Overview of the immune system

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Objectives

- What is immunity?
- What mediates it?
- What is immune system?
- What are foreign invaders?
- Is immune system always protective?
- How does the immune system work against pathogens?
- What are the types of immune responses?
- What are the components of immune system?
- What are the phases of immune response?
- Antigen, Antibody, epitope, immunogen, hapten, adjuvant
- Active and passive immunity
- What are the factors affecting immunogenicity?

What is immunity?

-The body's defense against disease causing organisms, malfunctioning cells, and foreign particles

-The ability to resist infection and disease

Original meaning: "exemption from taxes"

What is immune response?

Response to harmful agents

What mediates it?

By the immune system

What is immune system?

- functional system rather than an organ system
  - Hematopoetic
  - Vasculature
  - Lymphatic

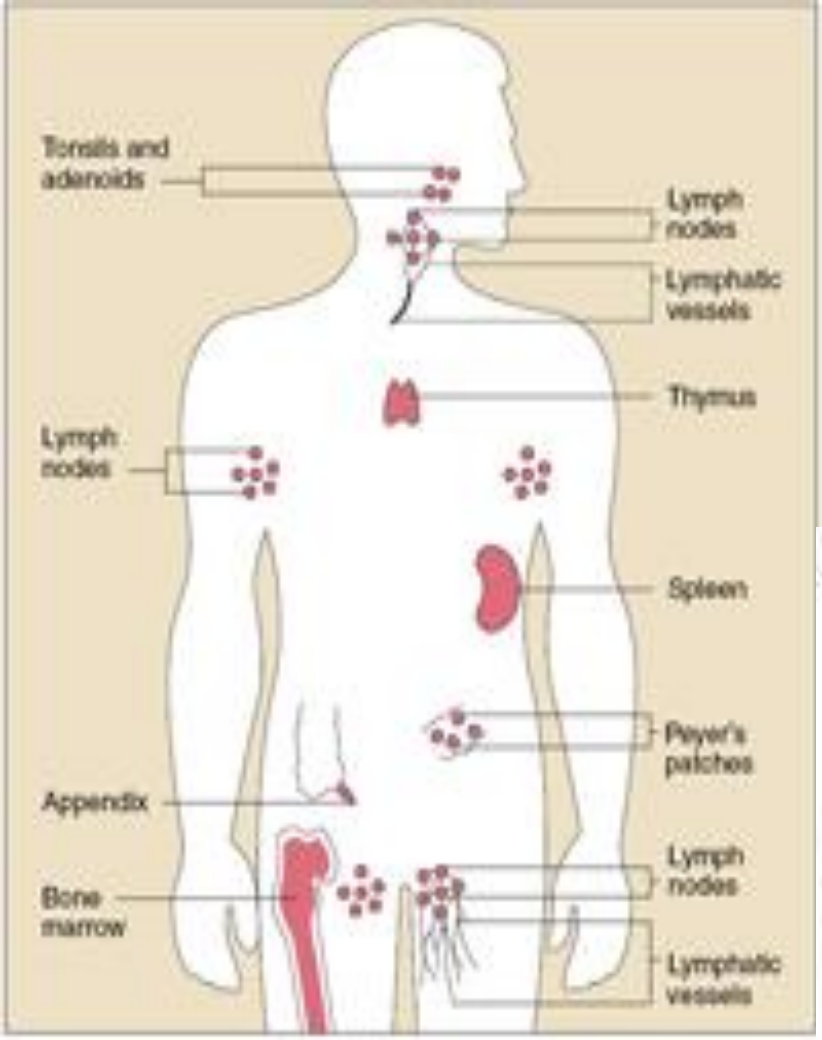
- The immune system is a network of
  - cells (neutrophils, macrophages, lymphocytes)
  - tissues /organs (bone marrow, thymus, lymph nodes, spleen)
  - molecules (cytokines, complements)

