HUMAN HEALTH AND DISEASE

IMMUNITY

IMMUNE SYSTEM IN HUMAN

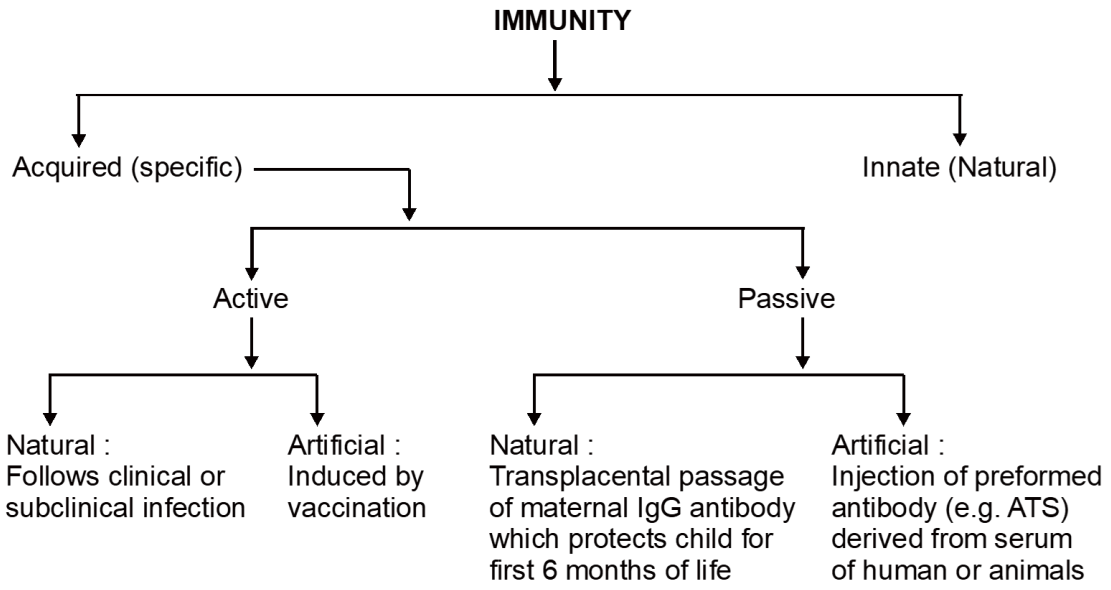
IMMUNE SYSTEM

System which protect the body from disease is called immune system.

(Immune = Letin term Exempt or Freedom)

mmunity (Two Types) :

- **Congenital immunity or innate Immunity or Non-specific immunity.**
- **Acquired immunity or Adaptive or specific immunity**



Innate immunity is non-specific type of defence, that is present at the time of birth. This is accomplished by providing different types of barriers to the entry of the foreign agents into our body. Innate immunity consist of four types of barriers. These are:-

1. **Physical/ Anatomical Barrier:** It is made up of two parts:-

(i) **Skin :** Skin on our body is the main barrier which prevents entry of the micro-organisms. Outermost layer of skin is dead (str. corneum), so the bacteria do not grow or enter into it. pH of skin (3 to 5) destroy the bacteria.

(ii) **Mucosa :** Mucus coating of epithelium lining of the respiratory, gastrointestinal and urogenital tracts also help in trapping microbes entering our body. Mucosa· contain mucosal cells and cilia. Mucosa entraps the micro-organism and cilia propel the microbes.

2. **Physiological Barriers :** Some physiological processes of body create adverse environment for growth of bacteria. Acid in the stomach, saliva in the mouth, tears from eyes-all prevent microbial growth.

(i) **Fever :** High temperature of body, inhibit the growth of microbes.

(ii) **pH of body :** Acidic pH of various part of body like oral cavity, stomach and vagina inhibit the growth of microbes.

(iii) **Secretions :** Secretions of body like eyes, sebum contain lysozyme, this enzyme destroys the microbes.

