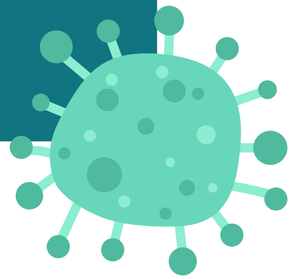
Creation of Immune Memory



Lesson created by Holly Sedgwick, University of Manchester, Olivia Shorthouse, University of Manchester and Rachel Hindmarsh, University of Oxford
as part of the *Thanks for the Memories* Public Engagement Project

Thanks for the Memories

wellcome

NUFFIELD DEPARTMENT of MEDICINE

UNIVERSITY OF OXFORD

MANCHESTER 1824
The University of Manchester

PRiSM
THE RNCM CENTRE FOR PRACTICE & RESEARCH in SCIENCE & MUSIC

Learning Objectives

1. Describe how the immune system responds to different types of pathogens (viruses, bacteria, fungi, protists)
2. Explain how immune memory forms after an infection
3. Compare the primary and secondary immune response

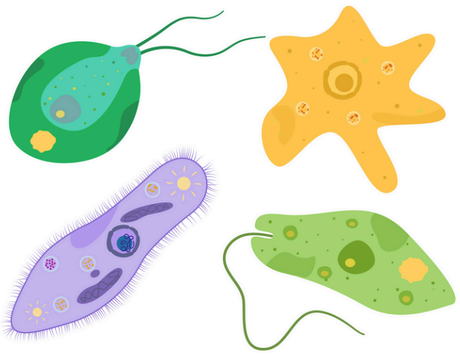
Last lesson we thought about what would happen if you got a cold.

Now - what would happen if you got the same cold again a few months later?