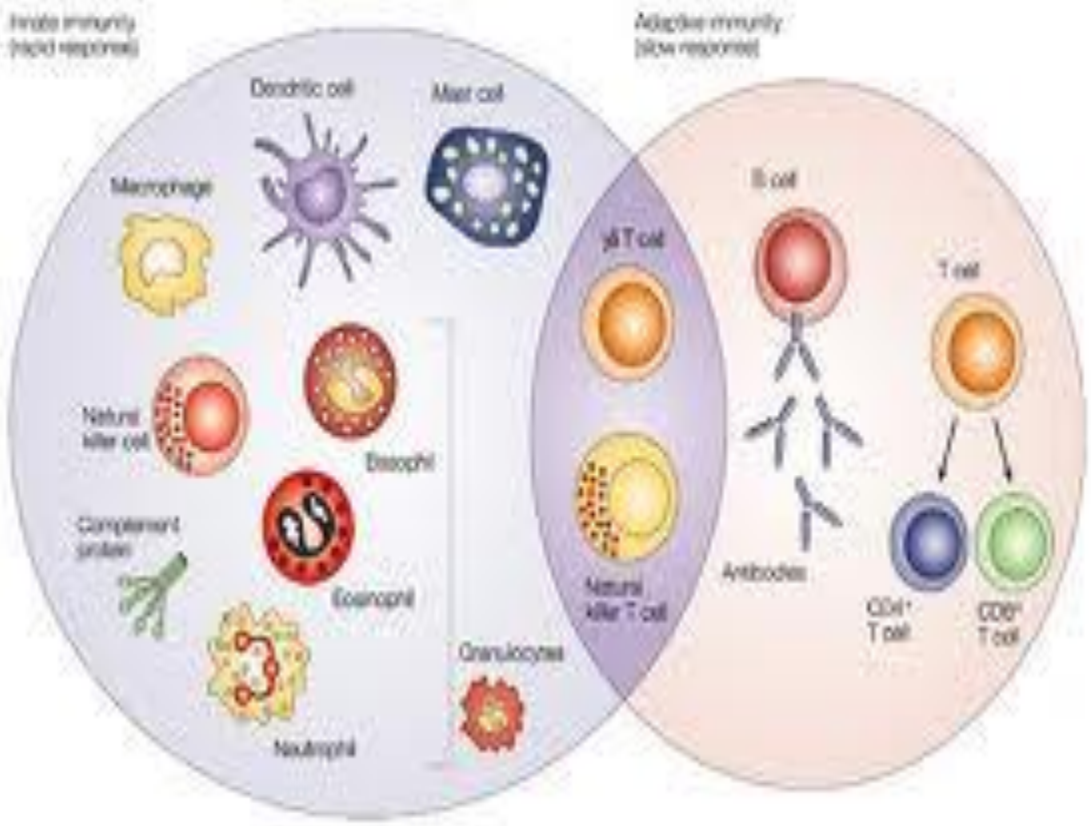
  that work together to defend the body against attacks by "foreign" invaders.

What is immune system

- It is the immune system’s job to keep them out or, failing that, to seek out and destroy them.

- It can recognize and remember millions of different enemies, and it can produce secretions and cells to match up with and wipe out nearly all of them


Tonsils and adenoids
Lymph nodes
Lymphatic vessels
Thymus
Lymph nodes
Spleen
Peyer's patches
Appendix
Lymph nodes
Bone marrow
Lymphatic vessels


Dendritic cell
Mast cell
Macrophage
γδ T cell
B cell
T cell
Natural killer cell
Basophil
Complement protein
Eosinophil
Antibodies
Natural killer T cell
Granulocytes
Neutrophil
CD4+ T cell
CD8+ T cell

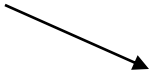
What are foreign invaders?

- These are primarily microbes—tiny organisms such as bacteria, parasites, viruses and fungi that can cause infections.

- The human body provides an ideal environment for many microbes.

- Some microbes are helpful and harmless (commensals/normal flora) while others can cause diseases (pathogens) and sometimes cause death of host.

