Our Immune System: How it Works?

The immune system has two parts 'innate' and 'adaptive'

Innate immunity

The 'innate' (meaning: "present from birth") part of the immune system is so-called because it has a number of set strategies for recognising and dealing with certain kinds of infection, without needing to be "trained" to identify them. This generally involves certain immune cells "sniffing-out" germs, via signs in the bloodstream, following the trail to the site of infection, and neutralising the invaders with special chemicals before swallowing them (a process known as 'phagocytosis'). Such cells are generally called white blood cells (but specifically known as 'macrophages' and 'neutrophils').

This approach is very effective for many infections, but certain germs have developed ways of avoiding detection. For instance, viruses can be particularly difficult to detect and target because they are much smaller, even than bacteria, and can actually hide and multiply within body cells.

During infections, signs such as the swelling and inflammation of the skin are often indications of immune activity, as they help the immune system by allowing blood carrying immune elements to flow more easily to the site of infection. However, if uncontrolled, inflammation can itself cause damage, so it has to be carefully controlled.

Adaptive immunity

The other part of the immune response is called the 'adaptive' immune system. Unlike the innate immune system, it isn't able to respond instantly to infections, as it needs time to adapt (or learn) to recognise them. Once it has learned, however, it is extremely effective and is also able to 'remember' particular germs that have previously infected the body, so that when (or if) they try to infect the body again, the next response is rapid, accurate, and effective.

Doctors can trick the body into producing a memory to a particular infection by using vaccines (harmless versions of germs) to create immune 'memory'. This gives you protection without having to experience the dangers of a real infection.

An advantage of the adaptive immune response, once it has developed, is that it utilises further specialised types of white cell, called lymphocytes, that coordinate and focus the immune system's response, and also produce specialised molecules to target the infection. These include an incredibly elegant molecule, called the 'antibody', that is produced in huge numbers during an adaptive response, and moves through the bloodstream during an infection, targeting germs with incredible accuracy.

It is thought that the human body can create enough different antibodies to recognise a total of 1 billion different targets (that's 1,000,000,000 or 'one thousand million').

As we have mentioned, the only drawback with the adaptive response is that it takes time to develop initially, and it can take several days for the primary response to be detectable, and longer still for it to become effective. The innate response is therefore still extremely important for controlling infection whilst the adaptive response builds up.

On patrol for signs of trouble!!

A further aspect of the adaptive immune system worth mentioning is its role in monitoring body cells to check that they aren't infected by viruses or bacteria, for instance, or in order to make sure that they haven't become cancerous. Cancer occurs when certain body cells 'go wrong' and start dividing in an uncontrolled way (body cells usually divide in an extremely regulated way), often spreading to other parts of the body. It is an extremely dangerous disease, so it is important to catch it before it develops.

Certain lymphocytes patrol the body, checking cells for signs that something is wrong, and so the immune system plays an important role in preventing tumours from developing.

To get a grip on just how small the world we are describing really is, click here

Immunity in the Gut: An Important Balancing Act

As we mentioned earlier, certain areas of the body, such as the lung and the gut, can be more difficult to 'police' because they have to be more open to certain elements in the environment. The gut, in particular, because of its role in absorbing food, has an enormous surface area. The small intestine alone (a part of the gut) has a surface area some 200 times that of the skin. For the immune system, this represents a big challenge to police just in terms of area. In addition, it must also be remembered that the food that we eat could be a potential target for the immune system, because it is foreign to the body. That's not to mention the other considerations we deal with below.

For instance, the gut also has nutrient-rich fluid, derived from the things we eat, continuously flowing through it, as part of the food absorption process. Due to the food-rich environment, this makes the gut a particularly attractive environment for bacteria â€“ it is estimated that over 500 microbial species live in the human gut, contributing some two pounds (about one kilogram) to the body's overall weight. It is estimated that over 90% of exposure to microorganisms occurs within the gut. Many of these bacteria (known as 'commensals') are a perfectly normal part of the gut population and do not cause disease, in fact they often perform some very useful roles such as aiding in the digestion of food.

If the immune system were simply to treat all of the many gut microorganisms as 'targets', especially in such a delicate environment, the immune response itself could cause more harm than good by producing excessive inflammation and damaging the gut surface.

Instead the immune system does an extremely clever job of regulating itself so that it doesn't react to harmless food, or overreact to commensals, whilst still performing the vitally important role of targeting really harmful germs when they infect. This is a remarkable feat about which there is still much to learn, and there is much research into how it achieves this remarkable balancing act. We do know that perhaps around 75% of the immune system's lymphocyte cells are found in association with the body's 'mucosal' tissues, of which the gut forms a large part, so gut immunity is obviously an important area of immune function.

We also know that the process is further helped by the fact that a healthy population of commensals in the gut can help to prevent colonisation by harmful bacteria â€“ by crowding them out and not allowing them take hold. Certain commensals have even developed particular substances, called colicins, that neutralise other bacteria. Due to certain differences in the way commensal 'behave', compared to disease-causing species, it seems that the immune system is able to tell the difference between the two.

Evidence for the importance of commensal bacteria is found when oral antibiotics are taken by people to counter harmful bacterial infections. These can also drastically reduce the population of commensal bacteria in the gut. Although the population grows back again, it has been noted that the gut is temporarily more vulnerable to infection with harmful bacteria, due to the breaking of the 'commensal barrier'.

It seems that in the gut, as in other aspects of life, it pays to cultivate a healthy group of friends to protect you from your enemies.

Key Facts:

The immune system is a network of cells, tissues and organs, found throughout the body that combats infectious disease and cancers. It is divided into 'innate' and 'adaptive' immune responses.

'Innate' immunity is quick to respond to certain general signs of infection, and includes certain specialised cells (phagocytes) able to track and 'eat' infective germs.

'Adaptive' immunity is used to develop a more specific response to particular germs that are more difficult to target by innate immunity. This takes time to develop â€“ but the adaptive immune system 'remembers' germs that it has previously encountered and responds immediately the next time they try to infect.

The 'antibody' is a key molecule in the adaptive immune response and is incredibly specific in targeting particular germs, millions of different antibodies can be made, each with unique targets.

Vaccines use adaptive immunity to 'trick' the body into creating an adaptive response, without the danger of a real infection. Millions of lives have been saved as a result. The 'Father of Vaccination' is Edward Jenner, and his development of a smallpox vaccine led to an effective treatment for this terrible disease and, eventually, its eradication (in 1979).

The lungs and the gut are key areas for the body to protect, as they are vulnerable to infection. In these areas, the immune response has to be effective, but controlled (to prevent damage) â€“ this is an important balancing act for the immune system.

People born without immune systems are extremely vulnerable to infection, and people infected with HIV/AIDS can experience similar symptoms because the virus targets the immune system. This illustrates the importance of a functioning immune system.

Many immunologists are involved in research into important diseases such as asthma, type 1 diabetes, rheumatoid arthritis, HIV/AIDS and tuberculosis. Effective therapies and cures are their goals.

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