



Part 3: How do living systems respond to disease?

- Activity 3.1 What is a disease?
- Activity 3.2 What causes disease?
- Activity 3.3 Detecting and treating disease
- Activity 3.4 Defending against infection
- Activity 3.5 How have scientists contributed to our understanding of disease?

PART

Activity 3.1 What is a disease?

Activity type

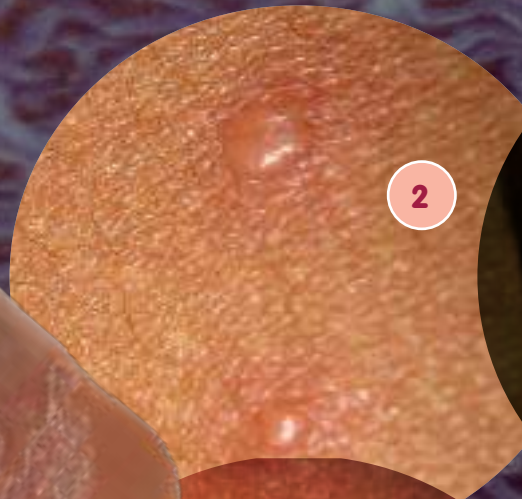


MYSTERY DISEASES

What diseases can you identify in these images?



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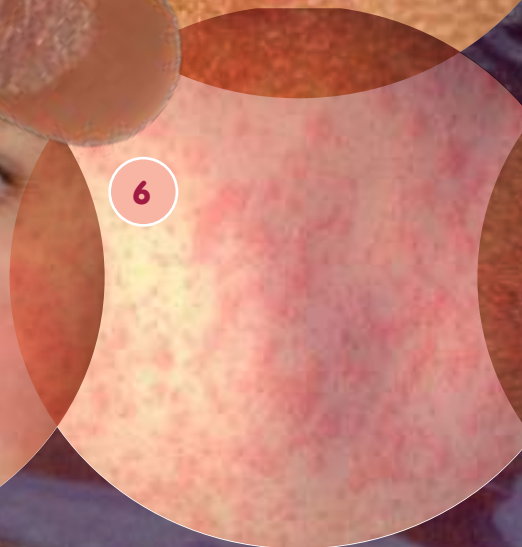
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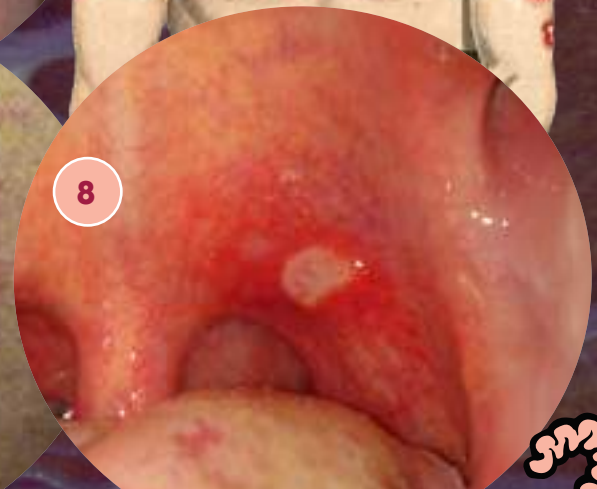
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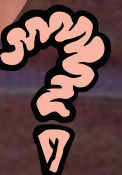
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Click here to find out if you are correct.



Activity 3.2 What causes disease?



PATHOGENS

Pathogens are micro-organisms that cause infectious disease.
Bacteria and viruses are the main pathogens.

VIRUSES

Viruses are many times smaller than bacteria. They are among the smallest organisms known and consist of a fragment of genetic material inside a protective protein coat.

Viruses can only reproduce inside host cells, damaging the cells as they do. A virus invades a cell, takes over and makes hundreds of thousands of copies of itself. Eventually, the copies fill the cell and burst out into the bloodstream, the airways or elsewhere.



BACTERIA

Bacteria come in many shapes and sizes, but even the largest are only 10 micrometres long (or a hundredth of a mm).

Bacteria are living cells and, in favourable conditions, can multiply rapidly. Once inside the body, they release poisons or toxins that make us feel ill.



Activity 3.2 What causes disease? Continued

SALMONELLA (FOOD POISONING)

Caused by: species of the *Salmonella* bacteria.

Symptoms: diarrhoea, fever, vomiting, and abdominal cramps. Diarrhoea may be so severe that the patient becomes dangerously dehydrated and must be taken to a hospital.

