

## Our protective shield: The Immune System

The confidence that our body has in combatting any infection is attributed to the intricate system of cells and tissues within it called the immune system. It is our protective shield and helps to keep the integrity of the body intact. It is a response that the body elicits against any infection and attacks from the exterior environment (exception is autoimmune diseases). The system is remarkably effective, most of the time. The foreign substance that attacks is termed the antigen and the response the body generates is in the form of antibodies. So basically the immune system is the interplay or “chess” between antigen and antibody.

The remarkable and unique feature of our immune system is Self/non-self recognition. It is achieved by having every cell display a marker based on the major histocompatibility complex (MHC). Any cell not displaying this marker is treated as non-self and attacked. The process is so effective that undigested proteins are treated as antigens. That can be explained as possessing “Identity cards” – the cells which have it are considered friends and those not in the possession of ID cards are attacked and fought against.

As there are exceptions to most cases so is this one. Sometimes the process breaks down and the immune system attacks self-cells (those having the Identity cards). This is the case of **autoimmune diseases** like multiple sclerosis, systemic lupus erythematosus, and some forms of arthritis and diabetes.

### The soldiers of the immune system army

They are comprised of two important cell types: the **B-cell and the T-cell**. The basic function of the B-cells is to produce antibodies against the antigen while the T-cells, by way of two types, either help the B-cells in their function or kill/damage the antigens.

The two main types of T-cells are the "**helper**" **T-cell** and the "**cytotoxic**" **T-cell**. The T-helper population is further divided into those which help B-cells (Th2) and those which help cytotoxic T-cells (Th1).

Cell	Function
B-cell	Production of antibodies
Helper T cell	Helps B-cells in their function
Helper Th2	Helps B-cells
Helper Th1	Helps Cytotoxic T cells
Cytotoxic T cell	Kills and damages the antigens

The dutiful soldiers get into action the moment any foreign substance or agent enters our body. Thereby the immune system is activated. The end result is the elimination of the substance or agent from our bodies.

In case of extracellular pathogen, which remains outside the cell at all times or much of the time (virus often released) the "best" response is the production by B-cells of antibodies which circulate all around the body in the bloodstream, and eventually bind to the agent. While in cases of intracellular pathogens like viruses or certain bacteria which require the inside of one of our cells in order to live, the "best" response is the activation of cytotoxic T-cells (circulate in the bloodstream and lymph), which eliminate the agent through killing of the cell which contains the agent (agent is otherwise "hidden").

Normally, these actions are wonderfully protective of us. The effect of HIV on the immune system is the result of a gradual (usually) elimination of the Th1 and Th2 helper T-cell sub-populations. Thereby HIV affects the immune system adversely.

### **The Aides in combat**

The main soldiers mentioned above comprising the immune system army, are helped in their battle against the antigens (the attackers) are two main fluid systems in the body: blood and lymph. The **blood and lymph systems** are intertwined throughout the body and they are responsible for transporting the agents of the immune system.

**Blood** is composed of 52–62% liquid plasma and 38–48% cells. The plasma is mostly water (91.5%) and acts as a solvent for transporting other materials. Blood is slightly alkaline (pH = 7.40) and a tad heavier than water (density = 1.057). The cell components of blood are RBC's (erythrocytes), WBC's (leukocytes) and Platelets (thrombocytes).

**Lymph** is an alkaline (pH > 7.0) fluid that is usually clear, transparent, and colourless. It flows in the lymphatic vessels and bathes tissues and organs in its protective covering. There are no RBCs in lymph and it has lower protein content than blood. Like blood, it is slightly heavier than water (density = 1.019)

### **The commander in chief: Innate Immunity**

Innate immunity is gifted to us by our parent that is it is hereditary. Its salient features are mentioned below.

#### **Surface Barriers or Mucosal Immunity**

1. **Skin**- it is the first line of defence for the body. The skin cannot be penetrated by most organisms unless it already has an opening, such as a nick, scratch, or cut.
2. **Lungs**- Pathogens are expelled from the lungs by ciliary action coughing and sneezing abruptly eject both living and nonliving things from the respiratory system.
3. **Mucous** - Sticky mucous in respiratory and gastrointestinal tracts traps many micro-organisms.
4. Acid pH (< 7.0) of skin secretions inhibits bacterial growth. Additionally hair follicles secrete sebum that contains lactic acid and fatty acids both of which inhibit the growth of some pathogenic bacteria and fungi

5. **Saliva, tears, nasal secretions, and perspiration** contain **lysozyme**, an enzyme that destroys Gram positive bacterial cell walls causing cell lysis. Vaginal secretions are also slightly acidic (after the onset of menses). Spermine and zinc in semen destroy some pathogens. Lactoperoxidase is a powerful enzyme found in mother's milk.
6. The **stomach** secrete hydrochloric acid ( $0.9 < \text{pH} < 3.0$ , very acidic) through its mucosa and protein-digesting enzymes that kill many pathogens.

