

# IMMUNITY-II

B.Sc. Part-II, (Sub/Gen)  
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# INTRODUCTION

Normally our body is exposed to a number of pathogens. How efficiently our body protects itself from these pathogens depends upon the complex defence system of our body.

The defence system for our body consists of a multilevel network of Innate or non specific and adaptive or specific immunity. It is referred to as the first, second and third line of defence, as the interaction and cooperation of these three levels of defence provides complete protection against any infection.

We have learnt from the last lecture that immunity is the ability of an individual to resist against infection by pathogens. The group of cells tissues and organs which carry out this function constitute the immune system.

# LINES OF DEFENCE

**The Immune System has 3 Lines of defence Against Foreign Pathogens:**

1. Physical and Chemical Barriers (Innate Immunity)
2. Nonspecific Resistance (Innate Immunity)
3. Specific Resistance (Acquired Immunity)

**NON-SPECIFIC DEFENCES  
(INNATE IMMUNITY)**

**SPECIFIC DEFENCES  
(ADAPTIVE IMMUNITY)**

**First line of defense**

- Skin
- Mucous membranes
- Secretions of skin and mucous membranes

**Second line of defense**

- Phagocytic leukocytes
- Antimicrobial proteins
- Inflammatory response
- Fever

**Third line of defense**

- Lymphocytes
- Antibodies
- Memory cells

# FIRST LINE OF DEFENCE

## Physical barrier

- The **skin** has thick layer of dead cells in the epidermis which provides a physical barrier. Periodic shedding of the epidermis removes microbes.
- The **mucous membranes** produce **mucus** that trap microbes.
- Hair** within the nose filters air containing microbes, dust, pollutants
- Cilia** lines the upper respiratory tract traps and propels inhaled debris to throat
- Urine** flushes microbes out of the urethra
- Defecation** and **vomiting** -expel microorganisms.

# Chemical Barriers

- **Lysozyme**-an enzyme produced in **tears**, perspiration, and saliva can break down cell walls and thus acts as an antibiotic (kills bacteria)
- **Gastric juice**- in the stomach destroys bacteria and most toxins because the gastric juice is highly acidic (pH 2-3)
- **Saliva**- dilutes the number of microorganisms and washes the teeth and mouth
- **Acidity**- on skin inhibit bacterial growth
- **Sebum**- (unsaturated fatty acids) provides a protective film on the skin and inhibits growth.

# SECOND LINE OF DEFENCE

The second line of defence is **nonspecific resistance** that destroys invaders in a generalized way without targeting specific individuals:

- **Phagocytic cells** ingest and destroy all microbes that pass into body tissues. For example **macrophages** are cells derived from **monocytes** (a type of white blood cell). Macrophages leave the bloodstream and enter body tissues to patrol for pathogens. When the macrophage encounters a microbe, this is what happens:
  - The microbe attaches to the phagocyte.
  - The phagocyte's plasma membrane extends and surrounds the microbe and takes the microbe into the cell in a vesicle.
  - The vesicle merges with a lysosome, which contains digestive enzymes.
  - The digestive enzymes begin to break down the microbe. The phagocyte uses any nutrients it can and leaves the rest as indigestible material and antigenic fragments within the vesicle.
  - The phagocyte makes protein markers, and they enter the vesicle.
  - The indigestible material is removed by exocytosis.
  - The antigenic fragments bind to the protein marker and are displayed on the plasma membrane surface. The macrophage then secretes interleukin-1 which activates the T cells to secrete interleukin 2, as described below under specific resistance .

- **Inflammation** is a localized tissue response that occurs when your tissues are damaged and in response to other stimuli. Inflammation brings more white blood cells to the site where the microbes have invaded. The inflammatory response produces swelling, redness, heat, pain
- **Fever** inhibits bacterial growth and increases the rate of tissue repair during an infection.

# THIRD LINE OF DEFENCE

## **Specific Resistance (Acquired Immunity)**

The third line of defence is **specific resistance**. This system relies on **antigens**, which are specific substances found in foreign microbes.

Most antigens are proteins that serve as the stimulus to produce an **immune response**. The term "antigen" comes from **ANTI**-body **Generating** substances.

Here are the steps in an immune response:

1. When an antigen is detected by a macrophage (as describe above under phagocytosis), this causes the T-cells to become activated.

The activation of T-cells by a specific antigen is called **cell-mediated immunity**. The body contains millions of different T-cells, each able to respond to one specific antigen.