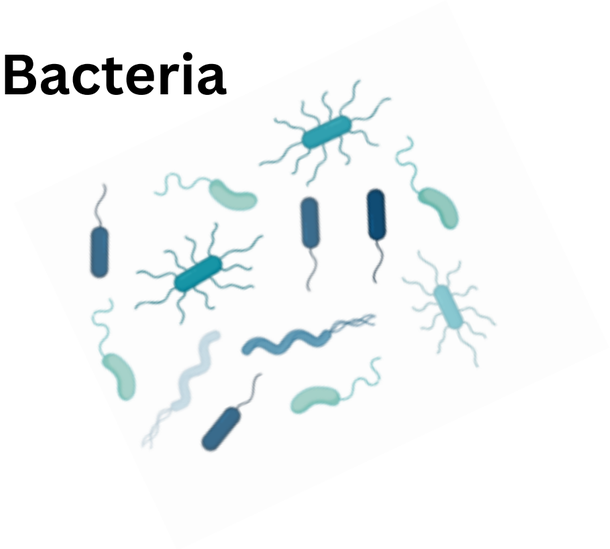
Pathogens

Fungi

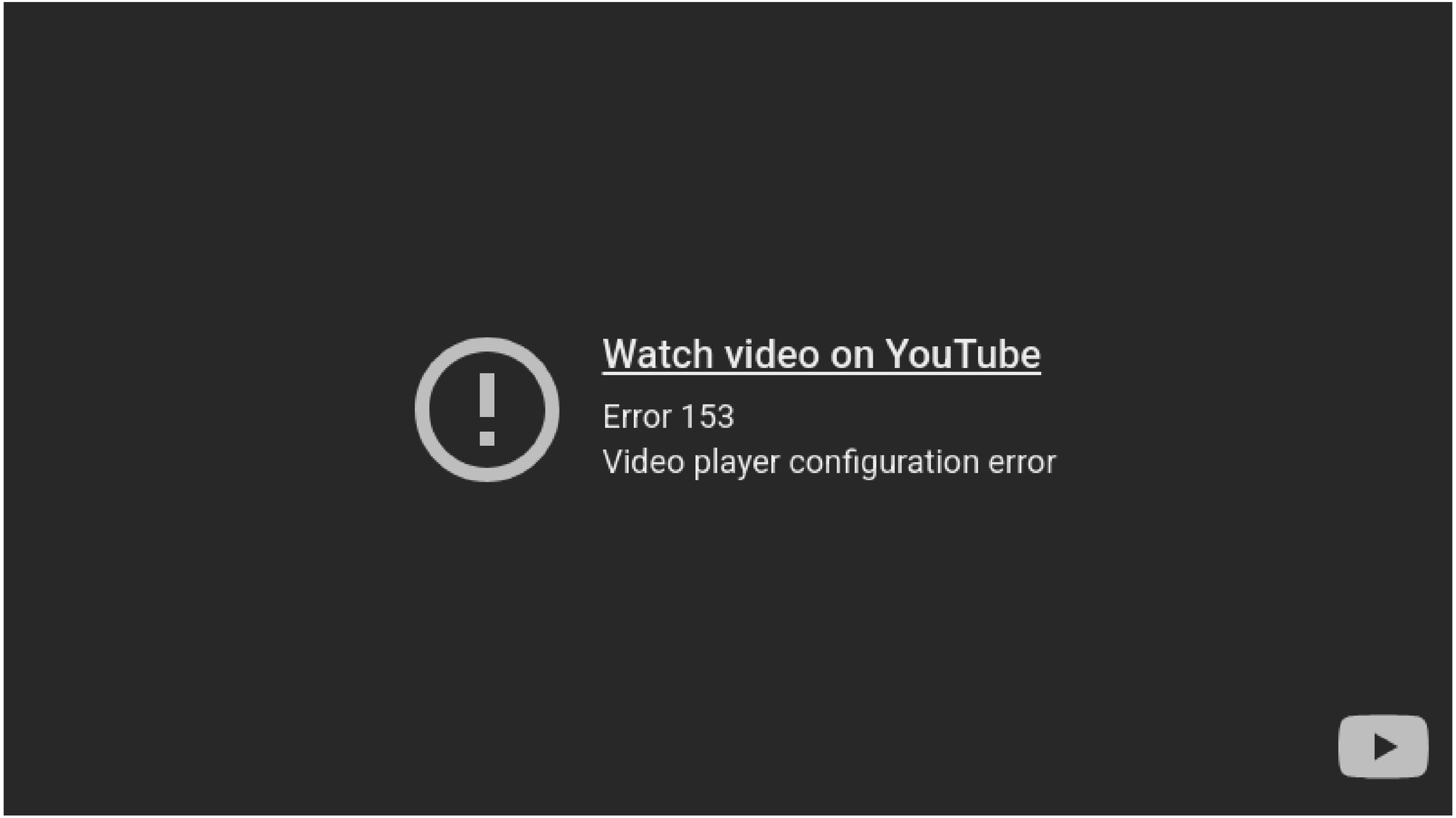
Protists (Protozoa)