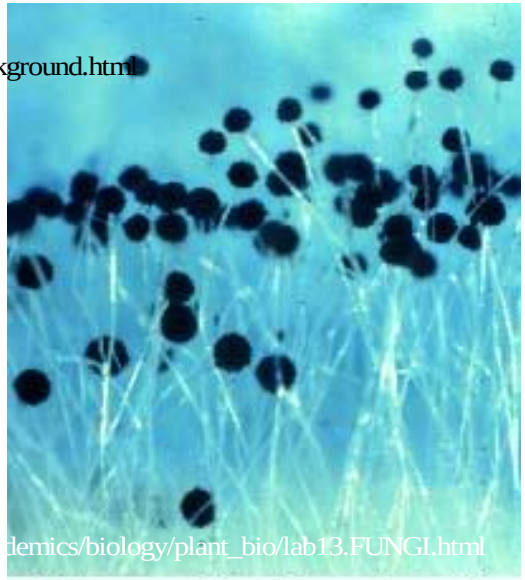
Pathogens

- Pathogens enter human body by many ways
  - Ingestion
  - Inhalation
  - Inoculation
  - Penetration through mucosa or non-intact skin
- They can be intracellular (inside cells) or extra cellular (outside cells)
- Enter human body ----> replicate ------> infection of host
  
  spread to others

Different types of immune response to overcome different pathogens

The Invaders . . .

http://www.sdnhm.org/exhibits/epidemic/teachers/background.html



Rhizopus -black bread mold

Is immune system always protective?

- If not regulated properly, it can cause harm to host
- If defective--------> Immunedeficiency ----> severe infections
  cancers
- If exaggerated------> Hypersensitivity
  tissue destruction
- If inappropriate -------> Autoimmunity -----> immune response to self tissues

How does the immune system work against pathogens?

- The immune system must be able to differentiate between material that is a normal component of the body ("self") and material that is not native to the body ("nonself")

- A highly specialized receptors present for discriminating between "self" and "nonself" body components

What are the types of immune responses?

- Mainly two arms

1) The innate (natural or nonspecific) immune response
   - Born with it

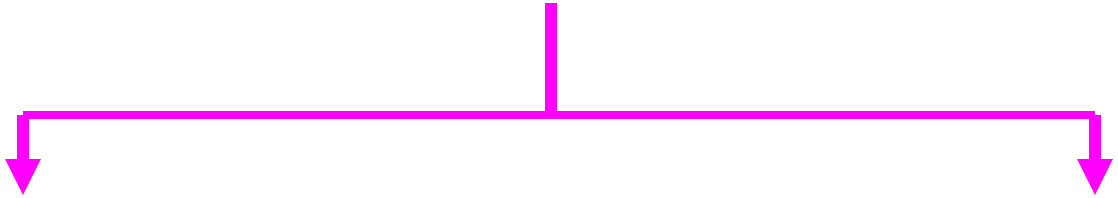
2) The adaptive (acquired or specific) immune response
   - stimulated by microbes
   - 1. humoral - by antibodies secreted by B cells
   - 2. cell mediated – by T cells

These two systems perform many of their functions by cooperative interactions

Defenses

1) Innate immunity (Natural or Non specific)

2) Acquired immunity (Adaptive or Specific)