2. The T-cells secrete **interleukin 2**. Interleukin 2 causes the proliferation of certain **cytotoxic T cells** and **B cells**.

3. From here, the immune response follows 2 paths: one path uses cytotoxic T cells and the other uses B cells.

# Immune System

## Innate Immunity



Macrophages



Neutrophils



Dendritic cells



Eosinophils



Basophils

## Adaptive Immunity

Antigen presenting cells



Professional APCs

Non Professional APCs

T cells



Memory T cells

Effector cells

Cytotoxic cells

Helper cells

Regulatory cells

B cells



Memory B cells

Plasma cells

# INNATE IMMUNITY

## **Innate or Natural immunity:**

- Immunity with which an individual is born is called innate or natural immunity.
- Innate immunity is provided by various components such as Skin, mucus membrane, Phagocytic cells etc.
- Innate immunity acts as first line of defence to particular microorganisms.

# TYPES OF INNATE IMMUNITY

## **Types of innate immunity:**

1. Species immunity
2. Racial immunity
3. Individual immunity

# 1. Species immunity:

- If one species is resistant to certain infection and the other species is susceptible to the same infection then it is called as species immunity.
- Anatomic, physiological and metabolic differences between species determine species immunity. For example, Birds are resistant to anthrax but Human are susceptible. It is simply because higher body temperature of birds kills *Bacillus anthracis*.
- Anatomic differences between species also determine species immunity. For example, Human are more susceptible to skin infection whereas Cattles are more resistant to the same skin infection. It is because of tough and hairy skin (hides) of Cattles.

## 2. Racial immunity:

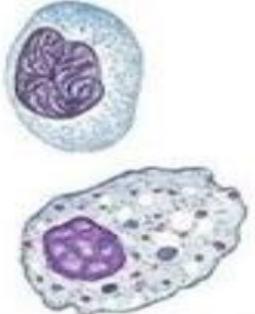
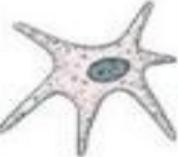
- If one race is susceptible while other race is resistant to same infection, then it is called Racial immunity.
- For examples; certain African race are more resistant to malaria and yellow fever where are Asian or Americans are susceptible to same infection. Similarly Orientals (East Asia) are relatively resistant to syphilis.
- Racial immunity is determined by difference in Socio-economic status, habitat, culture feeding habits, environments, genetic, etc.

### 3. Individual immunity:

- If one individual of certain race or cast is resistant while other individuals of same race or cast are susceptible to certain infection, then it is called as individual immunity
- Individual immunity is determined by various factors such as health status, nutritional status, previous illness, personal hygiene, genetic differences etc.
- For examples; Individual with genetic deficiency of glucose-6 phosphate dehydrogenase are resistant to Malaria.

