



## HUMAN IMMUNE SYSTEM AND IMPORTANCE OF IMMUNITY BOOSTERS ON HUMAN BODY: A REVIEW

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### ABSTRACT

Human body is the most complex and advanced system on the planet. Although it is capable of many big possibilities but diseases and infections are those invaders that hamper the body adversely. There are some diseases that are caused by the dysfunction of organs or fluids of the human body but some diseases are caused by the invasion of foreign microbes like bacteria, viruses and other parasites in our body. These foreign microbes can cause various diseases such as rhinitis, tuberculosis, dysentery and sometimes fatal viral diseases like AIDS and COVID-19 which are incurable till date. So to safeguard our body from such infection we have a potent system that is known as the immune system. This immune system helps in the removal of microbes by the means of immune cells like lymphocytes (B-cells and T-cells), macrophages and monocytes etc. these cells either remove the foreign particle from the blood stream itself or from the target site. Immunity can be enhanced by using immunity boosters and having a balanced lifestyle. In this paper details about human immune system have been discussed and it contains details about natural immunity boosters like giloy, neem, turmeric etc. Ayurvedic perspective of immunity is also discussed in the paper.

### INTRODUCTION

Human body is a complex system of various cells, tissues and organs which is capable of many different abilities. Sometimes the human body gets various ailments because of dysfunction in their internal system or organs but sometimes the human body gets affected by the foreign agents like bacteria, virus, fungi etc. which causes various ailments. To safeguard the body from such foreign agents immunity plays a big role. Immunity can be defined as the ability of the body to fight against the disease-causing micro-organisms. The immunity is provided to the body by an elaborate system which is called the immune system and it is composed of various cells, tissues and organs

**Immune system:** It is an interlinked complex system of cells, tissues and organs that work in

synchrony to defend the human body against attacks by harmful microbes like bacteria, viruses, fungi and other parasites from outside environment. The immune system functions on the process of memory as it first recognizes the foreign particle in the body then makes a memory of it and whenever this foreign particle attacks the body again, it eliminates it through various cells or complexes of immune system. This foreign particle that triggers the immune system is known as antigen and when this antigen causes allergy then they are known as allergens. In order to eradicate or kill these antigens the immune system produces anti-bodies in response and these anti-bodies facilitate in elimination as well as keeping memory for further killing of these antigens.

**Structure of immune system:** The organs related to the immune system are spread all over the human body and are known as lymphoid organs. The lymphoid organs contain small white blood cells called lymphocytes, which are involved in showing immune responses in the body. The lymphoid organs are as follows:

**Primary and Secondary lymphoid organs**

**Primary Lymphoid Organs** – These include

**Bone Marrow** – It is a soft tissue found in the hollow center of the larger bones. Bone marrow is the primary center where blood corpuscles are formed. This is a place where major lymphocytes (white blood cells) both B-cells and T-cells are produced. All the cells of the immune system are made in the bone marrow from the stem cells, through a process called hematopoiesis. The cells either develop and mature in the bone marrow itself or migrate to other peripheral sites for maturation.

**Thymus** – This is a gland found behind the sternum. Here storage and maturation of T-cells or T-lymphocytes that originate from the bone marrow takes place. Thymus is enlarged in small children and with age size of thymus reduces significantly. That is why it is even more crucial to look after one's immune system as the person ages.

**Secondary lymphoid organs** – These include

**Spleen** – This is a bean shaped flattened organ that is found in upper left abdominal cavity just beneath diaphragm. It contains compartments where immune cells confront the antigen and get activated. The Structure of spleen is similar to lymph node where outer connective tissue divides organ into lobules with sinuses filled with blood. The Blood vessels of spleen are expandable hence, spleen functions as blood reservoir, making blood available in times of low pressure or oxygen need. The Pulp is of 2 types:

**Red pulp** contains RBCs, lymphocytes, and macrophages and functions to remove bacteria and worn-out red blood cells.

**White pulp** contains mostly lymphocytes and aids in immunity and purification of blood.

**Lymph nodes and Vessels** – Lymph vessels are tube like structures through which a viscous material called lymph is carried throughout the body. This lymph contains lymphocytes involved

in immune responses. Lymphocytes travel both through the lymphatic vessels and blood stream. Lymphocytes perform the immune functions either in the blood stream itself or through targeting a specific site. Lymph nodes are small bean shaped nodules found throughout the lymph vessels concentrated in patches at different sites of the body which include neck, armpits, abdomen and groin. Each nodule contains sinus filled with lymphocytes and macrophages. In the lymph nodes the lymphocytes congregate and encounter the antigen. Here the immune cell kills the antigen and makes a memory for future recognition and elimination of the same antigen from the body. There are various prominent lymph node in the body which are:

**Tonsils**- These are located in back of mouth on either side

**Adenoids**- These are located on posterior wall above border of soft palate

**Peyer's patches**- These are found within intestinal wall

**Types of Immunity:** Immunity is basically of 2 types according to presence or absence from birth which is - (i) Innate immunity and (ii) Acquired immunity

Further immunity is divided as – (i) Active immunity and (ii) Passive immunity

**Innate Acquired Immunity**

**Innate Immunity:** Innate immunity is the basic type of immunity that a person has from birth. It is a non-specific type of immunity. This immunity works through different types of barriers which restrict the entry of the foreign agents into the body. Innate immunity possesses 4 types of barriers which are:

**Physical barriers:** This barrier includes the skin of the body, which is the first barrier that stops entry of the micro-organisms. Another physical barrier is the mucus lining of the epithelium that lines the respiratory, gastrointestinal and urogenital tracts. This mucus coated lining helps in trapping microbes which enter the body.

**Physiological barriers:** This barrier includes the protective fluids in the body such as the Hydrochloric acid in the stomach, saliva in the mouth and tears from eyes. These fluids prevent all microbial growth.

**Cellular barriers:** This barrier includes specialized protective cells like some types of leukocytes (White Blood Cells), polymorphonuclear leukocytes (PMNL-neutrophils), monocytes and natural killer in the blood for destruction of any foreign, harmful microbe present in the blood stream.

**Cytokine barriers:** This barrier is formed by the Virus-infected cells itself. Such infected cells secrete proteins called interferons which protect non-infected cells from further viral infections.

**Acquired Immunity:** This is a pathogen specific immunity. It has characteristic memory cells which ensure that when the body encounters a pathogen for the first time it produces a response called **primary response** which is of low intensity. Later encounter with the same pathogen elicits a highly intensified secondary or anamnestic response. This **shows** that human body has memory of the first encounter.

There are special lymphocytes which help in mediating the primary and secondary immune responses, these lymphocytes are **B-lymphocytes** and **T-lymphocytes**. The B-lymphocytes produce antibodies made of proteins in response to pathogens into the blood to fight with them.

**Formation of B-cells and T-cells** – initially in the bone marrow, the immature immune cells are known as the stem cells. In the bone marrow cytokines act upon the stem cells and the accordingly convert them to T-cells, B-cells or Phagocytes.

#### **Antibody mediated/Humoral immunity:**

The B cell antigen-specific receptor identifies the whole pathogen without any need for antigen processing. This is present on the surface of the B-cell molecule. Different antibody is depicted by a different B-cell receptor which shows the uniqueness of each anti-body. To fight antigens present in the blood the B-cells form antibodies called immunoglobulins (Ig) which kill the antigens. Types of immunoglobulins (Ig) are as follows:

**Ig G-** It works to capture and cover the microbe, speeding their uptake by the immune cells for further elimination

**Ig M-** This antibody is specialized in killing the bacteria

**Ig A-** This antibody is concentrated in the fluids of the body such as secretions of the respiratory and digestive tract, tears, saliva etc. This antibody protects the entrances of the body. It is also found in the breast milk of human mothers the milk called colostrums which is highly beneficial to the infants.

**Ig E-** This antibody is responsible for symptoms of allergy as it is activated during allergic responses. Its natural job is to protect from allergens.

**Ig D-** This antibody remains attached to the B-cells and initiates the early B-cell response

**Cell mediated Immunity** – This immune system does not recognize free floating antigens rather it directly attacks specific target antigens. These are of two types:

**Helper T-cells** – It coordinates immune responses by communicating with other cells. They call on phagocytes and killer cells to perform the elimination by identifying the antigen.