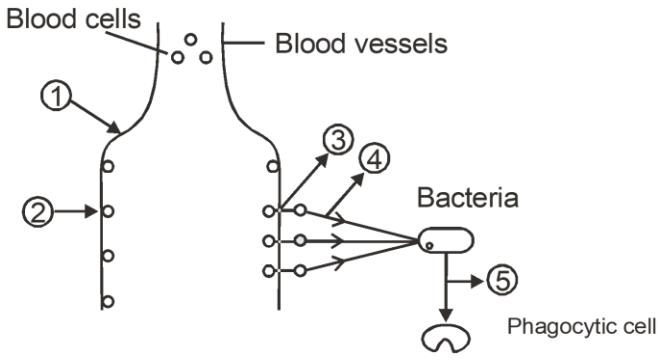
3. **Cellular Barrier:-**

Polymorpho-nuclear leukocytes (PMNL-neutrophils), monocytes and natural killer cells (type of lymphocytes) in the blood as well as macrophages in tissues can phagocytose and destroy microbes.

(A) **Phagocytic Cells -** (e.g. Monocytes. PMNL – neutrophil, Macrophage), In response to pathogenic infection, the total count of WBC in body increases. Phagocytosis is exhibited by some types of WBC's such WBC's are called phagocytes.
Most important phagocytes are macrophages and neutrophils. Monocytes are liberated at the site of infection these later converted into macrophages.
Macrophages are large irregular shaped cells that engulf microbes, virus, cellular debris etc. In response to an infection.

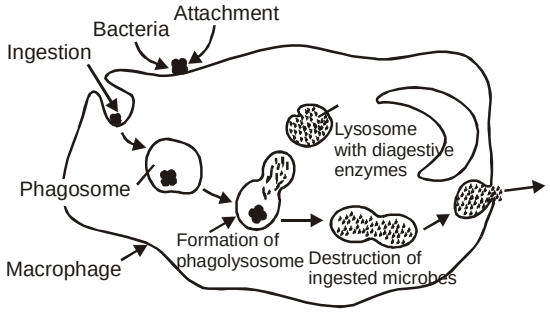
Steps of Phagocytosis -

- Vasodilation (Blood stasis)
- Adhesion
- Migration or diapedesis
- Chemotaxis (Neutrophils or Monocytes)
- Phagocytosis



Steps of Phagocytosis -

- **Vasodilation :** At site of entry - Increased diameter of blood vessels.
- **Adhesion :** Accumulation of leucocytes at periphery of blood vessels due to decreased blood flow.
- **Diapedesis :** Now the leucocytes (neutrophils or Monocytes) migrates from the blood vessel by Active movements (Amoeboid movement) into the E.C.F. This kind of active movement of cell, is called diapedesis.
- **Chemotaxis :** Now this leucocyte cells move towards the pathogen by chemotactic movement (Active).
- **Phagocytosis :**



Phagocytosis

Attachment (adherence) : The infective agent gets attracted to the membrane of the phagocyte.

- **Ingestion :** Phagocyte engulfs the particular material into a vacuole (Phagosome). The membrane of which fuses with a lysosome forming a phagolysosome. Lysosome contains hydrolytic enzymes and other bactericidal substances.
- **Intracellular killing of bacterium :** Most bacteria are slaughtered in the phagolysosome by the hydrolytic enzymes within a few minutes of phagocytosis.

(B) **Non-Phagocytic cells :** (Eg : Natural Killer Cell)

It is a large granular lymphocyte cell. During this process apart from the phagocytes, another type of cells called Natural killer cells kill virus infected cells and tumour cells of body by creating perforin lined pores in the plasma membrane of target cells (i.e. infected cells). Water enters through these pores causing swelling and bursting of the diseased cells.

(4) Cytokine Barriers: Virus-infected cells secrete proteins called interferons which protectnon-infected cells from further viral infection.

Interferon are anti-viral protein made up to 270 amino acids secreated by virus infected cells and stimulates the adjacent cells to produce the Translation Inhibiting Protein (T.I.P.) By this mechanism interferon limits the infection of virus.

Interferons are species specific i.e. interferons produced by one species can protect only cells of same species against viral infection.