Spread by: ingestion of contaminated food such as raw or uncooked meat.

Treatment: in severe cases, the *Salmonella* infection may spread from the intestines to the blood stream, and then to other body sites, and can cause death unless the person is treated promptly with antibiotics.



CHOLERA

Caused by: the bacterium *Vibrio cholerae*.

Symptoms: the bacteria releases a toxin causing cells in the intestines to release water creating severe diarrhoea.

Spread by: drinking water or eating food that has been contaminated by the faeces of an infected person. Cholera is more common in areas of poor sanitation.

Treatment: in most cases, cholera can be successfully treated with oral rehydration therapy (ORT). An untreated person with cholera may produce 10 to 20 litres of diarrhoea a day, with fatal results.



INFLUENZA (FLU)

Caused by: influenza virus

Symptoms: chills, fever, sore throat, muscle pains, severe headache, coughing, weakness/fatigue and general discomfort.

Spread by: coughs or sneezes, creating droplets in the air containing the virus. Or direct contact with nasal secretions or contaminated surfaces.

Treatment: influenza is caused by a virus; antibiotics have no effect on the infection, unless prescribed for secondary bacterial infections such as bacterial pneumonia.

Protection: the influenza vaccine, also known as a flu shot, is an annual vaccine that can be administered to protect against the highly variable influenza virus. A new flu vaccine has to be developed every year, after the strain has been analysed.



CHICKEN POX

Caused by: *Varicella zoster virus*

Symptoms: nausea, loss of appetite, aching muscles, and headache. This is followed by the characteristic rash, weakness/fatigue and general discomfort. It is usually more severe in adults and chickenpox may affect an unborn baby.

Spread by: coughing or sneezing of ill individuals or through direct contact with secretions from the rash. It is a highly contagious illness.

Treatment: chickenpox treatment mainly consists of easing the symptoms.

Protection: The varicella vaccine, developed in 1974, increases protection against the disease.



Activity 3.2 What causes disease? Continued

ATHLETES FOOT

Caused by: fungus from the genus *Trichophyton*.

Symptoms: athlete's foot is a fungal infection of the skin on the foot and causes scaling, flaking, and itching of the affected skin. Blisters and cracked skin may also occur, leading to exposed raw tissue, pain, swelling, and inflammation.

Spread by: direct contact through moist areas where people walk barefoot, such as showers and locker rooms. It can also spread by sharing footwear with someone affected.

Treatment: topical antifungal medication, in a spray, powder, cream, or gel. Secondary bacterial infection can occur, sometimes requiring antibiotics.



MALARIA

Caused by: protozoa from the genus *Plasmodium*.

Symptoms: includes fever, sweats, shivering, joint and muscle pain, headache and nausea. The consequences of severe malaria include coma and death if untreated.

Spread by: female mosquitos from the *Anopheles* genus feeding on human blood. It spreads when the mosquito bites and sucks the blood of an infected person then bites another person.

Treatment: a combination of anti-malarial drugs can be used.



GIARDIASIS

Caused by: the protozoan parasite called *Giardia intestinalis*.

Symptoms: giardiasis is an intestinal infection and symptoms are caused by giardia organisms coating the inside of the small intestine. Symptoms include loss of appetite, fever and explosive diarrhoea. The active form cannot live outside the body but the inactive form, called the cyst, can. Cysts are present in the faeces of infected persons.

Spread by: person to person by contamination of food with faeces, or by direct faecal to oral contamination.

Treatment: there are some antiprotozoal medications that help to treat giardiasis.



Click here to explore pathogens further.

Activity 3.3 Detecting and treating disease



Drawing of outer protein shell of Zika virus

The Aedes mosquito can spread serious diseases such as dengue fever, yellow fever, the Zika virus and chikungunya. Aedes mosquitoes are visually distinctive because of their noticeable black and white markings on their body and legs. It has a typical flight range of 400 meters, prefers to be indoors and bites humans primarily during daylight hours.

An epidemiologist tests human blood samples for the Zika virus at the Epidemiology Lab.

Epidemiology is the part of medicine that deals with the incidence, distribution and possible control of diseases. Epidemiologists study disease outbreaks and help governments and health services make evidence-based decisions to combat disease. Can you do the same?



