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## **Our Astonishing Immune System**

How it protects and heals us - and how we can strengthen it every day

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## Chapter 2 – The body's miraculous defence system

The term 'immune system' seems simple at first: an instrument at the body's disposal which enables it to protect itself against danger. In fact, it is an incredibly complex, multifaceted intermeshing of different cells, whole organs, proteins and special molecules, and it is constantly changing. How efficient it is depends on the general condition of our health, nutrition, sleep and even our emotional state. We enter the world with part of this system already in place (the 'innate' system) and develop the rest over the course of our lives, by interacting with our environment or through vaccinations. Both ensure our ability to survive.

Let's try to outline this system in greater detail. Don't be surprised if the language begins to sound a little warlike: it is a matter of life and death, after all.

### The general – innate – immune system

#### The skin and the mucous membranes

Our wonderful, delicate skin serves not only to protect us against drying out, against heat and cold, it also provides a strong defensive wall against pathogens, which are only able to surmount the wall with great difficulty, for example when we get injured. This defence is strengthened by a salty, sour secretion on the surface of our skin which acts as a disinfectant. The importance of this outer barrier remaining intact becomes clear in the case of the not uncommon condition *neurodermatitis*, in which small defects in the genetic material cause tears and brittle patches in the body's protective armour, allowing particles of foreign bodies, mites or germs to take hold. The immune system responds aggressively to this with allergic reactions, causing inflammations and the fiendish itching which characterises the condition.

The mucous membranes which coat our airways, digestive tract and sexual organs, i.e. the areas where the body comes into contact with the outside world, also have features which serve to defend the body against harmful foreign substances and foreign organisms. The trachea and the bronchial tubes are coated with a layer of mucus and countless tiny cilia which act like tentacles, grabbing dust and other foreign bodies and carrying them back up and out of the body.

The vagina has a particularly high number of mucus cells and is populated by a colourful range of 'flora', friendly organisms which serve to stop pathogens from settling in the area.

Barriers – robust layers of skin – in the mouth and the oesophagus ensure that the foreign bacteria we ingest when we eat cannot travel further into the body. If they make it into the stomach, they are met by a flood of acid which serves primarily to aid digestion but also to kill off a large number of pathogens. Any remaining pathogens have even worse luck when they reach the intestines. The walls within the bowel are coated with microbes and immune cells which bring the invasion to an end.

## The watch guards behind the barriers

The cells which stand guard in this part of the body are **phagocytes** (from the Ancient Greek "phagein", 'to eat') and are able to consume both living and inanimate foreign substances and render them harmless. The phagocytes are supported by curious structures known as **dendritic cells** ("dendritic" means "branched"), so named because the cell body branches out like a small tree. The branches act like tentacles which the cell uses to capture bacteria or other pathogens before carrying them to the lymph nodes for assessment or straight to the phagocytes, which make quick work of them.

If bad microbes, such as viruses, nevertheless succeed in sneaking into the somatic cells, they use chemical messenger substances to send out a cry for help which attracts another troop of 'natural killer cells', which promptly identifies cells infected with the virus as 'sick' and destroys them.

These defence cells are part of the innate system, they are not specialised and are not very picky when it comes to selecting their prey. They don't much care what it is they are doing away with. They pounce on anything harmful entering the body.

## The special – acquired – immune system

### Recognising, targeting and destroying the enemy

The acquired immune system is the army of immune cells which we develop much later, over the course of our lives. This includes, first of all, **lymphocytes**, white blood cells which originate in the bone marrow and the spleen. They have the amazing ability to differentiate between insurgent pathogens, identifying them and then attacking them with the most effective weapons.

There are two types of lymphocytes: **T lymphocytes** or **T cells**, which enter the bloodstream as immature structures from the bone marrow, after which they are sent to a 'training camp', namely the thymus gland behind the breastbone. Here, they receive a little training, learning to distinguish between 'me' and 'not-me', enabling them to differentiate between the body's own cells which they should on no account attack, and foreign cells. This is an extremely important property and one we will be hearing more about later. Once it has completed its training, the T lymphocyte becomes a reliable fighter against viruses and bacteria.

**B lymphocytes** are cells which are able to precisely identify pathogens and their special characteristics – 'antigens' – and specialise in a certain antigen themselves. They send data about viruses, bacteria or fungi

straight to the lymph nodes for analysis, asking: are we already aware of this enemy, or not? If not, they begin producing perfectly adapted weapons – antibodies – at a rate of several millions per minute. These specific antibodies chain themselves to the antigens of the insurgent enemies – much as you would with handcuffs – and neutralise them or eliminate them. They may also call on other cells for help – other white blood cells such as the scavenger cells **granulocytes**, **mastocytes** and **macrophages**. These then devour and digest their prey.

A simple cold sees our bodies become a veritable battleground, and the most we know about it is a few days of fever or coughing and perhaps some muscle weakness.

When the enemies have been defeated, information about them is saved in memory cells. Should the same pathogens at some point attack again, they'll regret it! They will be met with a defence system which is already highly equipped with special antibodies, which they will be powerless to defeat. This time, the person will remain healthy.

This is also the principle behind vaccinations.

## **The lymph nodes**

If the immune cells are like police officers on the beat, the lymph nodes are a little like a police station. This is where the immune cells drag their prey, where different strands of information about possible enemies converge. This is also where filtration takes place via the lymphatic vessels, thin tubes similar to blood vessels which extend throughout the body, bringing waste from the muscle and fat tissues. This waste is examined and disposed of in the lymph nodes.

You cannot usually feel these small, bean-shaped structures, though they are situated all over the body at regular intervals. They only swell up and become apparent underneath the skin when something is wrong, such as an infection or inflammation in their immediate vicinity or when they themselves are affected.

## **The spleen and liver**

The **spleen** is an organ measuring around 11 x 7 x 4 centimetres, suffused with a plentiful supply of blood, and is located under the left costal arch. It serves as a kind of filtration system for the blood and its tasks include supporting the rapid propagation of lymphocytes in the event of an infection, helping to dispose of seized pathogens and destroying old, weak red blood cells. Immune defence in people who have had to have their spleens removed is considerably limited.

The **liver** and its endless number of functions could fill a book on their own. It is our largest and most important metabolic organ, energy saver, and waste disposal plant, but it is primarily a huge chemical factory; everything which enters the blood via ingestion streams into the liver via a system of vessels. This includes nutrients, vitamins, hormones, but also harmful substances such as pollutants. The liver cells now have the tremendous task of analysing and organising these substances, processing them in different departments and using them to assemble components which are vital for life, such as cholesterol, bile and substances which clot the blood. Sugar, fats and vitamins are stored in 'pantries' and the detoxification department works to break down foreign substances such as alcohol, medicines and pathogens. The liver is

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also where the proteins which help immune cells to kill bacteria emerge. ...]