# CELLULAR COMPONENT OF INNATE IMMUNITY

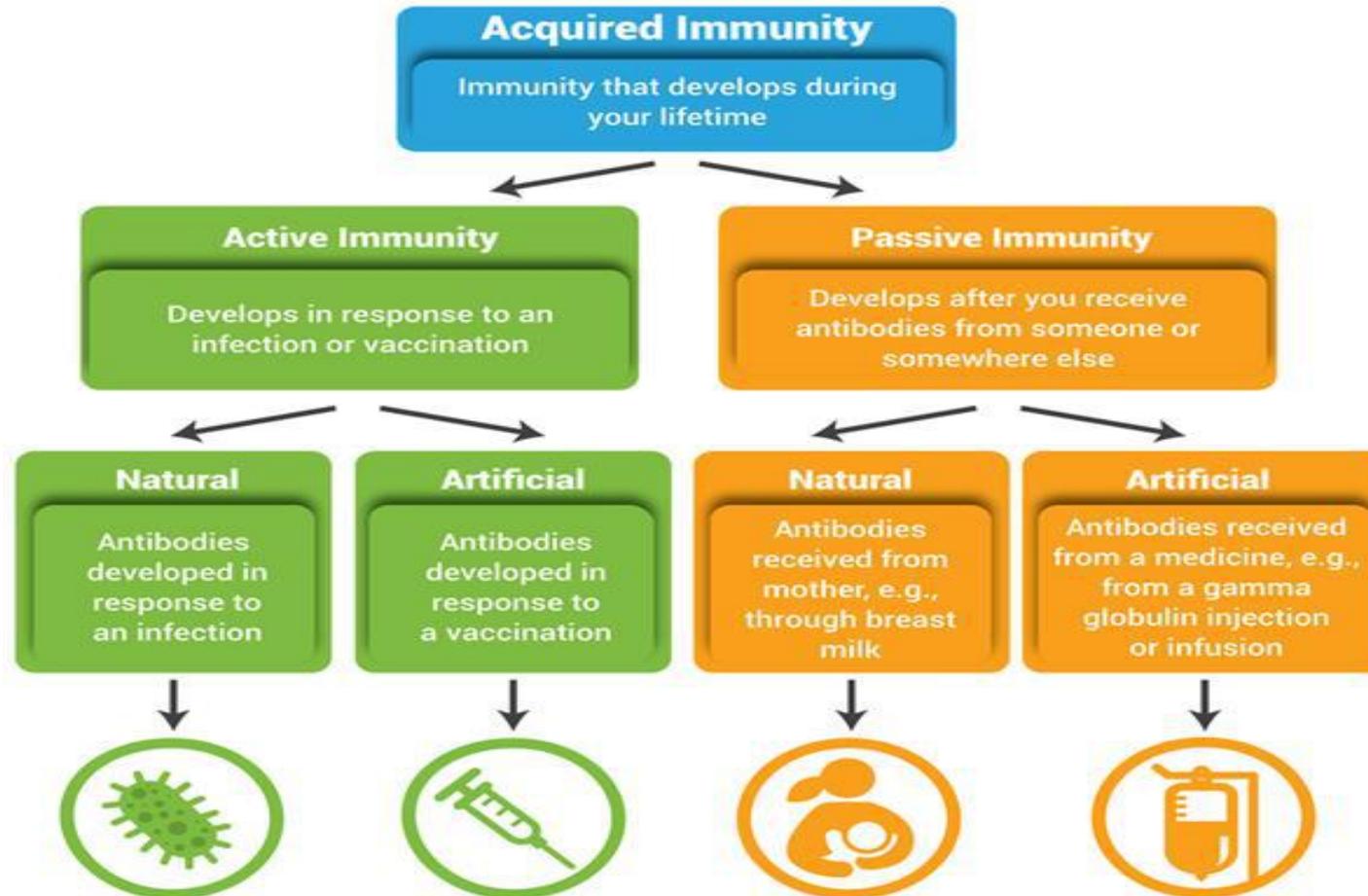
## Cellular components of innate immunity

|                     | <i>Basophils and mast cells</i>  | <i>Neutrophils</i>   | <i>Eosinophils</i>  | <i>Monocytes and macrophages</i>   | <i>Dendritic cells</i>  | <i>NK Cells</i>   |
|---------------------|--|--|---|--|---|---|
|                     |  |  |  |  |  |  |
| Primary function(s) | Release chemicals that mediate inflammation and allergic responses                 | Ingest and destroy invaders  | Destroy invaders, particularly antibody-coated parasites                            | Ingest and destroy invaders<br>Antigen presentation                                  | Recognize pathogens and activate other immune cells by antigen presentation         | <i>Recognize and destroy cancer and virally infected cells</i>                      |

# ACQUIRED IMMUNITY

- Immunity which is developed later in life after microbial infection in host is called as Acquired or developed immunity. For example, If an individual is infected with chicken pox virus, he/she become resistant to same virus in later life.
- Acquired immunity is provided by Antibodies and certain T-lymphocytes.
- Components of acquired immunity such as Antibodies and T- cells are specific to particular microorganism. Therefore acquired immunity is also known as Specific immunity.

# ACQUIRED IMMUNITY



# TYPES OF ACQUIRED IMMUNITY

## 1. Active immunity:

- If host itself produces antibodies, it is called active immunity.
- It is of two types; artificial active immunity and natural active immunity.
- **Artificial active immunity:** Immunity provided by vaccination.
- **Natural active immunity:** immunity provided by natural infection.

## 2. Passive immunity:

- If host does not produce antibodies itself but antibodies produced in other host provides immunity, than it is known as Passive immunity.
- It is of two types; natural passive immunity and Artificial passive immunity
- **Natural passive immunity:** IgG antibody produced in mother cross placenta and protects fetus up to 6 month old age.
- **Artificial passive immunity:** if preformed antibody are injected into host for immunity. E.g. Anti-venom, Rabies vaccine (\* it is not a vaccine, it is preformed anti rabies antibody)