**Killer T-cells (Cytotoxic T-lymphocytes) CTLs** - T cells recognize a ‘non-self’ target, like a pathogen, after the antigens are processed to show in combination with a ‘self’ receptor called a major histo-compatibility complex (MHC) molecule. Killer T cells identify antigens coupled to Class I MHC molecules, whereas the Helper T-cells identify antigens coupled to Class II MHC molecules and after identification of the antigen, it kills and removes them

#### **Some other Cells involved in immune system:**

**Phagocytes** – These are large white blood cells that travel throughout body in pursuit of invading pathogens and can swallow and digest foreign particles and microbes. Phagocytes are generally of two types which are:

**Monocytes** – These are phagocytes which circulate in blood and ingest foreign material or microbes present in blood stream. They are non-specific in nature.

**Macrophages** – When monocytes migrate into tissues they transform to macrophages. These are not found in blood stream rather these are found in organs like lungs, liver, kidney and brain etc. They get rid of worn out and dead cells in the body. Macrophages are cells that are present

inside tissues and produce varied chemicals that include enzymes, complementary proteins, and regulatory factors such as interleukin 1.

**Natural Killer Cells** – These cells belong to the family of B and T-cells but are of wider range in identifying harmful foreign particle and eliminating it. Natural killer (NK) cells are involved in immunity against viruses and other intracellular pathogens. These cells participate in antibody-dependent cell-mediated cytotoxicity (ADCC).

**Granulocytes** – These cells contain granules filled with potent chemicals which kill foreign particles and microbes. For example, chemical like histamine is involved in inflammation and allergic reactions. They are of three types:

**Neutrophil:** Neutrophils are the most numerous white blood cells found in blood. They are about 50% to 60% of circulating leukocytes. Neutrophils are the first cells to arrive at the site of infection like during an acute phase of inflammation, specially in bacterial infection, they migrate toward site of inflammation in a process called chemotaxis, and perform necessary immune function.

**Eosinophiles:** These are generally involved in allergic response. High number of eosinophiles in blood is a signal of some allergy or infection in the body. It kills Ab-coated parasites through degranulation. It is closely linked with IgE antibodies and responsible in allergy related inflammation.

**Basophiles:** They are present in the blood stream in very minimum quantity and are involved in infection related responses through secretion of chemicals like histamine.

**Dendritic cells:** These cells are star shaped and capture the antigens like the T- lymphocytes. These cells act like phagocytes and are present in the tissues that are usually in contact with the external environment such as skin, nose, stomach, intestines etc. These cells have strong resemblance to neuronal dendrites, as both have many spine-like projections called dendrites. Dendritic cells interlink the bodily tissues and the innate and adaptive immune systems, as they present antigen to T cells.

**Mast cells:** These cells are located mucous membrane and connective tissue throughout

body. These cells are major effectors cell in allergy and are responsible for modulation of initial immune response. They cause expulsion of parasites through release of granules that contain chemicals like Histamine, leukotrienes, chemokines, cytokines which are also involved in allergic responses.

**Cytokines**–These are known as the mediators of the immune system. Their task is to act as bridge between the specialized cells of the immune system. They do so by integrating the action responses of the cells with each other. Cytokines are important for both innate and acquired immunity. Structurally and chemically cytokines are a group of soluble extracellular proteins that are glycoproteins in the form of interleukins (ILs), interferons, chemokines, etc. These cytokines maintain physiological stability within the immune system through their secretions in all nucleated cells.

#### **Active vs. Passive Immunity**

Active Immunity is a protective immunity that stimulates the immune system of the individual to produce antibodies and lymphocytes. It needs to get exposure of a pathogen or the antigen of the pathogen and there exist active involvement of the immune system of an individual, in the process. Active immunity emerges naturally when there is exposure to a pathogen or antigen. They are given artificially to an individual through vaccines. Active immunity includes both cell mediated immunity and humoral immunity. The components of active immunity are- T-cells which includes memory T-cells, helper T-cells, cytotoxic T-cells and suppressor T-cell, B-cells which includes , includes plasma cells and memory B-cells, and antigen presenting cells which includes B cells, dendritic cells and macrophages. The antibody production of active immunity is induced by infection. The result of active immunity is the formation of memory cells that remain in the body. Active immunity performs such that, when the body has its first exposure to a pathogen, the active immunity responds, however if any subsequent exposure is felt by the body, the secondary response is much stronger and faster than the initial response. The individual is protected for a longer period of time through active immunity and due to this reason of prolonged protection; the response time taken by this immunity is also longer. Active immunity can be activated again either by re-vaccination or