Bacteria



Viruses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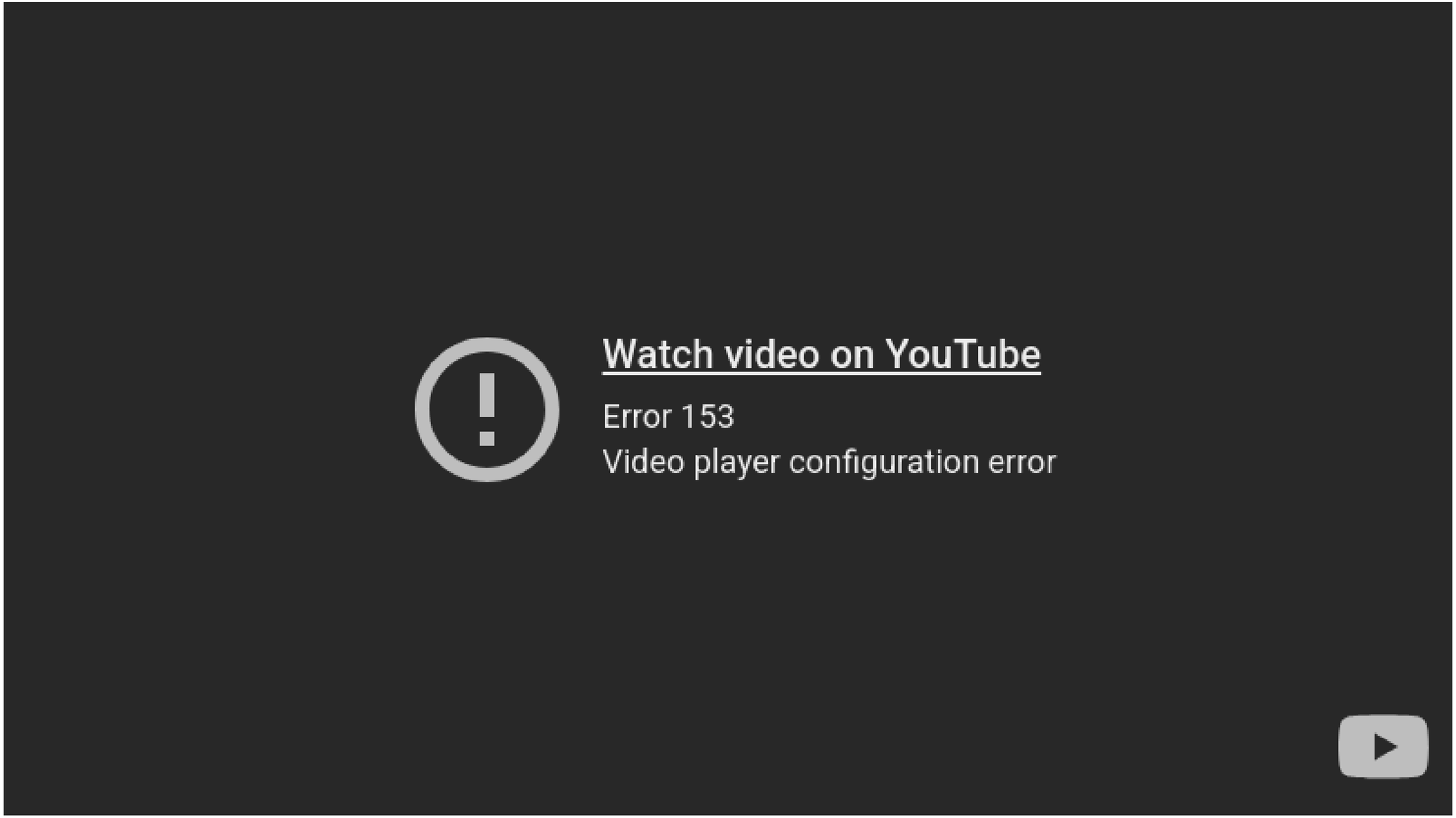
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Activity 1: Pathogen Match and Memory

1. Carefully read the table - the different categories (Pathogen Example, Type of Pathogen, How it Damages the Body, Symptoms, and How it Reproduces) are all mixed up

Activity 1: Pathogen Match and Memory

Pathogen Example	Type of Pathogen	How It Damages the Body	Symptoms	How It Reproduces	How the Immune System Responds
Athlete's foot (Trichophyton)	Protozoa	Produces toxins that irritate the gut lining and damage cells	Fever, chills, sweats, muscle pain	Divides quickly by binary fission	The **skin** provides the first barrier against fungal infection. When fungi grow on or under the skin, **phagocytes** attack the fungal cells, and **inflammation** brings more immune cells and blood flow to the area. Fungal infections often require a **local immune response** rather than a whole-body one.
Malaria (Plasmodium)	Fungi	Grows on skin surface, damages skin cells, causes itching and flaking	Diarrhoea, stomach cramps, vomiting, fever	Uses host cells to copy its genetic material and make new viruses	**Phagocytes** quickly **engulf and digest** bacteria that enter the body. **Antibodies** can also attach to **toxins, neutralising them** or clumping bacteria together so they're easier for phagocytes to destroy.
Salmonella	Virus	Invades red blood cells and liver cells, causing them to burst	Itchy, red, cracked skin (especially between toes)	Spreads by spores, often in warm, moist environments	Protozoan parasites are harder to destroy because they **live inside body cells** and **change form** during infection. The immune system must use both **antibodies** (to target the parasite in the blood) and **T-cells** (to destroy infected cells) at different stages of the infection.
Influenza	Bacteria	Invades cells, takes over cell machinery, causes cells to burst and die	Fever, cough, muscle aches, tiredness	Reproduces inside mosquitoes and human liver cells	**B-lymphocytes** make **antibodies** that recognise and attach to **viral antigens**, marking infected cells or free viruses for destruction. **T-lymphocytes** then destroy the body's infected cells to stop the virus spreading. The immune system also makes **memory cells** so it can respond faster next time.

