Antibody production before an attack...

Our immune system has the potential to produce 10 billion different antibodies, even before it meets an invader! Antibody generation starts in developing B cells, beginning before you are born and continuing throughout life. Each antibody has a different ‘variable’ region, the top of the ‘Y’ shape, where antigen-recognition and binding takes place.

A process used to create variation in antibodies is called ‘V(D)J’ recombination. This involves shuffling of different variable (V), diversity (D) and joining (J) genes. Because there are hundreds of V genes, tens of D genes and only a few J genes there is huge potential to create a range of antibodies.

Ask about our ‘V(D)J’ jigsaw games to learn more about antibody production.

What happens to our immune system as we get older?

Your immune system protects you from diseases. It changes throughout your life; getting stronger and stronger from birth to becoming an adult. Vaccinations against diseases work by teaching your immune system to recognise a pathogen without having to suffer from the disease.

As we go beyond middle-age, our immune system has trouble defending against attack, so we are more likely to catch infections. This happens because the thymus shrinks and produces fewer T cells with diverse antigen receptors; also fewer B cells are made, reducing the range of antibodies produced, therefore vaccinations are less effective.

At the Babraham Institute we’re trying to work out why the immune system changes as we get older – once we know, we hope to be able to add something to vaccines for older people so they will be more effective.

What happens when your immune system goes wrong?

If something goes wrong with your immune system you may suffer from immunodeficiencies or autoimmune disease. Immunodeficiency occurs when your immune system becomes compromised or it is not present at all; this means that the body is very vulnerable to infections. Some people are born with immunodeficiency; others become immune deficient following treatment for other diseases or after organ transplant.

Autoimmunity is when your immune cells recognise your body’s cells as pathogens and attack. Rheumatoid arthritis is an example of an autoimmune disease – it occurs in the joints and causes pain and impaired movement.

The flu virus continually changes and evolves, so scientists have to re-develop the flu vaccine and we have to have another jab each winter.

Weapons of Microscopic Destruction

Contact us

Babraham Institute
Babraham Research Campus
Cambridge
CB22 3AT
UK
www.babraham.ac.uk
Tel: +44 (0)1223 496000
Email: immunearmy@babraham.ac.uk
@BabrahamInst #immunearmy
The Babraham Institute

1 Week
2 Weeks
3 Weeks
1 Month
2.5 Months
6 Months
18-22 Months

This image shows the effect of the ageing process on the mouse thymus. As the mouse ages the thymus shrinks, and changes in its structure occur which means that fewer T cells are produced. Figure from Frontiers in Bioscience 16, 2461 – 2477, June 1, 2011

Antibody from one person are all the same in this ‘constant’ region

Antibodies stick to antigens via the ‘variable’ region

Antigen binding site

Antibodies are specific to one antigen – they will only bind to one antigen like a key fits only one lock

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Why do we need an immune system?
Your body is under attack! Around you are pathogens – or germs – that cause disease, bacteria, viruses, fungi and parasites. Pathogens are microorganisms that make you unwell. It is your immune system that helps keep you healthy. It helps you fight disease and protects you from infections. To understand how your immune system works, we need to understand how pathogens work.

Immune cells are white blood cells which are made in your bone marrow. They are essential for protecting your body from disease, injury or even helpful; the ‘bad’ bacteria can cause stomach upsets and other diseases. Bone marrow is the site where many of your immune cells are born.

Where is our immune system?
How do the cells know where to go?
Some immune cells reside in our tissues, but others travel around your body. Using two main routes, the circulatory system (your bloodstream) and the lymphatic system. Both of these networks are made up of many tiny vessels allowing the cells to reach every nook and cranny of your body.

Within these networks there are meet-up points (like a base camp) where your immune cells interact. The spleen and lymph nodes are examples of these meet-up points where immune cells share information. They use special proteins on their surface to exchange information.

How does our immune system deal with the bad stuff?
Our own cells, as well as the invaders, have unique identifiers which are recognised by immune cells and antibodies. These identifiers are called antigens.

A single invader can have hundreds of antigens, which allows many immune cells or antibodies to identify and lock it in place. Different cells have different antigens, which means you can identify a certain invader and decide how to deal with it. This is called antigen specificity.

Key players in innate immunity are always on guard and ready for action, they include:

- epithelial barriers – cells on our skin, gut wall, in our nose and ears
- macrophages, neutrophils, natural killer cells and dendritic cells.

These immune cells are residing in the walls of the intestine. This allows them to identify and attack any intruders coming in through the gut.

How does our immune system destroy invaders?
Our immune system has two strategies for destroying pathogens, innate and adaptive immunity. The cells of the innate immune system respond quickly to defend you, but adaptive immunity is much slower and can take up to 1 week to reach full force.

Pathogens – macrophages, neutrophils, natural killer cells and dendritic cells.

How do our immune system tell the good from the bad?
Our immune system is a huge army of defender cells – these cells are white blood cells and are known as leukocytes. You make about 5 billion of them every day. These cells develop in your bone marrow from ‘haematopoietic’ stem cells; just one of these cells can make any type of immune cell such as:

- macrophages – the clean-up crew – eat any bacteria, pollen and even our own damaged cells.
- dendritic cells – the detectives – collect parts of pathogens and show them to T cells and B cells, helping them to identify which pathogens to destroy.
- neutrophils – the body’s rapid response force – first on the scene when you graze your knee or cut your finger neutrophils travel through your blood and destroy the pathogens by killing them.
- B cells – the spies – create weapons called ‘antibodies’, these immune cells recognise and destroy it.
- helper T cells – the courier majors – coordinate an attack by sending molecules to boost antibody production and activate macrophages.
- killer T cells – the soldiers of the immune system – recognise our cells that have been invaded by viruses and destroy them, they also recruit more ‘helpers’ to do the same.

Pathogens – any cells including those in your body, that aren’t recognised by your immune system.

Antibodies produced
Antigen presentation.
Dendritic cell ‘activated’
B cell
T cell
Helper T cell
Killer T cell
Marrow
Spleen
Thymus
B lymphocytes
T lymphocytes
B cells
B cells
Dendritic cells
Helper T cells
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Upon infection, some 10 billion of these immune cells get to work destroying the invader.

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