Cell-mediated immunity Humoral immunity

Innate Vs. Adaptive

- Born with it
- 1st line
- acts immediately

- Less specific

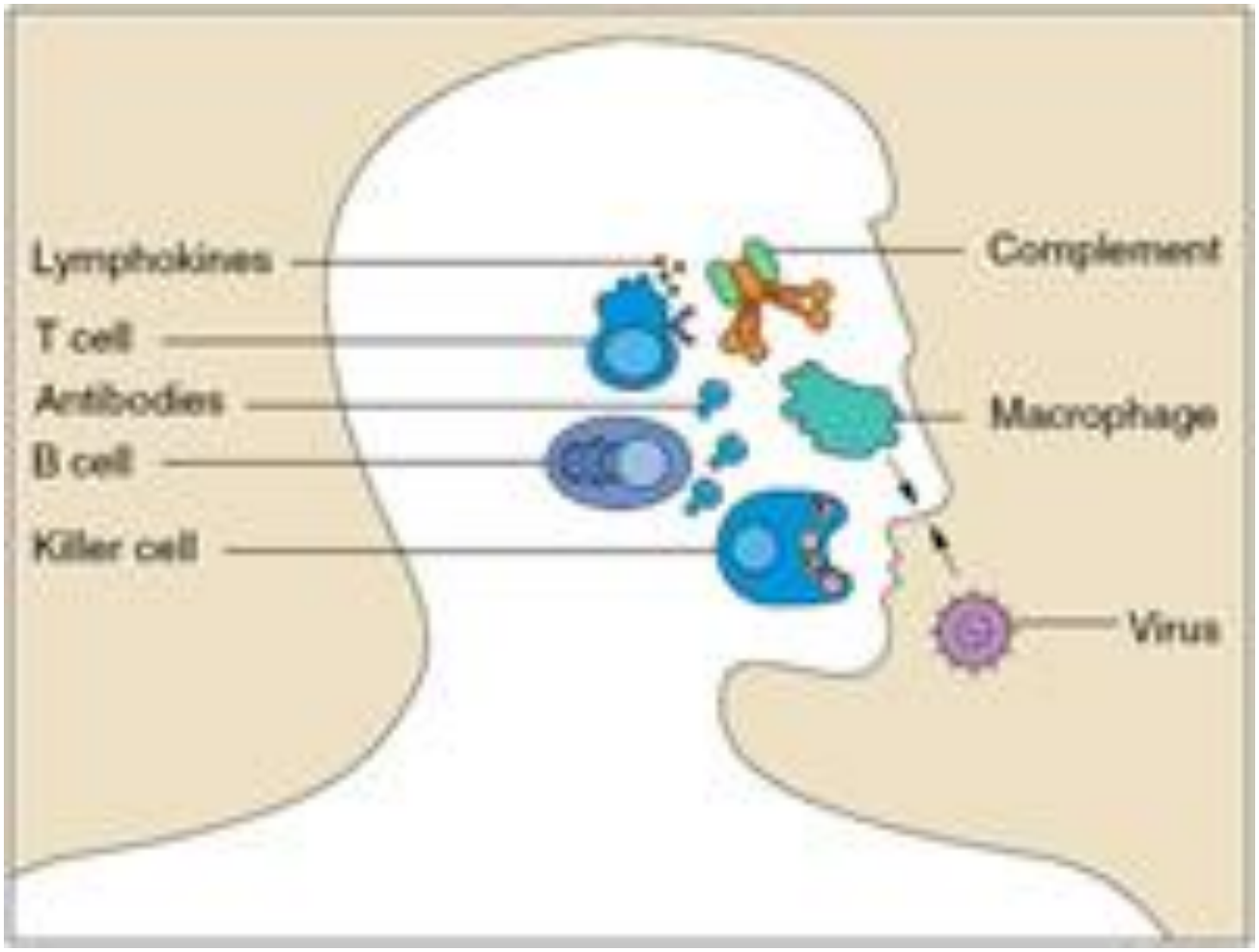
- Components
  - Barriers
  - Secretions
  - cells

- Stimulated by pathogens
- 2nd line
- takes time
- Specific

- Components
  - Secretions
  - Cells

Components of immune system

- Barriers
  - Ex. Skin
- Secretions
  - Ex. Sweat in innate immune response
    antibodies in adaptive immune response
- Cells
  - Ex. WBC


Lymphokines
T cell
Antibodies
B cell
Killer cell
Complement
Macrophage
Virus

What are the phases of immune response?