Interferons make cells resistant to viral infection by synthesis of antiviral proteins in that cell.

Interferons can be used for prophylaxis and treatment of viral infections.

Types of interferons :

α - produced by Leucocytes. (B-lymphocytes)

β - produced by Fibroblasts.

γ - produced by Lymphocytes. (T-lymphocytes)

Interferons can be used for **prophylaxis** and **treatment** of viral infections.

INFs - α = activate immune system and destroy tumor. It has shown some success in causing of regression of Kaposi sarcoma in AIDS patients.

Inflammation : Local response of living mammalian tissue to injury due to any agent. It is the body defence reaction in order to eliminate or limit the spread of infectious agent. Inflammation is characterised by -

(i) **Redness (Rubor/Erythema) -** due to vasodilation.

(ii) **Heat (Calor) -** metabolic reactions proceed more rapidly.

(iii) **Swelling (Tumor) -** due to increased permeability of blood vessels.

(iv) **Pain (Dolor) -** resJllts from injury to neurons and chemicals released by damaged cells (eg. prostaglandins) .

Acquired Immunity :

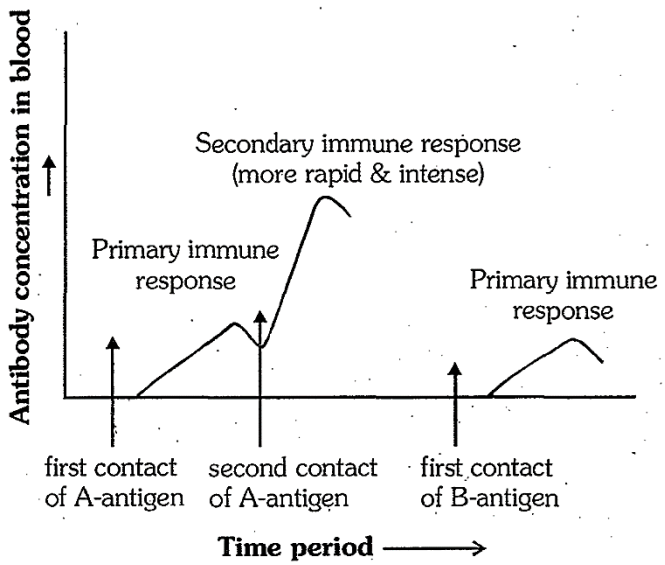
It is the resistance that an individual acquires during life. This is generated in response to an exposure to the micro-organism in question.

- This type of immunity is founds only in vertebrates.
- It is also called Adaptive or specific immunity.
- This immunity is **accquired after birth** by experience.
- This immunity recognise and selectively eleminate the pathogen.

Features of Acquired immunity :

- **Specificity :** Acquired immunity is specific for specific micro-organisms.
- **Diversity :** This system have capability to recognise vast variety of micro-organisms.
- **Discrimination between self and non-self.** It can recognise self (body or tissue) and non self (Foreign tissue) and respond according to them.
- **Memory :** When a pathogen enter inside the body, body takes longer times to recognise and respond to it this is called **primary immune response** but the memory of this encounter remain in immune system.

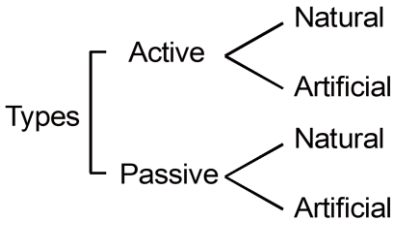
When this pathogen enters second time inside the body, body immune system rapidly recognise this pathogen and respond quickly to it. This is called **secondary immune response.** This is based on memory of immune system.



The primary and secondary immune responses are carried out with the help of two special types of lymphocytes present in our blood, i.e., B-lymphocytes and T-lymphocytes.

The B-lymphoces produce an army of proteins in response to pathogens into our blood to fight with them. These proteins are called antibodies. The T-cells themselves do not secrete antibodies but help B cells, to produce them.