Activity 1: Pathogen Match and Memory

2. Match each pathogen example with its correct type, the damage it causes to the body, its symptoms, and how it reproduces - use a highlighter or a coloured pen to show which squares match. Check your finished chart with who is sat next to you

3. Pick an example from the table and write a paragraph, in your own words, the immune response process on your worksheet - using at least 4 key terms from the Word Bank!

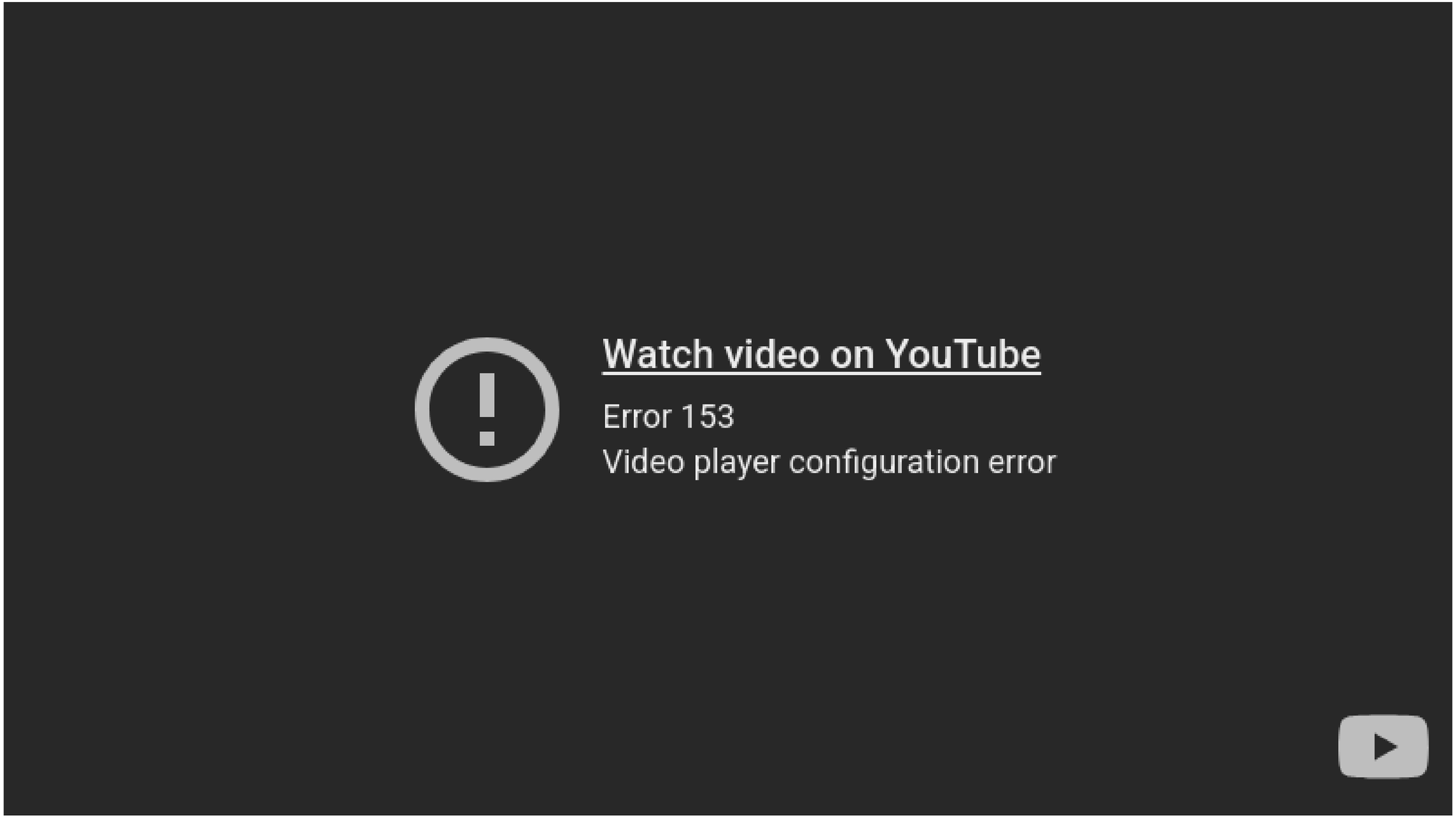
Extension:
Try to think of another pathogen which is not listed, and explain on your worksheet how it damages the body, its symptoms, and how it reproduces

Activity 1: Pathogen Match and Memory

Answers!