Another important recruit of the immune system army is a **phagocyte**. It is a cell that attracts (by chemotaxis), adheres to, engulfs, and ingests foreign bodies.

**Natural killer cells** move in the blood and lymph to lyse (cause to burst) cancer cells and virus-infected body cells. They are large granular lymphocytes that attach to the glycoproteins on the surfaces of infected cells and kill them.

### **Adaptive or Acquired Immunity**

Besides the natural immunity there is Acquired Immunity as well. Parts of the immune system are changeable and can adapt to better attack the invading antigen. There are two fundamental adaptive mechanisms: cell-mediated immunity and humoral immunity.

### **The bone of contention**

The culprit behind the collapse of the Immune system is the virus named HIV. Before talking about HIV one needs to understand AIDS.

AIDS stands for **acquired immunodeficiency syndrome**, a disease that makes it difficult for the body to fight off infectious diseases, and it is caused by the **human immunodeficiency virus** known as HIV. It acts by infecting and damaging part of the body's defenses against infection, namely the white blood cells known as **lymphocytes**, a type of white blood cell in the body's immune (infection-fighting) system that is supposed to fight off invading germs.

It is becoming a menace and affecting large number of people across the globe. To understand the devastation of AIDS, one has to understand the high mortality rate of people who develop the disease. Basically, that means that each year AIDS kills the same number of people that populate the third largest city in the United States. Between 36.7 and 45.3 million people are infected with the HIV virus worldwide as of November 2005, with as many as 25.8 million of those cases in sub-Saharan Africa. The regions with the greatest number of people living HIV/AIDS, according to the World Health Organization, include:

Sub-Saharan Africa - 25.8 million, South and Southeast Asia - 7.4 million, Latin America- 1.8 million, North America - 1.2 million, Eastern Europe/Central Asia - 1.6 million

AIDS is clearly one of the worst health crises facing the world today. Without any truly effective treatment, most health experts are putting an emphasis on prevention to stop the spread of HIV. That is the best bet the world has as of now.

## **HIV and the Body**

The battle between HIV and the Body is like a snake and the mongoose.

The virus attacks specific lymphocytes called T helper cells (also known as T-cells), takes them over, and multiplies. This destroys more T-cells, which damages the body's ability to fight off invading germs and disease. This results in the diminishing soldiers which can fight off the infection and as a result the body gets weaker and the immune system ineffective by the day. It is a cascading effect and not just one infection.

When the number of T-cells falls to a very low level, people with HIV become more susceptible to other infections and they may get certain types of cancer that a healthy body would normally be able to fight off. This weakened immunity (or immune deficiency) is known as AIDS and can result in severe life-threatening infections, some forms of cancer, and the deterioration of the nervous system.

A very important point to keep in mind is that although AIDS is always the result of an HIV infection, not everyone with HIV has AIDS. In fact, adults who become infected with HIV may appear healthy for years before they get sick with AIDS.

## **The strategy of HIV Attack**

Once the HIV virus enters the body, it heads for the lymphoid tissues, where it finds T-helper cells. It first binds with the CD4 protein of the T-helper cell. The viral core enters the T-helper cell and the virion's protein membrane fuses with the cell membrane. Thereby the viral enzyme, reverse transcriptase, copies the virus's RNA into DNA. The newly created DNA is carried into the cell's nucleus by the enzyme, viral integrase, and it binds with cell's DNA. HIV DNA is called a provirus. The process of transcription follows which is succeeded by translation. RNA and viral enzymes gather at the edge of the cell. An enzyme, called protease, cuts the polypeptides into viral proteins. Then assembly of the entire structure takes place. To achieve multiplication new HIV virus particles pinch out from the cell membrane and break away with a piece of the cell membrane surrounding them. This is how enveloped viruses leave the cell. In this way, the host cell is not destroyed. They then start attacking and destroying T-helper cells.

When a person's T-helper cell count drops below 200,000 cells per one milliliter of blood, he or she is considered to have AIDS. The development of AIDS takes about two to 15 years.

No one dies from AIDS or HIV specifically. Instead, an AIDS-infected person dies from infections, because his or her immune system has been dissipated. An AIDS patient could

die from the common cold as easily as he or she could from cancer. The person's body cannot fight off the infection, and he or she eventually dies.

### **Prevention is better than Cure**

This is a very old adage but fits perfectly in this context. There has been exhaustive and ever expanding research for that Vaccine which would put an end to HIV misery, but till date there is none. So the second best thing is to practice avoidance. Infection can be prevented by never sharing needles, and abstaining, or not having oral, vaginal, or anal sex. Additionally the use of latex condoms always for all types of sexual intercourse, and avoidance of contact with the blood, semen, vaginal fluids, and breast milk of an infected person should be helpful.

The most important means of preventing HIV/AIDS in infancy is to test all pregnant women for the virus. If the result is positive, treatment can immediately begin before the baby is born to prevent HIV transmission.

Thus, the best policy is being educated, aware and knowledgeable about the whole issue, which would result in protection for self and helping others stay safe.

So here is to “prevention is better than cure”!

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