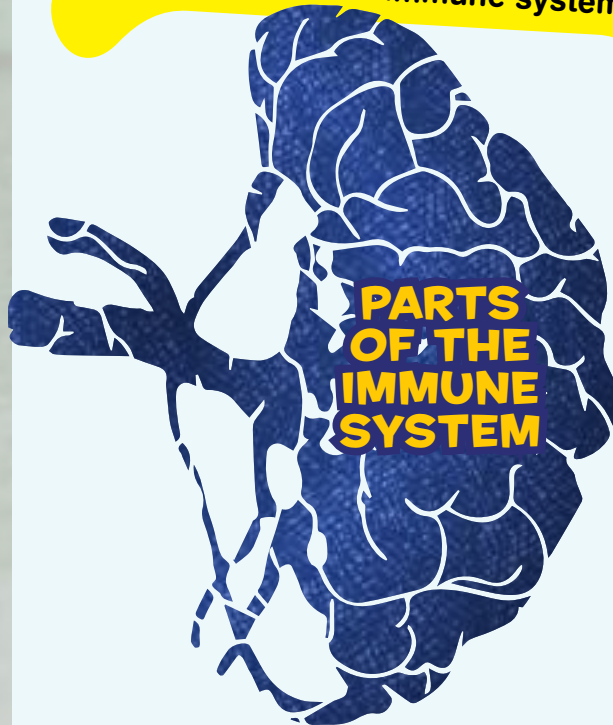
Click here to explore, detect and treat diseases.



Activity 3.4 Defending against infection

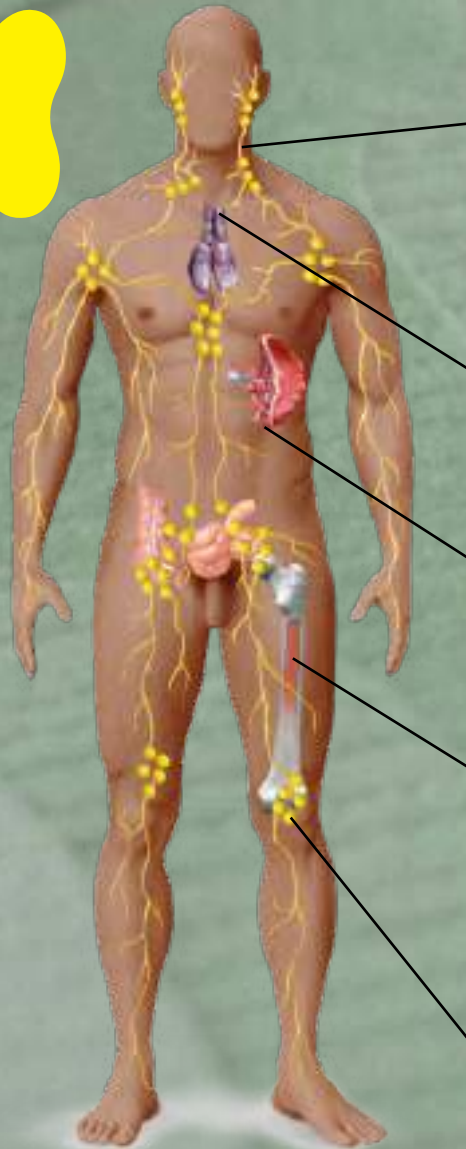


? What parts of the human body are involved in the immune system?



Our internal immune system consists of specialised cells, tissues and organs that work together to protect the body from invading pathogens.

Have you ever been told that your glands are swollen when you have had an infection? Why might this be?



LYMPHATIC VESSELS

A network of vessels that run throughout the body that carry a clear fluid called lymph fluid between the body tissues and the bloodstream. Lymph fluid contains substances such as nutrients, waste and white blood cells.

THYMUS

A gland that is only active during childhood and is involved in the development of specialised white blood cells that are important in fighting infection.

SPLEEN

An organ that helps filter and remove foreign particles from the lymph fluid.

BONE MARROW

A tissue found inside bones where blood cells, including white blood cells that fight infection, are produced.

LYMPH NODES

Oval shaped organs distributed throughout the body and linked by lymphatic vessels. As lymph fluid flows through lymph nodes, bacteria, viruses and other foreign particles get trapped and are destroyed by white blood cells.



Click here to explore our immune system further and the body's three lines of defence against pathogens.

Activity 3.5 How have scientists contributed to our understanding of disease?



