

Innate immunity and trained immunity

Mommy, how does my immune system become stronger?

HOW TO TRAIN YOUR IMMUNE SYSTEM



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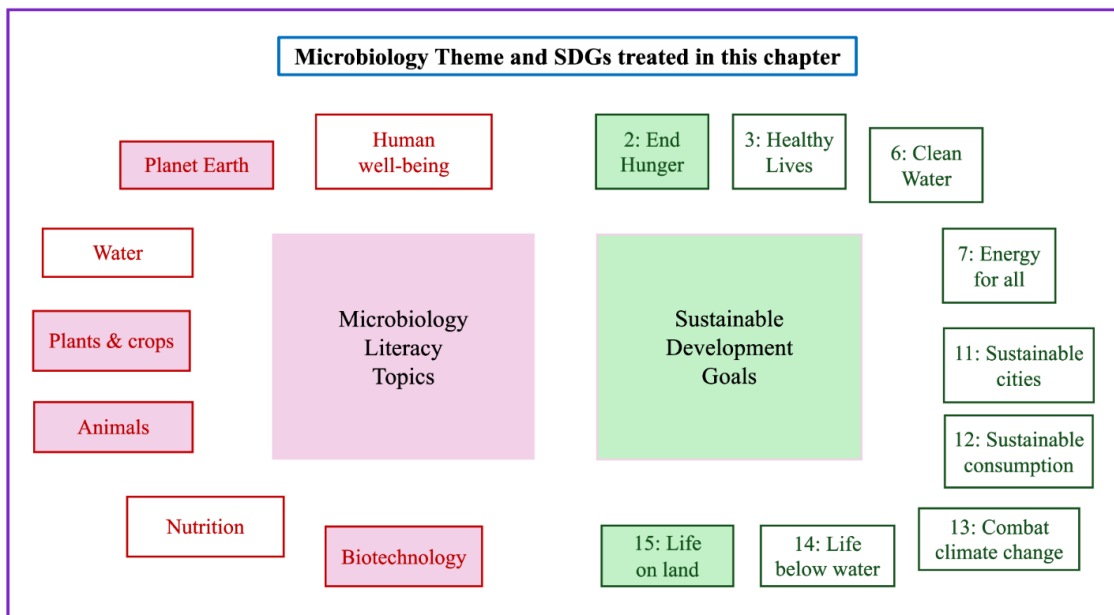
A child-centric microbiology framework

Our defense against infections: innate immunity and trained immunity

Storyline

Microbes are everywhere. Most of these microbes are harmless and we live with us peacefully. However, there are a few microbes that can cause disease, we call them *pathogens*. These can be found in the air, water, soil, and even on our skin. We are constantly exposed to microbes that can cause us harm. Luckily, our immune system is always alert to eliminate these threatening microbes as soon as possible.

Our immune system is not simply born knowing everything, it learns through experience. The learning process begins already early in life when a baby's immune system encounters foreign invaders and recognizes parts of the microbes that are not found in our bodies. The different components of our immune system learn the best way to attack each invader and begin to develop a memory for that encounter. Every type of immune cell has a different job, just like different members of an army, such as scouts, cavalry, or ground troops. Our immune system will remember the looks of the invader, so the next time we face such a microbe it will be quickly recognized and eliminated.



The microbiology and the societal context

Our immune system is the body's defense team. It protects us from tiny germs such as bacteria, viruses, fungi, and parasites that can make us sick.

From a microbiology point of view, these tiny organisms are everywhere—in the air, water, food, and on our skin. Most are harmless, and some are even helpful, like the bacteria in our gut that

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help us digest food. Harmful microbes can cause diseases, and the immune system works to stop them.

From a societal point of view, keeping everyone healthy is a shared responsibility. Washing hands, getting recommended vaccines, eating healthy foods, and staying home when sick help protect not only ourselves but also our families, friends, and the whole community. This is why good hygiene and vaccination are important for public health.

What happens when we encounter a pathogen?

Activation of the immune response

When a pathogen enters our body, our alarm systems quickly get activated. Our body mounts a strong immune response in the place where the pathogen is located. The area may become swollen, red, itchy or sore. All those are signs that a microbe tries to invade us, but also that our body is fighting back.

Inside the body, there are a series of alarm signals that are detected by the immune cells, who are quickly recruited to the area to try to contain the invasion and eliminate the pathogen before it spreads to other zones of the body. The first immune cells to respond to the infection are the so-called **innate** immune cells. They are called innate because they are born ready to act. They are ready to act from birth and have the tools necessary to detect and fight many different pathogens. We also have a second type of immune system, called **adaptive** immune cells. These cells are like the specialists of the immune system: they are trained to recognize one specific invader and can remember it for many years, sometimes even for lives. A bit like a sharpshooter. But for every new invader, we need another super-specialist, so they are a bit slower to react. This is why it is good we have two systems, one super-fast and one a bit slower but super-special. They work together.

