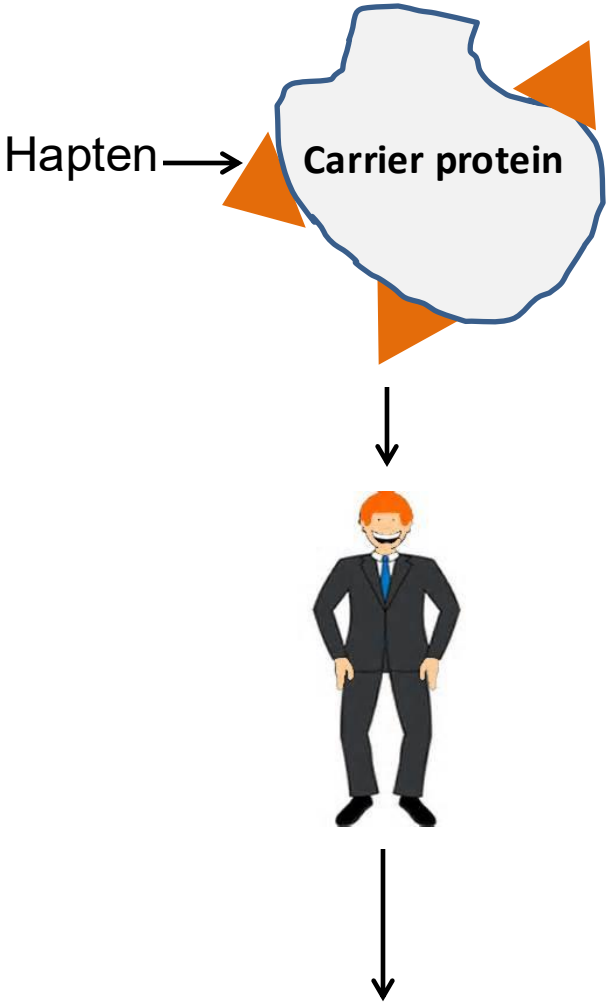
complete antigen (immunogen)

Haptens

Hapten

No activation for
immune response
No antibody production

Exposure to hapten
and carrier protein



Activation for immune response
and antibody production

Characteristics of the Immune response

- **Specificity:** The ability to discriminate among different molecular entities rather than making a random, in differentiated response.

- **Adaptiveness:** The ability to respond to previously unseen molecules that may in fact never have existed before

- **Discrimination between “self” and “nonself” antigens**

- **Memory:** Is the ability to recall previous contact with a foreign molecules and respond to it in a learned manner (more rapid and larger response)

Routes of acquiring immunity

Types of Immunity

1. **Natural acquired immunity:**
   - Active immunity (Reaction of your own immune system)

✓ Antigens enter body naturally with response of both innate and adaptive immune systems

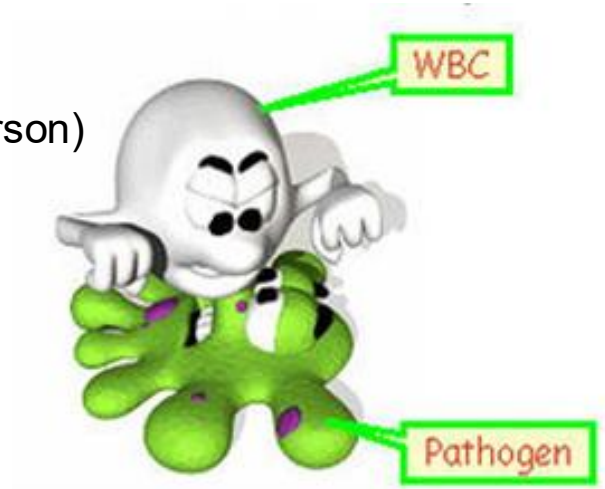
✓ provides long term protection

   - Passive immunity (Borrow immune agents from other person)

✓ Antibodies pass from mother to Fetus across placenta

✓ Infant in breast milk

✓ Provides immediate short term protection



2. **Artificial acquired immunity:**
   - Active immunity

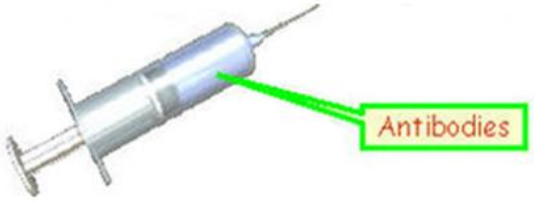
✓ Antigens enter body through vaccination with response of innate and adaptive immune systems

