



# **The Immune System**

**Your Personal Army**

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## Your Skin: The Barricades

Your skin is an important and often overlooked part of the Immune System. It is the first thing that comes between harmful bacteria (AKA antigens) and your immune system. Your mucous and saliva also help keep out unwanted invaders. These substances, quite simply, act as a physical barrier. Though they are the first line of defense, they are often breached by things like cuts. If breached, your dead and damaged civilian cells will release cytokines, tiny chemicals meant to convey info and spread news. Since cells are blind and deaf, the only way they can communicate is through cytokines. The kind of cytokines released in the case of a bacterial invasion, conveys a message something like this: **HELP! WE ARE BEING INVADED!** This activates the Innate Immune Response, which is the first of 2 immune responses.

## The Innate Immune Response: A General, one-size-fits-all battle plan

If bacteria breaches your physical defenses, your innate immune response is activated. Immune cells will exit your bloodstream and rush to the warzone when they receive the cytokines. The most notable of these cells are the Macrophages, your general troop, and Neutrophils, the crazy bombers with machine guns. Both of these cells have exclusive ways to kill antigens. Macrophages use phagocytosis, and Neutrophils use NETs

## Phagocytosis : Sophisticated and effective

Using their cytoplasmic extensions, which are a bit like arms, Macrophages pull in harmful bacteria and absorb them. Then, the Macrophage will open up a part of its body, forming a kind of prison cell, and seal it off, trapping the bacteria. Then, using the patches of acid inside of them, they dissolve the bacteria until it is down to its simplest form, a clump of actually beneficial proteins.

## NETs : It is exactly what it sounds like

NETs are a very simple yet brutal way of killing bacteria. Basically, the Neutrophil rips itself open, and weaves its DNA into a net, spewing out its insides, which are harmful to bacteria, as well as trapping them.

Remember, this is all on a microscopic level, so even though it may not seem logical, it is very possible for this to happen. Neutrophils can also spew out their insides by exploding instead, but NETs are obviously more effective.

## **Fever, Inflammation, Loss of Appetite and Tiredness: The way civilians protect themselves**

Fever, tiredness, and inflammation are ways that your body's innate immune response helps to keep out antigens. Fever is just macrophages increasing your internal temperature to make antigens uncomfortable, and tiredness is the way your body saves energy. Most of the symptoms of illness that you feel are often just the Immune System doing its job! Fever, Tiredness, Loss of Appetite, and Inflammation are all just ways your body withers down bacteria. This is why you should let your body do its thing for a few days, if you still feel worse, then you can go to a doctor or take over-the-counter medicine.

## The Adaptive Immune System: The Special Ops

In the case that your Innate Immune Response cannot get rid of the harmful bacteria, which is at this stage known as a pathogen, your Adaptive immune response is called in. This is a special part of the immune system that can, as the name suggests, adapt to the situation. The first stage is when your dendritic cells come to the warzone. They are like intelligence officers, taking samples of antigens and studying them. Then, they enter the lymphatic system and try to find a T cell suitable for the enemy. They do this by presenting the antigen samples in MHC II molecules. If a T cell is stimulated by the sample, the dendritic cell gives it a sort of confirmation that they activated. The reason the T cell has to be stimulated first is because T cells are all unique. They all are different, so the right one needs to be chosen.

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## The Adaptive Immune System: The Special Ops

Then, the activated T cell starts multiplying by the thousands. Once it is done multiplying, it splits into two groups. The first group enters your blood and defends it, while the second group goes to the warzone. There, they act as commanders, and revive tired macrophages, making them more effective and strong. If the invasion is stopped, the T cells that survive become memory cells and help to defend you the same illness ever comes again.



## B Cells

### Activation by Innate Immune Response

B Cells require 2 stimulations to become truly activated. The first one is by the Innate Immune Response. While the Dendritic cells run around looking for T cells, B cells run around looking for antigens they can connect with. They do this by rubbing themselves in everything they see, and if they find an antigen they can connect with, no matter how it is presented, they will activate and clone over 20 000 times, each clone producing hundreds of antibodies per second. If the forces are still too weak, a second activation is required

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## B Cells

### Activation by Adaptive Immune Response

This activation is fairly straightforward. The B cell rips up antigens and presents them on MHC class II molecules, and if they stimulate an active T cell clone from earlier, the B cell gets activated and turns into a Plasma cell, which heads to the battlefield and starts producing over 2 000 antibodies per second. If they survive the attack, they become long-lived Plasma Cells.

## The Thymus

The Thymus is a chicken wing sized organ between your two lungs. It is one of the most important organs when it comes to the immune system, as it trains T cells. What happens is that T cells follow the lymphatic system to the thymus, where they undergo three tests. If they fail in even one, they are ordered to do apoptosis, which is just cell suicide. The role of the thymus is to prevent autoimmune disease, which is just a disease where your immune system starts attacking you! This is why the Dendritic cells must deliver a confirmation when it is activating a T cell. These three tests are as follows

Do they have working receptors?

Can they recognize and communicate with Immune Cells?

Can it recognise cells in your own body?

## The Complement System

The complement system is an integral part of your immune response. There are over 30 types of complement proteins, and they all are just floating around in your blood, waiting to be hit with the exact right thing at the exact right time, or they will just dissolve. Complement proteins have an extremely short life, and can dissolve in about 3 seconds if not activated, because they are very dangerous if they go out of control.

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## C3 Complement Protein

Let's say there is a C3 complement protein floating around, and it gets activated by a cytokine. It will split into C3b and C3a proteins. For now, let's follow C3b. It has an extremely short amount of time to find an enemy to latch on to, but let's say that it does. It will root itself into the membrane of that pathogen, and it gets activated again, changing its shape. Then, it catches more proteins and activates more C proteins, and eventually the right type of protein latches on to the C3b and becomes a C3 Convertase. Then, the convertase grabs C9 proteins and drives them into the pathogen, killing it. This is now known as a Membrane Attack Complex. The second group floats around releasing cytokines to activate more immune cells

## How to Boost Your Immune System

Now that we know how your immune system works, it begs the question, how do you boost your immune system? You can't boost your immune response, since it has been refined over millions of years, but you can strengthen your immune response. So the real question is "How can I strengthen my immune response?". Well, it is easier than you think! Sure, fancy diet plans and workout regimens work, but they also put a lot of stress on your body. Some effective way to strengthen your immune response are:

Drinking alcohol in moderation

Not smoking

Getting good sleep

Minimizing stress

Keep up to date with vaccines

## Conclusion

In today's date, we as a community do not give the immune system enough credit even though we rely on medicine and drugs heavily. These days, especially right after the Covid-19 pandemic, the immune system is extremely important. It is the second most complex system in the body, and people devote their whole lives to understanding how it works. I have just barely scratched the surface of how this amazing system works, and couldn't dream of ever mastering all of this knowledge! I hope I have enlightened you on the importance of the immune system and helped you understand how it really works. Thank you for giving me the opportunity to share this knowledge with you, and thank you for your consideration. Any questions?

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