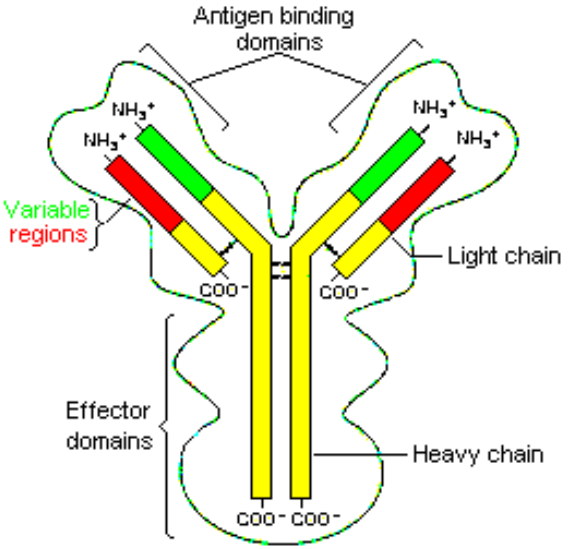
- Three main phases
  - Recognition
  - Activation
  - Effector (Elimination) phase

What is an Antigen?

- This is a molecule that is recognized by the acquired immune system as foreign
- They can be proteins, carbohydrates, lipids or nucleic acids

What is an Antibody/Immunoglobulin

- A serum protein secreted by B lymphocytes
- Binds to a specific antigen

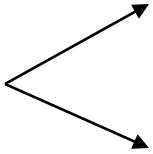


What is an epitope?

- Smallest unit on an antigen (part of antigen) which can induce an immune response
  - Also called antigenic determinant

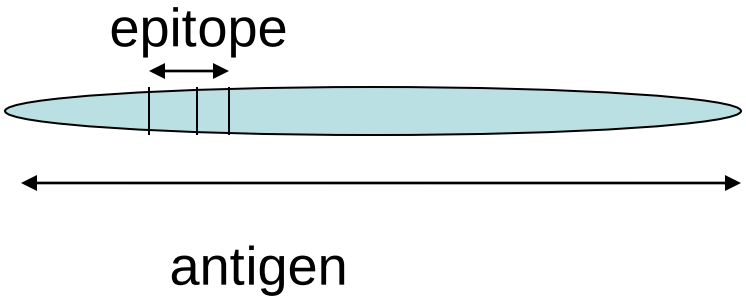
- This part binds to the receptor on Immune cells (T cell/ Bcell)

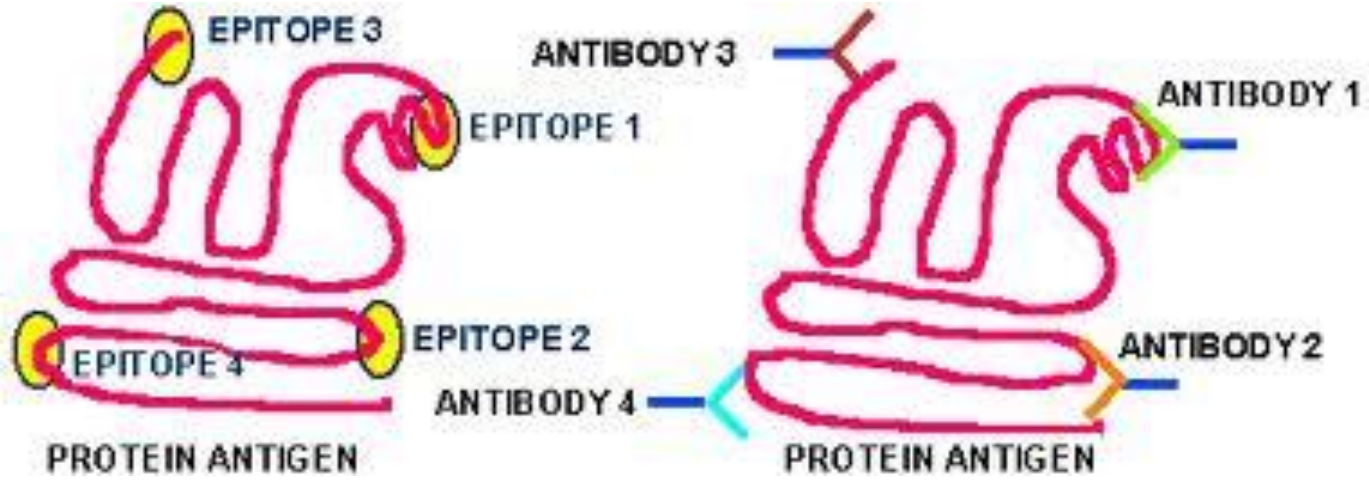
- An antigen may contain a number of same type or different types of epitopes to which individual antibodies or cell responses are made

