Types of Immunity

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The Immunity is defined as the body's ability to resist infection. The immune system is:

Defense body mechanism

an interacting set of specialized cells and proteins designed to identify and destroy foreign invader
Natural & Acquired Immunity

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Introduction

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
*The discrimination between “self” and “non-self” and the subsequent destruction and removal of foreign material is accomplished by the two arms of the immune system

1) The innate (natural or nonspecific) immune system

2) The adaptive (acquired or specific) immune system

*These two systems perform many of their functions by cooperative interactions
Immunity

Innate immunity

- Components
  - Macrophages
  - Granulocytes
  - Natural killer cells
  - Complement
  - Other chemicals: HCL, lysozyme

- Characteristics
  - Action is immediate
  - Response is non-specific
  - Response is not enhanced on repeated exposure to pathogen

Adaptive immunity

- Humeral
  - Components
    - Antigen presenting cells
  - Characteristics
    - Action requires days to develop
    - Response is specific
    - Response is enhanced on repeated exposure to pathogen

- Cell-mediated
  - Components
    - T-cells
    - B-cells
  - Characteristics
    - Action requires days to develop
    - Response is specific
    - Response is enhanced on repeated exposure to pathogen
Overview of the innate immune system

* It is the first line of defense

* It is active at the time of infection

  • It consists of:

  a- protective cellular (WBCs and derivatives)

  b- chemical components
Defensive mechanisms include:

1) Innate immunity  (Natural or Non specific)

2) Acquired immunity  (Adaptive or Specific)

- Cell-mediated immunity
- Humoral immunity
Component of Innate Immunity

Innate Immune system

First line
1) Mechanical barriers
2) Chemical & biochemical inhibitors
3) Normal flora

Second line
A- cells
1- Natural killer
2- Phagocytes
B- Soluble factors
C- Inflammatory barriers
1) Mechanical barriers

- Intact skin
- Mucous coat
- Mucous secretion
- Blinking reflex and tears
- The hair at the nares
- Coughing and sneezing reflex
2) Chemical & biochemical inhibitors

- Sweet and sebaceous secretion
- Hydrolytic enzymes in saliva
- HCl of the stomach
- Proteolytic enzyme in small intestine
- Lysozyme in tears
- Acidic pH in the adult vagina
3) Normal bacterial flora

- Competition for essential nutrients
- Production of inhibitory substances
A) cells

1- Natural killer (NK)

**Definition:** Large granular lymphocytes
Innate cytotoxic lymphocytes

**Source:** Bone marrow precursors

**Location:** 10% or 15% of lymphocytes in peripheral blood
1% or 2% of lymphocytes in spleen

**Function:** Cytotoxic for viral infected cells
Bacterial, fungal, parasitic infection
Responsible for antibody-dependent cell-mediated cytotoxicity (ADCC)
2- Phagocytes
Specialized cells for capture, Ingestion and destruction of invading microorganisms

* Polymorphonuclear leucocytes, mainly neutrophils: granulocytes circulate in blood

* Mononuclear cells (macrophages)
  - Monocytes in blood
  - Histocytes in connective tissues

- Fixed reticuloendothelial cells in liver spleen, lymph nodes, bone marrow
B- Soluble factors

1- Acute phase protein (Plasma protein, CRP=C reactive protein, Fibrin.)
2- Complement (proteins in serum, body fluids)
2- Interferons (Proteins against viral infections)
3- Properdin (Complement activation)
4- Beta lysine (Antibacterial protein from Platelets)
5- Lactoferrrin, Transferrin (Iron binding protein)
6- Lactoperoxidase (Saliva & Milk)
7- Lysozyme (Hydrolyze cell wall)
Interferons

Proteins usually produced by virally infected cells

* Types of interferons:

1- Alpha interferon  
   Secreted by   Macrophages
   Induced by   Viruses or Polynucleotide

2- Beta interferon  
   Secreted by   Fibroblasts, Viruses

3- Gamma interferon  
   T- lymphocytes, Specific antigens
Protective action of interferons:

1) Activate T-cells
2) Activate macrophages
3) Activate NK
Phagocytosis

The engulfment, digestion, and subsequent processing of microorganisms by macrophages and neutrophils

1) Chemotaxis & attachment:

a- Attraction by chemotactic substances (microbes, damaged tissues)

b- Attachment by receptors on surfaces of phagocytes
2) Ingestion:

* Phagocyte pseudopodia surround organism forming phagosome

* Opsinins and co-factors enhance phagocytosis

* Fusion with phagocyte granules and release digestive, toxic contents
3- Killing (two microbicidal routes)

a- Oxygen depended system (powerful microbicidal agents)
Oxygen converted to superoxide, anion, hydrogen peroxide, activated oxygen and hydroxyl radicals.

b- Oxygen-independent system (anaerobic conditions)
Digestion and killing by lysozyme. Lactoferrin, low pH, cationic proteins and hydrolytic and proteolytic enzymes
C) Inflammatory Barriers

* Tissue damage by a wound or by invading pathogen

* Inflammatory response:

**Release of chemical mediators from** Leukocytes

(Hashamine, fibrin, kinins, cytokines)

**Invading microbe**

Tissue damage

Redness of tissue

Tissue temperature

Capillary permeability

Influx of fluids

Influx of phagocytes into tissues
Acquired Immunity
Defensive mechanisms include:

1) Innate immunity (Natural or Non specific)

2) Acquired immunity (Adaptive or Specific)

- Cell-mediated immunity
- Humoral immunity
* The acquired immune response is more specialized than innate immune response

* The acquired immune response involves a combination of two mechanisms:

  1) Humoral immune response

  2) Cell mediated immune response

* They interact with one another to destroy foreign body (microorganisms, infected cells, tumor cells)
Aquired (specific) immunity

Two mechanisms

1) Humoral immune response:
   - Antibodies are produced by B-lymphocytes
   - These have the ability to recognize and bind specifically to antigen that induced their formation

2) The cell mediated immune response (CMI)
   - It is mediated by certain types of T-lymphocytes
   - T-lymphocytes recognize foreign material by means of surface receptors
   - T-lymphocytes attack and destroy foreign material directly or through release of soluble mediators i.e. cytokines
Characters Of Acquired Immune Response

1) Highly specific for the invading organism

2) Discrimination between “self and “non self” molecules
   The response only occurs to “non self” molecules

3) Diversity:
   - It can respond to millions of different antigens
   - Lymphocytes population consists of many different clones (one cell and its progeny)
   - Each clone express an antigen receptor and responds only to one antigenic epitope
Mechanism Of Acquired Immune Response

Acquired immune response is initiated by:

* Recognition of the antigen by specific lymphocytes

* Activation of these specific lymphocytes

* Proliferation and differentiation into effector cells;
  - The effector cells eliminate the antigen

- Return of homeostasis and development of memory cells

* Memory cells evoke a more rapid and long response on re-exposure to same antigen
I- Passive acquired immunity

- a- Naturally passive acquired immunity
  Antibodies are passed through placenta to the fetus

b- Artificially passive acquired immunity
  The injection of already prepared antibodies, such as gamma globulin
  short-term immunization(}
II- Active acquired immunity

a- Natural active acquired immunity:
  - Following clinical or subclinical infections
  - measles or mumps, in which immunity is long lasting

b- Artificial active acquired immunity:
  - Following vaccination with live or killed infectious agents or their products
Mechanism of Humoral immunity

* Antibodies induce resistance through:

1) Antitoxin neutralize bacterial toxins (diphtheria, tetanus)

   Antitoxin are developed actively as a result of:

   a- Previous infection

   b- Artificial immunization

   c- Transferred passively as antiserum

* Neutralization of toxin with antitoxin prevents a combination with tissue cells
Mechanism of Humoral immunity

2) Antibodies attach to the surface of bacteria and

a- act as opsonins and enhance phagocytosis

b- prevent the adherence of microorganisms to their target cells, e.g. IgA in the gut

c- Activate the complement and lead to bacterial lysis

d- Clump bacteria (agglutination) leading to phagocytosis
Vaccination

* Vaccination prevents and control such diseases as *cholera*, *rabies*, *poliomyelitis*, *diphtheria*, *tetanus*, *measles*, and *typhoid fever*.

* Vaccines can be:
  a- *prophylactic* (e.g. to prevent the effects of a future *infection* by any natural or "wild" *pathogen*).
  b- *Therapeupic* (e.g. vaccines against cancer are also being investigated).
Vaccination:

*Producing immunity against pathogens (viruses and bacteria) by the introduction of live, killed, or altered antigens that stimulate the body to produce antibodies against more dangerous forms

*Vaccines work with the immune system's ability to recognize and destroy foreign proteins (antigens)
Vaccination

Immunization of young children and adolescents:

- Hepatitis B (HepB) and Hepatitis A (HepA)

- Diphtheria, tetanus and pertussis (whooping cough) given together as DTaP (formerly DTP)

- Haemophilus influenzae b (Hib)

- Poliomyelitis (IPV)

- Measles, Mumps, and Rubella, given together as MMR

- Chicken pox (Var)

- Neisseria meningitidis (meningococcal meningitis)
Cells involved in specific immune mechanisms are:

I) Hematopoietic leucocytes

1- Lymphoid

* T-lymphocytes:
  - Antigen specific cells carrying CD3 complex, CD4, CD8
  - Dominant blood lymphocytes (70%)
  - Produce cytokines
  - Activation of other cells (Th CD4)
  - Suppressors for others (Ts CD8)
Cells Of Immune Response

* B-lymphocytes:
  - Antigen specific cells with surface receptor
  - Less common lymphocytes (20%)
  - Responsible for antibody production

* NK, K cells:
  - Not antigen specific
  - Carry Fc receptors, NK-target cell receptor
Cells of Immune Response (cont.)

2- Monocytic myeloid

a- Monocyte-tissue macrophages:
  . Non specific
  . Carry Fc receptors
  . Phagocytic
  . Antigen processing and presenting cells
  . Produce cytokines

b- Neutrophils:
  . Non specific
  . Carrying Fc, complement molecules
Cells of Immune Response (cont.)

c- Eosinophils:
  . Non specific
  . Carrying Fc receptor
  . Produce allergic mediators

d- Basophils and Mast cells:
  . Non specific
  . Carrying Fc receptors
  . Produce allergic mediators
Cells of Immune Response (cont.)

II-Non hematopoietic cells:
- Dendritic cells
- Astrocytes and
- Endothelial cells

Function: antigen presentation
Thanks