✓ Provides long term protection

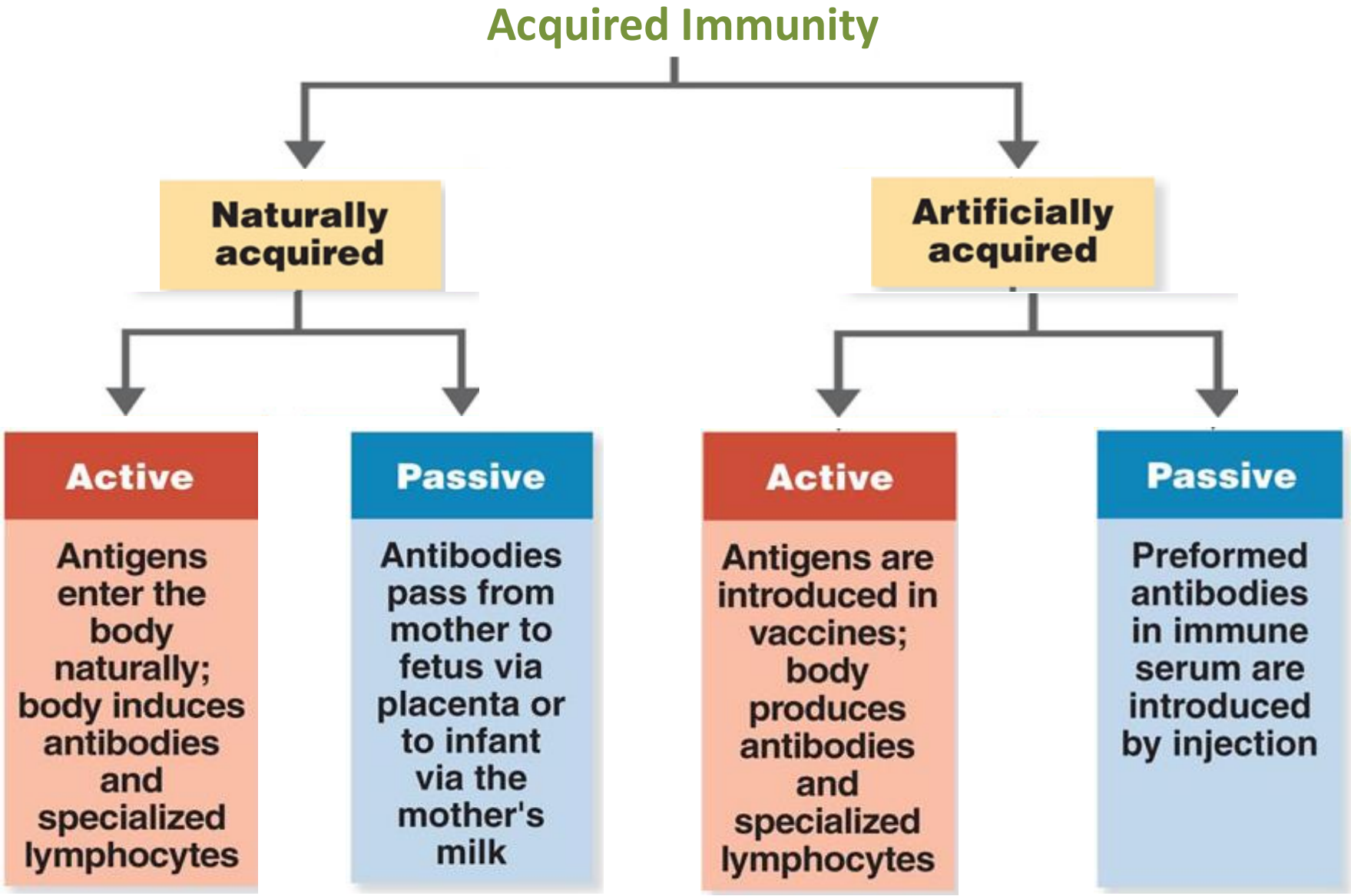
   - Passive immunity

✓ Transfer of antibodies from immune individuals into a recipient

✓ Provides immediate short term protection



Routes of acquiring immunity



Thank you