by the reoccurrence of the infection. This type of immunity is not effective for immune-compromised or immune-deficient individuals, however it is highly suitable for prophylaxis of diseases because it provides complete protection to the individual. The natural course of action for this immunity is that it produces antibodies in response to exposure to pathogens. Whereas, Passive Immunity is the type of immunity that allows the individual to take antibodies from the immune system of another individual. There exist no need for the exposure to any pathogen or antigen because the immunity of the individual is passively involved in the process. Passive immunity is acquired naturally either when mother delivers antibodies to the fetus through placenta or when a child breast-feeds from his/her mother. It is given artificially to an individual through administration of performed antibodies. Here, the immunity can only be transferred through the medium of artificial antibodies and also there is no involvement of any immune cell. The antibodies are not produced rather they are directly transferred. In passive immunity there is concept of memory and therefore they only perform primary response and not secondary. The protection from the passive immunity is immediate, for example in case of vaccines and anti-venom injections the effect is usually very immediate. For the purpose of renewed protection by the passive immunity, the frequent re-administration is compulsory. Passive immunity is helpful in the cases of immuno-compromised, immuno-deficient and combined immunodeficiency syndromes.

**Disorders of immune system –Auto immune disorders** – An immune system is healthy when it is able to make clear distinction between own cells and other cells when it is killing any foreign agent. When the immune system confuses between own and other cells and starts attacking body's own cells then such a condition where one's own immune system has turned against them, this gives rise to the auto immune disorders. Two common autoimmune diseases are-

**Rheumatoid arthritis** – It is a chronic inflammatory disorder that is caused when the immune system starts attacking self-cells due to which there is swelling in the joints. Symptoms of rheumatoid arthritis include swollen, warm joints, joint stiffness, fatigue, fever and loss of appetite. Early rheumatoid arthritis affects

smaller joints like that of fingers or toes but as the disease complicates further it starts affecting bigger joints of knees and ankles as well.

**Lupus**–It is an inflammatory disease that affects joints, skin, kidney and muscles. Symptoms of this disease include fatigue, joint pain, rashes and fevers. It can be fatal to life as well if early intervention is not done.

**Allergy**– Allergy can be defined as the excess response of the immunity towards certain antigens that are present in the surroundings. The substance against which an immune response is created is called an allergen. IgE type antibodies are produced for these types of allergen. Some of the common examples of these allergens are pollens, mites in dust, animal dander, etc. The symptoms of allergy towards an allergen are, runny nose, sneezing, watery eyes and difficulty in respiration. Allergy is caused due to the release of some chemicals such as histamine and serotonin. Diseases caused due to allergy are the most common health conditions in the world. Some allergic diseases include hay fever, eczema, hives, asthma, and food allergy are some types of allergic diseases. Allergic reactions begin in your immune system. When a harmless substance such as dust, mold, or pollen is encountered by a person who is allergic to that substance, the immune system may overreact. It may produce antibodies that attack the allergen. These can cause wheezing, itching, runny nose, watery or itchy eyes, and other symptoms. Hormones, stress, smoke, perfume, or environmental irritants may trigger the development or severity of allergies.

