The Body’s Defences
The Body's Defences

Pathogens

The body's defences

Summary activities
Pathogens are micro-organisms that can cause disease. What happens when a pathogen enters your body?

The pathogen begins to reproduce and may make toxins. The pathogen or toxins may destroy the body’s cells and make you feel unwell.

Painkillers can relieve the symptoms of an infection but do not kill the pathogen. Your immune system must begin to mount an attack.
How do pathogens cause illness?

Pathogens cause illness in three main ways:

**Toxins**
Toxins are harmful substances produced by the pathogen that poison the body’s tissues and enzymes.

**Reproduction**
A rise in the number of pathogens can damage a cell, even causing it to burst. Some pathogens hijack resources that the cell needs to survive.

**Immune response**
Sites of infection often become swollen, sore and hot as a result of increased blood flow.
Bacteria and viruses can reproduce rapidly in warm, moist environments like the human body. How does temperature affect the growth rate of E.coli bacteria? Drag the temperature on the thermometer to 15°C, 37°C and 46°C to compare the growth rates. Press "start" to begin.
How big are micro-organisms?

1 mm ($10^{-3}$ m)

The head of a pin is 1 mm wide.
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Examine the illustration below. How does it depict the ways in which the body can fight infections?
The body has many different lines of defence:

- physical and chemical barriers that prevent micro-organisms entering the body. These make up the first line of defence.

- non-specific defences (within the body). These make up the second line of defence, and include inflammation to attract white cells into tissues, and the ingestion of bacteria by white cells.

- pathogen-specific defences (within the body). These make up the third line of defence, and involve antibodies and T- and B-cells.
How the lines of defence work

Physical barriers, such as the skin, are part of the first line of defence. Chemical barriers, such as mucus and stomach acid that coat the lining of the lung and digestive system, also contribute.

Macrophages provide the second line of defence. These are white blood cells that circulate in the blood. Their role is to ingest microbes through a process known as phagocytosis.

If the macrophages are unable to cope with the infection, the body’s third line of defence is mobilized – antibodies. Antibodies recognize and lock onto the molecules on the surfaces of microbes.
What are the body’s physical and chemical defences?

Press on a body part label to find out how each part of the body defends itself against infection.

- skin
- eyes
- lungs
- blood
- stomach
How do macrophages destroy pathogens such as bacteria?

Press "play" to find out more about phagocytosis.
What are antigens?

Every cell is surrounded by a cell membrane. This is mainly made of lipid, but it has special molecules stuck into it. These are called **antigens**.

Different types of cell have different antigens on the surface.

Our immune system responds to these antigens to protect us from infection.

Where are the antigens on the cell shown here?
Lymphocytes are a type of white blood cell found in the blood or lymph nodes and made by bone marrow. There are several types of lymphocyte, including:

- **T-lymphocytes** – recognize antigens and either attack them directly or co-ordinate the activity of other cells of the immune system.

- **B-lymphocytes** – recognize antigens and produce special chemicals called **antibodies**.
The third line of defence

**Antibodies** are special Y-shaped proteins produced by B-lymphocytes in response to antigens.

Antibodies work by binding to antigens on pathogens, ‘labelling’ them and causing them to clump together.

The pathogen can then be destroyed by:

- phagocytosis by macrophages
- T-lymphocytes
- the antibodies themselves.
Recap of key words

Match the key word to its definition

- **lymphocyte**: a special protein produced by B-lymphocytes in response to antigens
- **pathogen**: a micro-organism that causes disease
- **antibody**: a molecule found on the surface of cells that triggers an immune response
- **antigen**: a type of white blood cell found in the blood and lymph nodes
Antibodies are specific

Different types of antigens cause different types of antibodies to be produced.

Different micro-organisms have different antigens on their surfaces. This means that a different antibody is needed to recognise and deal with each different type of pathogen.
Delayed response

If a pathogen enters the body, the B-lymphocyte that produces the correct antibody for the antigen begins dividing. This produces many more antibody-producing cells.

It takes a few days to produce enough antibodies to destroy the pathogen. This results in a delay before the person feels better.

Once a pathogen has been destroyed, a few memory cells remain. These recognize the pathogen if it re-infects, and make the immune response much quicker and more effective.
Antibody levels during infection

Antibody count during two infections by the same pathogen

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<th>Antibody count</th>
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What is the order of stages in fighting an infection?

1. The person begins to feel well again.
2. The antibodies help destroy the pathogens.
3. T-lymphocytes recognize the pathogens.
4. The pathogens reproduce and make toxins.
5. B-lymphocytes make antibodies.
6. Pathogens enter the body.
Active immunity is when your body responds to an infection by making its own antibodies or antitoxins. Active immunity can be stimulated by vaccines.

Vaccines contain a small amount of dead or weakened pathogen particles. A vaccine stimulates the production of antibodies and memory cells against the target pathogen, without making the person ill.

If a vaccinated person is later infected by the same pathogen, their immune system can destroy it very quickly. If lots of people are immune to a pathogen it does not spread easily in the population.
Passive immunity

Many snakes produce a powerful nerve toxin that can be lethal to humans.

People bitten by poisonous snakes can be treated with antivenin.

Antivenin contains antibodies to give instant immunity. It is produced by injecting horses with small, non-lethal doses of venom. Over time, the horses produce antibodies, which are extracted and processed.

As the person didn’t make the antibodies themselves, this is called passive immunity.
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Glossary of keywords: the body's defences

**active immunity** – When the body responds to infection by making its own **antibodies** or antitoxins. Active immunity can be stimulated by giving **vaccines**.

**antibody** – Special Y-shaped proteins produced by **B-lymphocytes** in response to **antigens**.

**antigen** – A special molecule found on the surface of a cell that can trigger an immune response.

**antivenin** – A biological substance that contains antibodies. Antivenin is used to give instant immunity to
Can you tell the difference between an antigen and an antibody?

Press "start" to begin.