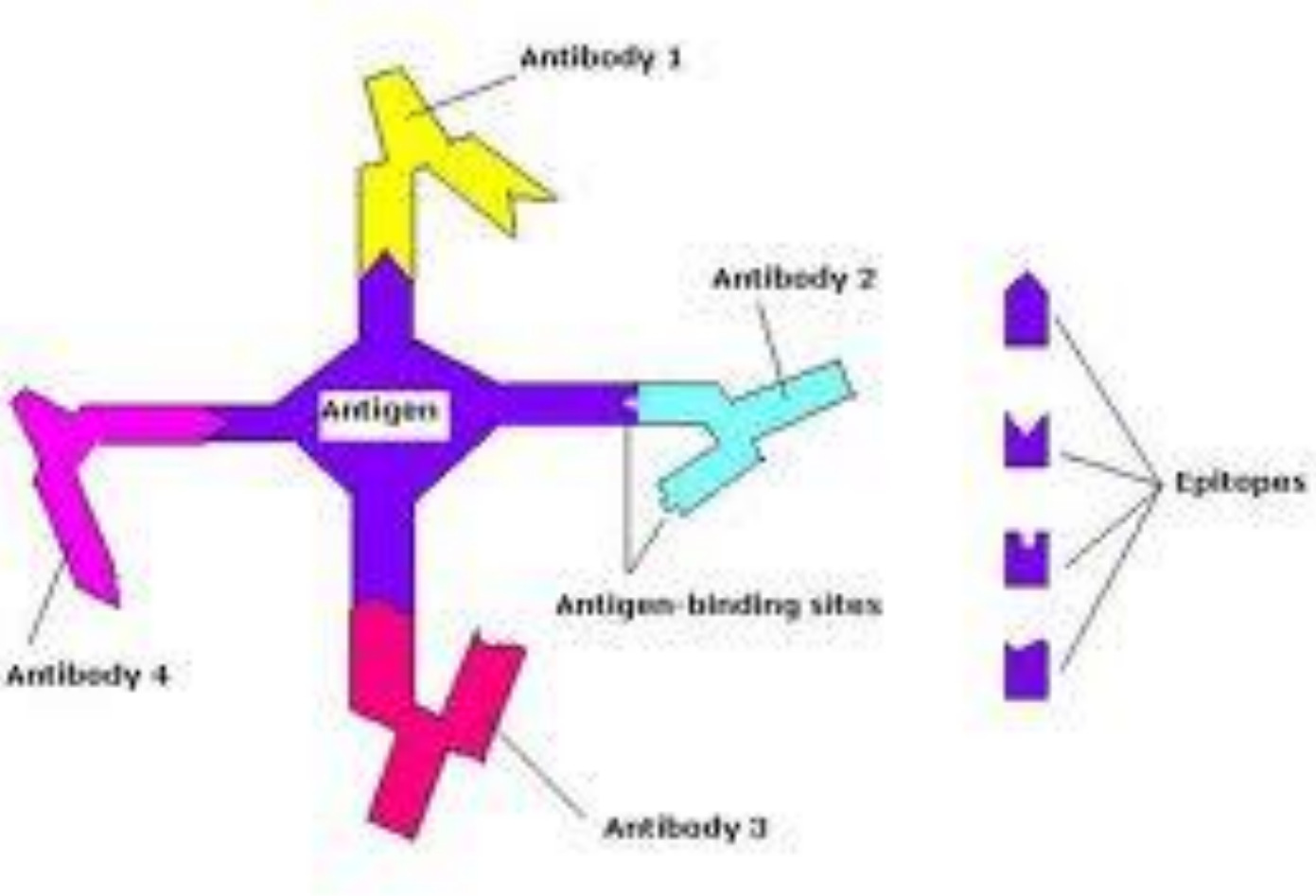


linear(sequential epitopes) – recognize by T cells

conformational epitopes (3D) – recognize by B cells


epitope
antigen


EPITOPE 3
EPITOPE 1
EPITOPE 2
EPITOPE 4
PROTEIN ANTIGEN
ANTIBODY 3
ANTIBODY 1
ANTIBODY 2
ANTIBODY 4
PROTEIN ANTIGEN

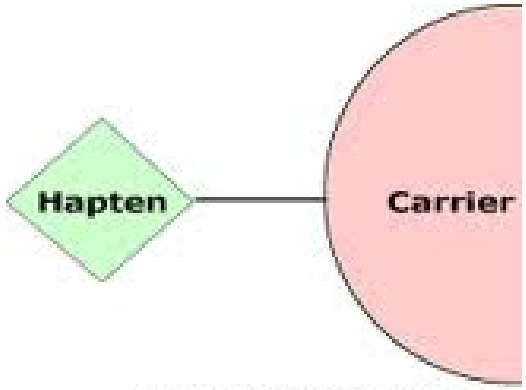

Antibody 1
Antibody 2
Antigen
Antigen-binding sites
Antibody 4
Antibody 3
Epitopes

Immunogens Vs. Hapten

- Not all antigens can mount an immune response
- An antigen which can induce an immune response------> Immunogen

  " immunogenic antigens"
- Small molecular weight compounds which can not induce an immune response by their own ------> haptens
- But when the hapten is covalently linked to a larger molecule (carrier) -----> can induce an immune response

no immune response



immune response

Adjuvant

- an **adjuvant** is an agent that may **stimulate** the immune system and **increase** the immune response
- Often used in vaccines
- any substance that acts to accelerate, prolong, or enhance antigen-specific immune responses when used in combination with specific vaccine antigens
- Eg - aluminum salts , Oil-based adjuvants

What are the factors affecting the immunogenicity?

- Nature of the antigen
  - Chemical nature - foreignness
  - Molecular weight - charge
  - degradability
- Exposure to the antigen
  - Dose - frequency
  - Route - adjuvants
- Nature of the recipient
  - Age
  - Nutrition
  - Genetic

Nature of the antigen

- Chemical nature
  - the more complex the substance is chemically the more immunogenic it will be
  - Macromolecular proteins are the most potent
  - Polysaccharides are also immonogenic
  - Lipids and nucleic acid are not generally immunogenic

Nature of the antigen

- Size
  - There is not absolute size above which a substance will be immunogenic. However, in general, the larger the molecule the more immunogenic it is likely to be.
  - Compounds wit molecular weight >6,000 are usually immunogenic.

Nature of the antigen

- Foreignness (phylogenetic distance)
  - The immune system normally discriminates between self and non-self such that only foreign molecules are immunogenic.
  - Size of the phylogenetic difference and the immune response are directly related

  (greater the phylogenetic difference----> greater immunogenicity)

Nature of the antigen

- Degradability
  - Antigens that are easily degradable are generally more immunogenic

Exposure to the antigen

- Dose
  - There is a dose of an antigen above or below which the immune response will not be optimal
- Route
  - Subcutaneous route is better than intravenous or intragastric routes
  - The route of antigen administration can also alter the nature of the response

Nature of the recipient

- Age
  - Age can also influence immunogenicity. Usually the very young and the very old have a diminished ability to mount and immune response in response to an immunogen.