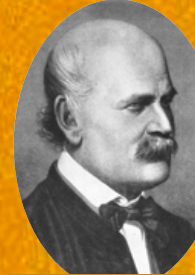
Each of these scientists has contributed to our understanding of disease. In groups, assemble a summary of one of these scientific discoveries.



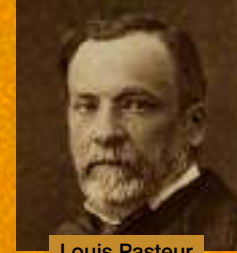
Antoni van Leeuwenhoek



Edward Jenner



Ignaz Semmelweis



Louis Pasteur



Joseph Lister



Fleming, Florey and Chain



Ruth Bishop



Ian Frazer



What needs arose in society that may have led to this discovery?



Why is this a significant discovery in our understanding of disease?



How does this discovery impact on quality of life for you and human society?



Click here to explore your scientific discovery.

Disease - a condition of the living animal or plant body or of one of its parts that impairs normal functioning and is typically manifested by distinguishing signs and **symptoms**.

Pathogens are micro-organisms that cause **infectious disease**. They include **bacteria**, **viruses**, **fungi** and **protozoa**. Bacteria and viruses are the main pathogens:-

Bacteria – are living cells that come in many shapes and sizes, up to 10 micrometres long. Once inside the body they can multiply rapidly and release poisons or toxins that make us feel ill.

Viruses – are many times smaller than bacteria. They are among the smallest organisms known and consist of a fragment of genetic material inside a protective protein coat. Viruses can only reproduce inside host cells, damaging the cells as they do.

Epidemiology is the part of medicine that deals with the incidence, distribution and possible control of diseases. **Epidemiologists** study disease outbreaks and help governments and health services make evidence-based decisions to combat disease.

Many organisms are so small we cannot see them unless we use a microscope. We call these organisms, **microorganisms** or **microbes**. They include bacteria, viruses, fungi, protozoans, algae and archaea. Scientists that study microbes are called **microbiologists**.

Our first line of defence against diseases are our body's physical and chemical barriers that prevent pathogens from entering our blood. These include:

- skin
- nasal hairs,
- mucus and cilia
- tears

If pathogens enter the bloodstream, blood rushes to the entry site, causing **inflammation**. The tissues become hot, red and swollen. **White blood cells**, called **phagocytes**, engulf, digest and destroy the pathogens.

The last defence against disease is a specialised and specific attack by white blood cells called **lymphocytes**. They recognise the pathogen by the particular **antigen** it carries. The lymphocytes divide rapidly to increase their numbers and produce **antibodies** that latch onto the antigen and destroy the pathogen. Lymphocytes remember the pathogen to develop future **immunity** from the same pathogen.

Scientists that have contributed to our understanding of disease include:-

Antoni van Leeuwenhoek – microscope developer and manufacturer and discoverer of microorganisms.

Edward Jenner – pioneered the process of **vaccination**. Jenner injected people with harmless cowpox to cause them to develop immunity against the more deadly smallpox virus.

Ignaz Semmelweis – introduced the practice of **hand washing** in hospitals to reduce the spread of infection.

Louis Pasteur – developed the **germ theory of disease**; that each infectious disease was caused by a germ. Pasteur identified such germs while studying the production of wine and the growing of silkworms.

Joseph Lister – introduced the use of **antiseptic** sprays during surgery and antiseptic treated dressings for wounds. His techniques saved many patients and are used in all hospitals today.

Alexander Fleming, Howard Florey and Ernst Chain – Fleming was trying to grow bacteria on agar plates. A fungal spore accidentally landed on an exposed plate and grew into a fungal colony and caused the surrounding bacteria to die. Fleming called the mould juice made by this fungus penicillin and wrote about his observation in a paper. Florey and Chain read Fleming's paper and tried to grow the fungus in large quantities to extract penicillin. They tested the **penicillin** on sick people and found that they became completely cured of their infections. They had developed the first **antibiotic**.

Ruth Bishop – developed a **vaccine against the rotavirus** which is responsible for causing the half a million children deaths each year from severe gastroenteritis. This vaccine is especially valuable to people living in developing countries that do not have access to clean water and sanitation.

Ian Frazer – developed the first **vaccine against a cancer**. The vaccine gives immunity against the **human papilloma virus (HPV)** which causes infections in males and females and leads to cancer of the cervix in women. Four out of five Australians will have a HPV infection in their lives. The HPV vaccine is provided free in schools to all males and females aged 12-13 years under the National HPV Vaccination Program.

Summary

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PART