Types of Acquired Immunity :



Active acquired immunity : Resistance developed by an individual as a result an antigenic stimulus. When a host is exposed to antigens, which may be in the form of, living or dead microbes or other proteins. antibodies are produced in the host body. This type of immunity is called active immunity. Active immunity is slow and takes time to give its full effective response. Injecting the microbes

deliberately during immunisation or infectious organisms gaining access into body during natural infection induce active immunity.

Natural : Results from a clinical or in a parents infection by a micro-organism.

Artificial : Resistances induced by vaccine

Vaccines : Prepaairation of live or killed micro-organism or their products used for immunisation.

Passive Immunity : It is received passively by host without participation or contribution from host's immune system. Immunological memory is absent here and the **readymade antibodies** are given in immuno suppressive individual this is called **passive immunity**.

- **Natural :** Resistance pasively transferred from mother to baby. **Mother milk** gives passive immunity to the new born child by **colostrum** (first mother milk) – IgA type of antibody.
- **Artificial :** Resistance passively transferred to a recepient by administration of antibodies.

  Examples : human immunological administration.

  Anti - tetanus serum (ATS)

  Anti - rabies serum (ARS)

  Anti - diptheria serum (ADS)

Difference between active and passive immunity

S. No.	Active immunity	Passive immunity
1.	Produced actively by the immune system of host.	Received passively by the host and the host's immune system does not participate.
2.	Induced by infection or by contacts with immunogen, e.g. vaccines.	Conferred by introduction of ready-made antibodies.
3.	Immune response-durable and effective.	Immune response-short lived and less effective.
4.	Immunity develops only after a lag period.	Immunity effective immediately.
5.	Immunological memory present.	No immunological memory.

6.	Serves no purpose in immunodeficient host.	Applicable in immunodeficient host.
7.	Used for prophylaxis to increase body resistance.	Used for treatment of acute infection.

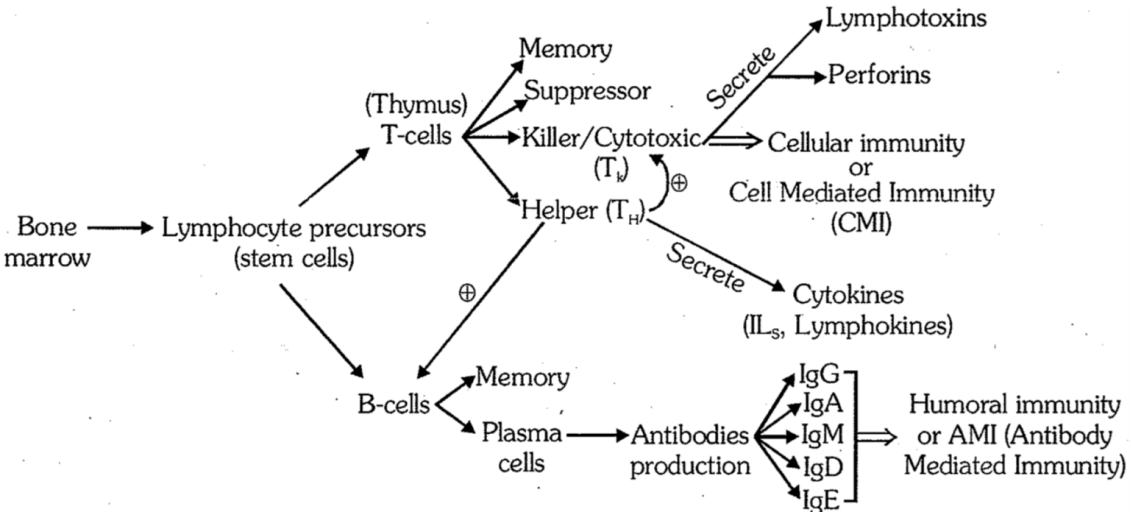
IMMUNE SYSTEM IN THE BODY

The human immune system consists of

(i) lymphoid organs
(ii) lymphoid tissues
(iii) cells (lymphocytes)
(iv) soluble molecules like antibodies.