Pathogen Example	Type of Pathogen	How It Damages the Body	Symptoms	How It Reproduces	How the Immune System Responds
Influenza	Virus	Invades cells, takes over cell machinery, causes cells to burst and die	Fever, cough, muscle aches, tiredness	Uses host cells to copy its genetic material and make new viruses	**B-lymphocytes** make **antibodies** that recognise and attach to **viral antigens**, marking infected cells or free viruses for destruction. **T-lymphocytes** then destroy the body's infected cells to stop the virus spreading. The immune system also makes **memory cells** so it can respond faster next time.
Salmonella	Bacteria	Produces toxins that irritate the gut lining and damage cells	Diarrhoea, stomach cramps, vomiting, fever	Divides quickly by binary fission (splits into two)	**Phagocytes** quickly **engulf and digest** bacteria that enter the body. **Antibodies** can also attach to **toxins**, **neutralising them** or clumping bacteria together so they're easier for phagocytes to destroy.
Athlete's foot	Fungi	Grows on skin surface, damages skin cells, causes itching and flaking	Itchy, red, cracked skin (especially between toes)	Spreads by spores, often in warm, moist environments	The **skin** provides the first barrier against fungal infection. When fungi grow on or under the skin, **phagocytes** attack the fungal cells, and **inflammation** brings more immune cells and blood flow to the area. Fungal infections often require a **local immune response** rather than a whole-body one.
Malaria	Protozoa	Invades red blood cells and liver cells, causing them to burst	Fever, chills, sweats, muscle pain	Reproduces inside mosquitoes and human liver cells	Protozoan parasites are harder to destroy because they **live inside body cells** and **change form** during infection. The immune system must use both **antibodies** (to target the parasite in the blood) and **T-cells** (to destroy infected cells) at different stages of the infection.

What is immune memory?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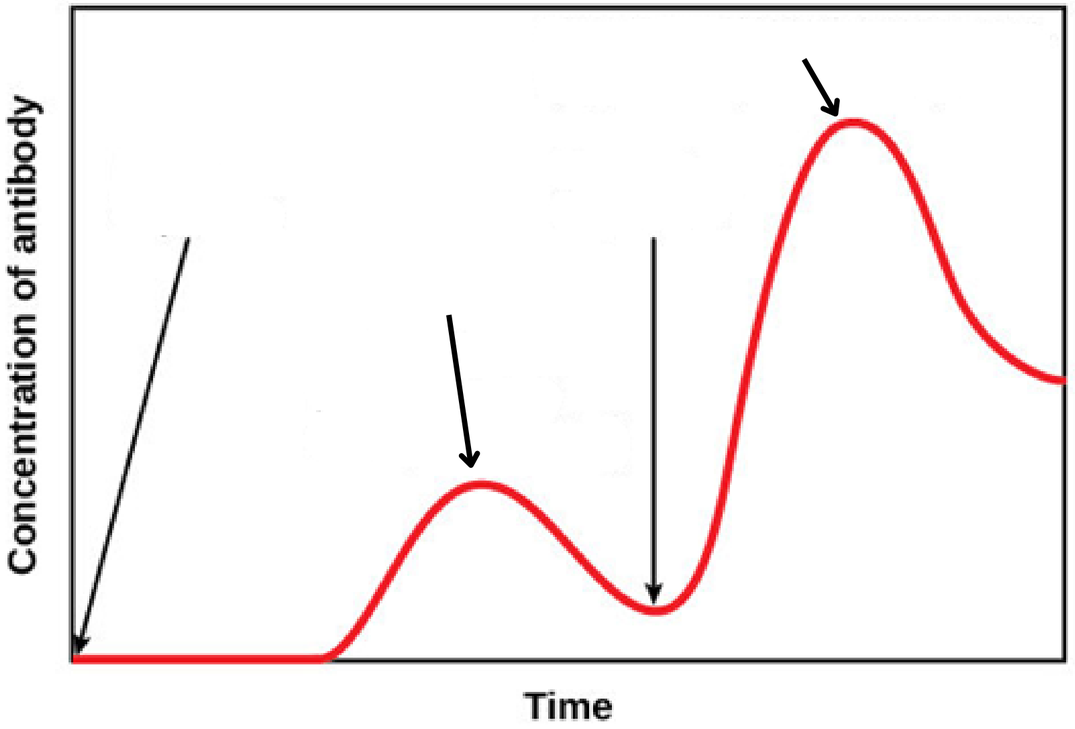
LO2 + LO3