**Immunity and Cancer**- Immune system can be weakened by cancer due to its spread into the bone marrow. In human body it is the work of bone marrow to produce blood cells that help in fighting an infection. For example, in diseases like leukaemia or lymphoma bone marrow plays a pivotal role, same is applicable to some other types of cancers too. However the cancer cells hinder or stop the production of blood cells in the bone marrow making the human body weaker and more exposed to any infection. Moreover the treatment that is provided to cure cancer also temporarily weakens the immune system of an individual. This is due to the fact that such treatment significantly reduces the number of white blood cells produced by bone marrow in the body. Some of the most common cancer treatments that weaken the

immune system are: Chemotherapy, Targeted Cancer Drugs, Radiotherapy, High dosage of Steroids. During certain times the body identifies cancer cells with the help of strong immune system and kills those cancer cells before they expand in the body. However this is not a successful way to eradicate cancer completely because cancer cells are very dangerous and their cure is not easy. There are few cancer treatments that use the immune system of the body to fight cancer. There exist two major parts of the immune system: Inbuilt immune system that gives protection to an individual since the birth. Acquired immune system that an individual develops after getting exposed to a certain disease and subsequently getting rid of it.

#### **General reasons for imbalance in immunity:**

#### **Immune system generally gets misbalanced due to following reasons-**

1. Unhealthy Diet – A diet that is not nutritionally balanced usually ends up hampering the immunity of the body. Excess intake of processed sugars, additives for artificial flavoring and junk food is known to weaken the immune system.
2. Alcohol intake, Smoking and Substance Abuse – Many studies prove that regular alcohol intake, smoking or substance abuse can weaken the effectiveness of the immune systems against common pathogens
3. Irregular sleep pattern – Constantly varying sleep patterns, lack of sleep or interrupted sleep causes stress which affects the immune system adversely.
4. High levels of stress – Stress increases the cortisol level in blood resulting in malnourished immune system.
5. Obesity – Excess fat in the body causes imbalance in metabolism and hormonal functions. Lack of exercise also leads to negative impact on immunity.
6. Prolonged medications – Use of antibiotics and certain other medications for a long period of time proves to be detrimental for immunity.
7. Dehydration – Various studies have shown that not having enough water can reduce the effectiveness of immune system.

**Nutrition and immunity:** Malnutrition and unhealthy diet is associated with poor immune function and adverse outcomes. Studies have shown that nutritional support can improve immunity and build more resilient immune system. Healthy changes like balanced diet, regular exercise etc can result in improved immunity. Sometimes when the natural remedies do not work then immunity supplements in the diet can help improve immunity. Such supplements can be in the form of tablets, tonics or capsules. Supplements that are usually given for immunity enhancement generally contain retinol, beta-carotene, thiamine, riboflavin, niacin, pyridoxine, folate, iron, zinc, copper, selenium, iodine, calcium, magnesium, and vitamins B12, C, D, and E. These supplements can be potent immunity boosters.

**Immunity Booster:** Immunity boosters are foods, fruits, vegetables, or even artificially designed supplements that help us increase this ability to fight against illnesses. There are a lot of foods, fruits, and vegetables that can naturally enhance your immune system. One of the easiest ways to improve your immunity is to have a healthy and wholesome diet. Fruits and vegetables that are rich in beta carotene, Vitamin C, Vitamin E, and zinc are good for boosting immunity. These include broccoli, cauliflower, kale, kiwi, orange juice, papaya, red, green or yellow pepper, sweet potato, strawberries, tomatoes, avocados, peanuts, almonds, spinach, eggs, dairy and milk. All kinds of berries, along with foods rich in omega-3 fatty acids such as beans, flax seeds, and even some nuts can be consumed to strengthen immunity. Some of the immunity-boosting herbs are garlic, black cumin, and licorice. Changes in immune system are brought about by the immunomodulators. Immunomodulators are those substances which induce, amplify, and inhibit any component of the immune system. There are 2 types of immunomodulators which are: Immunostimulators and Immunosuppressant. Various herbal medicines have been found to modulate various components of innate and acquired immune system. Plant derived secondary metabolites can pose to be potent immunomodulators for therapeutic use. Immunomodulators can be used in curing various allergic diseases including asthma and allergic rhinitis. There are researches which show that various plant products act as immunity boosters. A study done by Halwani R, et al. have reported that the reduction in eosinophil infiltration of