When the invader and the innate immune cells meet each other, an intense fight starts. The pathogens try to hide, escape, to evade the action of the immune system. Some pathogens invade our cells, others multiple outside them and some spread through the blood to other places of the body, they will multiply to be stronger. Our innate immune cells will follow them wherever they go and will try to eliminate the pathogens by engulfing and digesting them, or by producing a series of substances that are toxic to the invader. Our immune system will not rest until the invading pathogen is eliminated.

After intense fights, that can be very short and finish in minutes, or be very long and take weeks, or even months, the pathogen will be eliminated. That means that the mission of our innate immune cells

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has been accomplished. However, this does not mean that they will relax. They learn from every encounter they have with a pathogen. This helps our cells to stay alert for the next encounters. The next time they face a pathogen, they will react faster and more efficiently. A bit like when you get stronger every time you go to the gym.

Activation of trained immunity. Protection against subsequent encounters

We know the existence of the cells of the innate immune system for more than a hundred years. For a long time, we thought that they were very strong but not very smart. We thought they were quickly activated in infection, that they fought the pathogen and that they did not learn anything from it. We thought that every encounter of the innate immune system with a pathogen felt like the first time. But a decade ago, we discovered that the cells of the innate immune system could also learn from these encounters with pathogens. They use these experiences to train, to become better defenders, and to be more efficient the next time they will face the same or even a different invader. This is called **trained immunity**, as the cells of the innate immune system use these encounters with pathogens to get trained and become more powerful.

Our cells do not have muscles, and cannot do push-ups, but they get trained in another way. One great example is by taking your shots. Vaccines are harmless versions of pathogens that activate our immune system in a way that will quickly recognize and eliminate the real pathogen when we encounter it. Originally, vaccines were designed to train only the adaptive immune cells, the super-specialist sharpshooters. But we found out that vaccines actually train both types of immune cells, also the quicker cells from the innate immune system. An exciting discovery is that the innate cells get stronger (trained) due to the vaccine, although are not super-specialists. These innate immune cells are not specialized for only one pathogen. Instead, they can recognize and respond to many different microbes. As a result, trained innate immune cells may also help protect you against other infections. A win-win situation, one vaccine may provide extra protection against infections beyond the disease they were designed to prevent. Thus, trained immunity makes our innate immune system stronger, quicker, and more efficient in the fight against all kinds of pathogens.

HOW TO TRAIN YOUR **IMMUNE SYSTEM**

DRINK WATER



EXERCISE



EAT HEALTHY



GET YOUR SHOTS



SLEEP



What can you do to keep or have a healthy immune system?

Your immune system does a remarkable job of defending you against pathogenic microbes. But sometimes it fails, a germ can invade your body and, if your immune system is weakened, cause disease. What can you do to keep a properly trained immune system? Following the general recommendations for healthy living is the best step you can take to keep your immune system strong and healthy.

- **Eat a healthy diet.** A healthy diet is key to a robust immune system. This means ensuring you eat plenty of vegetables, fruits, legumes, whole grains and healthy fats.
- **Get regular physical activity.** Be physically active on a regular basis. Physical activity helps your immune system work well.
- **Get enough sleep.** People who don't get enough sleep are more likely to get sick after exposure to pathogens, so getting enough rest can strengthen your immunity.
- **Drink water.** Our bodies are 70% water. Water plays an important role in all organisms, including our immune system. Drinking enough water helps your body function properly including your immune system.
- **Vaccinate.** Vaccinating is the best way to protect our bodies against infections. Vaccines are harmless versions of pathogens that activate our immune system in a way that will quickly recognize and eliminate the real pathogen when we encounter it. Some vaccines can also activate trained immunity, helping the cells of our innate immune system to become stronger,

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so they will protect us not only against the disease were designed to prevent but may also protect us against other infections.

Glossary

Adaptive immunity. Long-lasting immune defense that specifically recognizes and remembers particular pathogens.

Adaptive immune cells. Specialized cells that target specific pathogens and remember them.

Defense. The body's protection against harmful microbes.

Engulf. To surround and digest harmful microbes.

Exposure. Contact with a microbe or pathogen.

Immune cell. A cell that detects and fights harmful microbes.

Immune response. The body's reaction to infection or harmful substances.

Immunity. The body's ability to protect itself from disease.

Infection. The invasion and growth of harmful microbes in the body.

Inflammation. The body's protective response causing redness, swelling, heat, or pain.

Innate immunity. The body's fast, non-specific first line of defense against infection.

Innate immune cells. Fast-acting cells that provide immediate defense against many pathogens.

Invader. A harmful microbe entering the body.

Memory. The immune system's ability to respond faster after previous exposure.

Microbe. A tiny living organism, such as bacteria, viruses, or fungi.

Microbiome. The community of beneficial microbes living in and on the body.

Pathogen. A microbe that can cause disease.

Trained immunity. Enhanced innate immune response after previous exposure to microbes or vaccines.

Vaccination. Receiving a vaccine to prepare the immune system against disease.

Vaccine. A harmless preparation that trains the immune system to fight infections.