- **Genetic Factors**

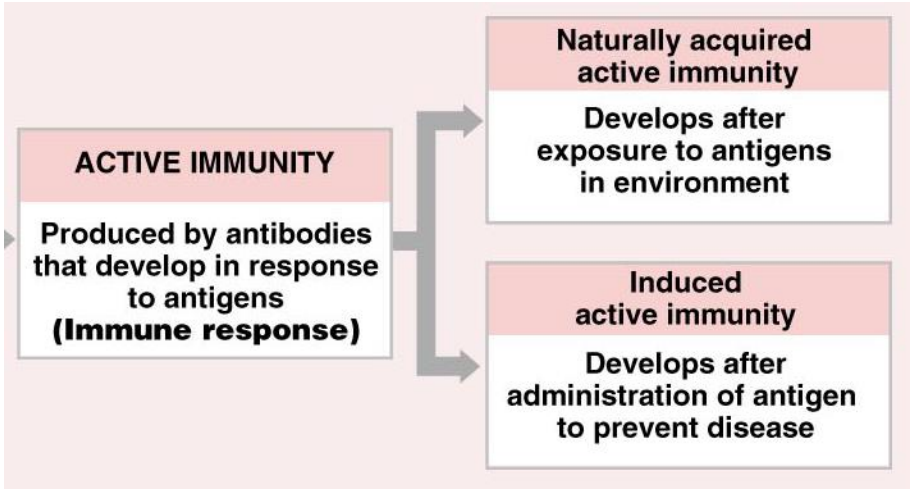
-Some substances are immunogenic in one species but not in another. Similarly, some substances are immunogenic in one individual but not in others (*i.e.* responders and non-responders).

Types of immunity

- Active Immunity
  - Naturally acquired
  - Artificial/ Induced
- Passive immunity
  - Naturally acquired
  - Artificial/ Induced

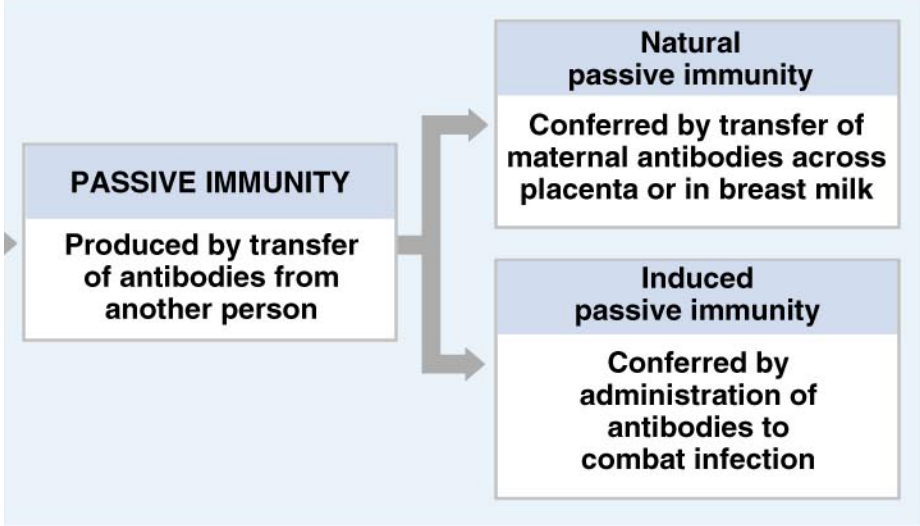
Active immunity – development of specific response (i.e. antibody (Ab) production) to specific disease secondary to exposure to specific Ag (pathogen)

- naturally acquired active immunity – natural exposure results in immune response & development of long term immunity
- induced (artificial) active immunity – deliberate "artificial" exposure to Ag (i.e. vaccine/immunization)



Passive immunity – development of immunity due to transfer of "pre-made" antibodies

- naturally acquired passive immunity – antibodies transferred from mom → baby across placenta or in breast-milk
- induced (artificial) passive immunity – administration of antibodies to fight disease after exposure to pathogen
  - Normal Immunoglobulin
  - Hyper-immune Immunoglobulin



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- Active and passive immunity

Thank You

Any Questions Please?