- As you have read, immune system is unique in the sense that it recognises foreign antigens. responds to these and remembers them. The immune system also plays an important role in allergic reactions, auto-immune diseases and organ transplantation.
- Lymphoid organs are the organs where origin and/or maturation and proliferation of lymphocytes occur.
- The primary lymphoid organs are bone marrow and thymus where immature lymphocytes differentiate into antigen-sensitive lymphocytes.
- After maturation the lymphocytes migrate to secondary lymphoid organs like spleen, lymph nodes, tonsils, Peyer's patches of small intestine and appendix. The secondary lymphoid organs provide the sites for interaction of lymphocytes with the antigen, which then proliferate to become effector cells.
- The bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced.
- The thymus is a lobed organ located near the heart and beneath the breastbone. The thymus is quite large at the time of birth but keeps reducing in size with age and by the time puberty is attained it reduces to a very small size. Both bone-marrow and thymus provide micro-environments, for the development and maturation of T-lymphocytes.
- The spleen is a large beanshaped organ. It mainly contains lymphocytes and phagocytes. It acts as a filter of the blood by-trapping blood-borne microorganisms. Spleen also has a large reservoir of erythrocytes.

- The lymph nodes are small solid structures located at different points along the lymphatic system. Lymph nodes serve to trap the micro-organisms or other antigens, which happen to get into the lymph and tissue fluid. Antigens trapped in the lymph nodes are responsible for the activation of lymphocytes present there and cause the immune response.
- There is lymphoid tissue also located within the lining of the major tracts (respiratory, digestive and urogenital tracts) called mucosal associated lymphoid tissue (MALT). It constitutes about 50 per cent of the lymphoid tissue in human body.



Based on these two type of lymphocytes there are **two types** of active immune system.

(1) CMIS (Cell mediated immune system) or Cellular immunity (T-cells)

(2) AMIS (Antybody mediated immune system) or humoral immunity (B-cells)

- **C.M.I.S.** Cell mediated immune system or Cellular immunity

  This immune system is based on T-cells, (60-70%)

There are 4 type of T-cell

- Helper T-cell
- Killer T-cell or cytotoxic T-cell
- Memory T-cell
- Suppressive T-cell

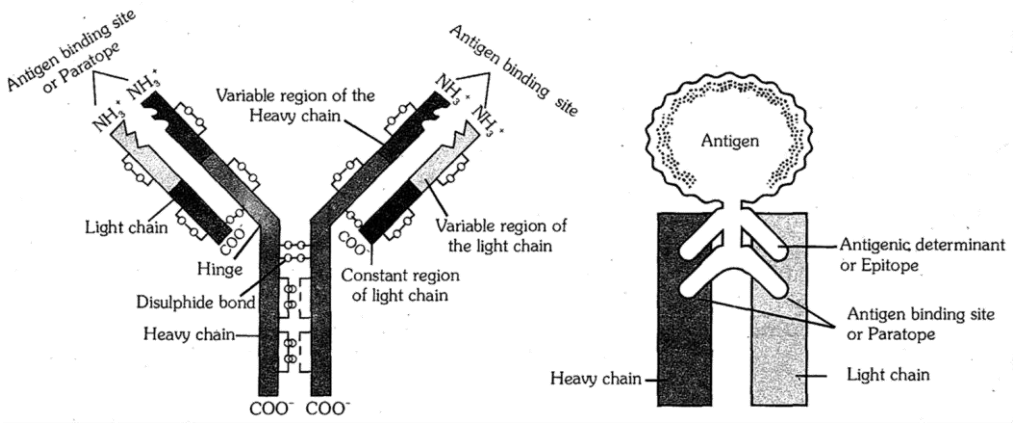
When pathogens enter inside the body first macrophage interact with them and activates T_H-cell by releasing cytokines or interleukin or Monokines.