lungs and inhibition of airway hyperresponsiveness among ovalbumin level of IgE and associated cytokines IL-5, IL-4, and IL-13 when they were treated with *Ganoderma lucidum*, *Glycyrrhiza uralensis*, and *S. flavescens*. Another study done by Patil et al. explained that extract of *Ficus carica* produces stimulatory effect on humoral and cell-mediated immune response. A study also showed that root extracts of *Chlorophytum borivillianum* is an immunomodulator which works on non-specific immune response, humoral as well as cell-mediated immunity. It may be useful in curing infections, enhancement of immunological response against foreign particles or antigens, and improving defensive response under normal circumstances. Extract from the plant *Picrorhiza kurroa* have the ability to stimulate humoral response by stimulating various levels of immune mechanism such as antibody production, release of mediators of hypersensitivity reactions, and tissue responses to these mediators in the target organs. Extracts of plants like *Astragalus membranaceus* which is also 'spleen chi tonic' is a Chinese plant used in curing various diseases of the body. The studies on the plant show that the root extract of the plant was found to lower IL-6 in *in vitro* human model, where IL-6 is an inflammatory and impending deterioration marker. A very extensive study done on garlic plant *Allium sativum* shows that the garlic extracts significantly lower IL-1 and IL-6. Garlic is a potent anti-inflammatory, hypocholesterolemic, antioxidant, and also angiotensin-converting enzyme inhibitor. Garlic use has been suggested in enhancing immunity as well. A research study done by Spelman et al. have reported that more than 18 herbal plants including *Acanthopanax gracilistylus*, *A. sativum*, *Ananas comosus*, *Cissampelos sympodials*, *Coriolus versicolor*, *Curcuma longa*, *Tinospora cordifolia*, and *Withania somnifera* show immunomodulatory activity. Studies also show that the aloe vera plant possesses the wound and burn healing properties due to its anti-inflammatory nature.

Advantages of consuming Immunity boosters:

- Immunity boosters protect the body from various diseases and infections
- The intake of **immunity boosters** is done in order to replenish various essential nutrients, like vitamins, minerals, etc. in the body

- Immunity boosters speed up the healing process of the body.
- Immunity boosters enhance the productivity of the body by keeping it energized.
- Immunity boosters assist in improving well-being by maintaining body weight, blood pressure, digestion, body growth and cholesterol levels.

**Good Immunity: Healthy Lifestyle:** In order to develop a healthy immune system, there is an inevitable need of regular intake of immunity boosters through balanced diet as well as some immunity boosting supplements. Moreover, some basic habits that leads to a healthy immune system can be inculcated to promote healthy lifestyle. Some of the basic practices are -

Regular exercise for a minimum of half hour should be done. This daily practice will not only improve the blood circulation rather it will keep the body relaxed and active throughout the day. Proper vaccinations and immunizations since birth are very essential. It will ensure the prevention of chronic diseases like polio, pneumonia, flu, hepatitis etc.

- Sufficient amount of sleep and rest is also necessary for the body to keep it rejuvenated. This is also important because providing rest to the body allows it to replenish itself naturally.

Water level in human body also plays a significant role in keeping it disease free. Hence the body should be well hydrated at all times. Consumption of alcohol and smoking should be limited as much as possible as they have severe effect on the immunity of an individual. Excessive smoking and alcohol intake weakens the entire immunity system making it susceptible to diseases.

## CONCLUSION

Human body is a sum total of various complex systems which integrate and interact together for efficient functioning of the body. The immune system is one such system of the body which is mainly responsible for building the resilience and

safeguarding the body from foreign infectious agents. Immune systems is responsible for maintaining body's natural resistance to any outside infection, this is called immunity. Immunity is categorized into two types; first type being, the innate immunity which acts as the first line of defense and is inherent in nature and the second type being acquired immunity which works in assistance of immune cells like lymphocytes (B-cells and T-cells) and macrophages. Acquired immunity is an immunity on which one has to work on constantly to maintain it well. In order to maintain immunity and stay healthy, foremost step is keeping a healthy lifestyle. A healthy lifestyle can be maintained by keeping balanced diet, doing regular exercise and keeping away from addictions of alcohol or smoking. For better immunity, immunity boosters can also be taken which can be plant extracts, vitamin C rich citrus fruits, certain green leafy vegetables like spinach and other potent immunity boosters like neem, turmeric and tulsi etc. Through this paper it can be concluded that though human immune system is very resilient but its effectiveness can be enhanced even more if certain immunity boosters are inculcated in the daily diets of people.

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