Explain how immune memory forms after an infection
Compare the primary and secondary immune response

Draw and annotate a graph showing the immune response to a first and second infection - with the concentration of antibodies measured against time. Make sure you include:

1. Initial exposure to infection
2. First immune response
3. Second exposure to infection
4. Second immune response



Activity 2: First vs Second Infection Storyboard

Now let’s visualise how the immune system responds differently on the second exposure to infection. Create a storyboard showing 6 panels showing the following stages. Annotate it with captions and explanations of how the immune system responds to first and second infections

1. Entry of a pathogen
2. First immune response
3. Memory cell formation
4. Second exposure to same pathogen
5. Fast immune response
6. Recovery

Activity 2: First vs Second Infection Storyboard

Success criteria

Scientific Accuracy - The storyboard should correctly show the stages of immune response (pathogen → antibodies → memory cells → faster response next time)

Clarity of Ideas - Each panel clearly shows what's happening and why. Top tip: Add short labels or speech bubbles explaining the science ("B-lymphocytes make antibodies to attack the virus")

Creativity and Presentation - Make the drawings neat and colourful, and helpful for explaining the science!

Clear Explanation - Each panel should include a short sentence or caption describing what's happening

Scientific Vocabulary - Use correct terminology to explain the immune response. Include at least 5 key terms from the Word Bank: Pathogen, Antigen, Antibody, Lymphocyte (B-cell, T-cell), Phagocyte, Memory Cell, Immune Response, Vaccination/Immunity

Activity 2: First vs Second Infection Storyboard

Top Tips!

Scientific Accuracy - Use key words like antigen, antibody, phagocyte, lymphocyte, memory cell, immunity

Clarity of Ideas - Add short labels or speech bubbles explaining the science (“B-lymphocytes make antibodies to attack the virus”)

Creativity and Presentation - Use arrows, labels, and different colours for cells, pathogens, and antibodies

Clear Explanation - Example: “Memory cells remain in the blood, ready to respond quickly next time.”

Scientific Vocabulary - Include at least 5 key terms from the Word Bank: Pathogen, Antigen, Antibody, Lymphocyte (B-cell, T-cell), Phagocyte, Memory Cell, Immune Response, Vaccination/Immunity

Activity 2: First vs Second Infection Storyboard

Example ideas/ captions:

Panel	Example Drawing / Caption
1. Pathogen Entry	Germs (e.g., virus) entering the body — draw sneezing or a cut. “Pathogen with antigens enters the body.”
2. First Immune Response	White blood cells attacking the pathogen. “Phagocytes engulf pathogens. Lymphocytes make antibodies to destroy the pathogen.”
3. Memory Cell Formation	Some white blood cells stay behind. “Memory cells remain in the blood.”
4. Second Exposure	Same pathogen re-enters the body. “Pathogen with same antigens returns.”
5. Fast Response	Rapid antibody production. “Memory cells quickly make antibodies — no symptoms. This response is both faster and stronger”
6. Recovery	Healthy person, pathogen defeated. “Body remains immune to this pathogen.”

Quick Quiz!

What is the role of a memory cell?

Quick Quiz!

What happens if the same pathogen infects you again?

Quick Quiz!

Which is usually faster: primary or secondary response?

Quick Quiz!

Answers!

1. What is the role of a memory cell? Memory cells are special white blood cells that "remember" a specific pathogen (germ) after an infection or vaccine. If the same pathogen enters the body again, memory cells help the immune system respond faster and stronger.
2. What happens if the same pathogen infects you again? If the same pathogen infects you again, the memory cells quickly recognise it and start a fast and strong immune response, often stopping you from getting sick at all.
3. Which is usually faster: primary or secondary response? The secondary response is faster and stronger than the primary response, because memory cells are already prepared to fight the infection.

Reflection

Write everything you know about vaccinations and how they work on your worksheet