An introduction to the immune system

What's the immune system for?

Every day, your body could succumb to hundreds of different infections or harmful substances. It is constantly under attack from microbes, parasites, allergens and other threats. The only reason you're not sick all the time – and probably the only reason you're alive today – is that your immune system deals with these assaults. It does so through processes and structures that try to prevent invasion, but it can also fight off an infection or disease that tries to take hold.

Vertebrates, including humans, have very sophisticated immune systems that adapt during a lifetime to take account of specific organisms and substances that enter the body. Most other animals and plants have immune systems too, even if they look different from ours. Both plants and animals have receptors on their cells that can recognise invading microbes.

Plants, however, don't have patrolling immune cells like we do, so infection has to be dealt with by ordinary cells at the site of infection. And even some of the organisms that attack us have their own immune systems. For example, we're only just beginning to understand those found in bacteria.

How does the immune system know you're you?

Would you be able to tell one of your own cells from someone else's, or from a bacterial cell? Perhaps not. But your immune system can distinguish self from non-self. If it couldn't, its attempts to deal with foreign substances would be directed at your own cells.

Among the many different proteins found on the cell surface are the major histocompatibility complex (MHC) proteins. MHC proteins indicate that your cells are self and should be left alone. Apart from identical twins, we each have our own unique set of MHC proteins. Even a mother and her baby do not share the same ones. Scientists recently discovered that, during pregnancy, certain signals that recruit immune cells are turned off in part of the placenta, helping to prevent the mother's body from attacking her child.

The recognition of non-self markers, known as antigens, on foreign materials triggers a response from the non-specific (innate) immune system. Pieces of these materials are presented to cells of the specific (adaptive) immune system, and a more focused, long-lasting form of immunity is developed, in the form of antibodies that can recognise the antigens in the future.

Different factors can suppress our immune systems

Not everyone has a perfectly functioning immune system. Many people, at some point in life, find that their immune system is weakened by disease or ageing. Some people are born with inherited disorders that affect their ability to fight disease.

Some acquire infections, like HIV (human immunodeficiency virus), that suppress their immune systems. In HIV, immune cells called helper T cells are destroyed, impairing the body's ability to fight ordinary infections like colds and flu. Certain cancers can suppress the immune system, and so can cancer treatments, especially chemotherapy.

Recent reports from the USA suggest that fasting could help the immune system regenerate in people being given chemotherapy for cancer. There are also experimental drugs as well as supplements, smoothies, herbs and teas that manufacturers claim will provide an immune boost. However, scientists remain sceptical about such remedies when the evidence is weak and there is money to be made by selling them. We do know, though, that staying healthy – getting enough sleep, eating a balanced diet, exercising and avoiding stress – helps to support your immune system.

The immune system can overreact

The immune system does not always behave as we would like it to. Autoimmune disease occurs when the immune system has trouble telling self from non-self. In rheumatoid arthritis, for example, immune cells attack cells in the patient's own joints, causing pain and inflammation.

Allergies are caused by overreactions to foreign proteins known as allergens. For example, in hay fever, the immune system reacts to wind-blown pollens from grasses, weeds and trees, and makes antibodies against them. Immune cells called mast cells have antibodies attached to their surface, and when these bind to their specific allergens they trigger an immune response.

This response includes the release of chemicals, including histamine, which are responsible for many of the symptoms of allergy. Histamine causes inflammation, drawing fluid into the affected zone and, in the case of hay fever, out of the nose. Hence the snotty mess and the antihistamine tablets. Meanwhile, in asthma, which is mainly thought of as an inflammatory disease, these chemicals may also make the muscles in the airways contract, causing breathlessness and wheezing.

Anaphylaxis is a severe and potentially fatal allergic reaction that affects the whole body, often just minutes after exposure to an allergen. It can be caused by many things, including peanuts, shellfish, eggs, bee or wasp stings, and drugs. Anaphylaxis can be fatal. People at risk often carry pen-like injectors that contain adrenaline to use in an emergency.

Organ donation requires a good match between donor and recipient

If a person needs an organ transplant, close relatives are potential donors. But the donor's blood group and tissue type must be compatible with the recipient's. Tissue type is determined by a set of genes that code for MHC (self) proteins.

Children inherit these genes from their parents, half from their mother and half from their father. Sometimes, the parents share some of the same genes, so the child may end up having a tissue type very like one or other parent, who may be a 'perfect match' for donation. Or the child may end up with a tissue type that is not really close to either parent. In this case, an unrelated donor may be a better match. Better matches reduce the chance of the recipient's immune system rejecting the donated organ as non-self.

Family members are not always good matches, and for some organs, like hearts, the donation can come only from someone who has died. Organ shortages mean that animals have also been considered as donors.

In 1983, the surgeon Leonard Bailey transplanted a baboon heart into a newborn baby. 'Baby Fae' lived for only 20 days, as her immune system rejected the organ. However, since then, many children born with heart defects have received replacement heart valves from pigs or cows. Transplanting tissue from one species to another is called xenotransplantation. The tissues are chemically treated to mask the antigens that the immune system reacts to.

People who receive transplants may have to take immunosuppressive drugs for the rest of their lives, with the unfortunate side-effect that they become more susceptible to infections. Different drugs address different aspects of the immune system, and many transplant recipients take drugs that reduce the activity or growth of T cells.

Disgust helps protect us from disease and illness

Why do we wince at the sight of wounds and recoil from rotting fruit? Is it that we're taught to avoid the sorts of things that might harbour microbes? Or is disgust more instinctive than that?

The origin and purpose of disgust is still debated by psychologists. Some argue that it is a learned response while others think it is a result of millions of years of evolution. Whatever its origin, it certainly serves an important purpose: helping to protect us from disease. The fact that you are disgusted by the smell of rotten meat means that you are very unlikely to touch it or swallow it, and so your chances of getting ill are reduced.

Food, however, forms an interesting part of the debate. While most people may agree that, say, vomit and faeces are disgusting, what is unappetising to eat differs across the world.