- **Helper T-cell :** This activated helper cell stimulates the killer T-cell and B-cell and these killer T-cell & B-cell start dividing and produce clone (group of similar cells) this phenomenon is called **clonal selection**.
  They produce lymphokines (messenger molecules) which cause accumulating of WBCs to the affected site. T_H-cells also stimulate B-cells to produce antibodies and facillitate the action of other T-cells.
- **Killer T-cell :** These cell or clone of these cell **destroy the infected cells or target cell** and kill the pathogen and virus infected cell by secreting Lymphotoxic substances and secret lymphokinin which attracts phagocytes. These are responsible for cell-mediated immunity. They also destroy transplanted and other foreign cells.
- **Suppressor Cells (T_S) :** These cell supress the functions of T_C and T_H cells. B-cells and plasma cells are also affected by T_S cells by secreting suppressor factors to suppress the entire immune system for attacking the own body.
- **Memory T-cell :** They don't kill the pathogen or don't form the antibodies but these cell **retain the memory** or every encounter.

They convertes into effector cells (T_C) on later encounter with specific antigen even after several years.

Antigen Presenting Cells : In immune mechanism every antigen molecule is processed by antigen presenting cells like macrophages, B-lymphocyts etc. This processed antigen is presented on the surface of these cells. When a T-helper lymphocyte passes closely by the side of the antigen presenting cell bearing the antigen on its surface. It recognise the antigen and become activated. Now T-helper cells activate the B-cells and T-killer cells. These cells in turn develop clones by frequent divisions in themselves.

(3) **A.M.I.S.** (Antibody mediated immune system or humoral immunity)



This immune system is based on B-lymphocytes (10-20%) and these B-lymphocytes secrete the antibodies.

Antibody or Immunoglobulin : These are complex glycoprotein molecule made up of 4 polypeptide chains, two light and two heavy chains.

These two chains are held together by disulphide bond in shape of Y, molecule is represented as H_2L_2. Two top tips of this molecule bind with antigen [large and complex foreign molecules mainly proteins that activate the specific immunity] like lock and key fashion and make antigen-antibody complex.

FUNCTION OF ANTIBODIES

(i) **Agglutination :** Antibody attach with the antigen which is present on the surface of pathogen and destroy the pathogen by cell lysis.

(ii) **Opsonisation :** Coating of bacteria (Ag) with opsonin antibody (IgG and IgM) facilitates the phagocytes cells and these antibodies or opsonin promote phagocytosis by combination with antigen.

(iii) Neutralization : Antibodies neutralize the toxin of bacteria by attaching with them.

IgG - Protects body fluids.

IgA - Protects body surfaces.

IgM - Protects body blood stream.

IgE - Mediates regional hypersensitivity.

IgD - Activation of B-lymphocyte

First line of defence : Skin, Mucous membrane

Second line of defence: Neutrophils, Monocytes, Macrophage, interferon,·fever.

Third line of defence : Specific immunity by T- and B-lymphocytes

Type of Antibodies –

S. No.	Group of Antibodies	Total Quantity (%)	Main Characters and occurrence	Functions
1	IgG (Gamma)	75-80	Most aboundantly antibodies main immunoglobulin of blood and interstitial fluid which has capacity to pass through placenta, M.W. 1,46,000 (lightest)	Stimulate complementary system, provide immune power to human embryo and specific linkage with phagocytic cells for phagocytosis.
2	IgA (Alpha)	10	The primary antibodies present in colostrum, M.W. 1,70,000 : present in saliva, mucus and other secretions.	Protection of mucous membranes and outer surface of body and protection from inhaled ingested pathogens.
3	IgM (Mu)	5-10	Oldest and first antibody generated in response to antigens, present in blood plasma (80%) and interstitial fluids and largest immunoglobulin with pentameric form, M.W. 9,60,000 (heaviest)	First antibody generated at the time of defence, strongest agglutination
4	IgD (Delta)	1-3	Present in trace amount on the surface of lymphocytes in blood, M.W. 1,85,000	Activation of B-lymphhocytes and development and maturation of immune reactions.
5	IgE (Epsilon)	0.05	Present in very small quantities, show specific linkage with mast cells and basophils, M.W. 1,88,000	Stimulation of mast cells, related to allergic reactions and protection from parasites.