Lesson Plan 2: Creation of Immune Memory

AQA Links:

- 4.3.1.1 Communicable diseases
- 4.3.1.6 Human defence systems

Learning Outcomes:

1) Describe how the immune system responds differently 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.

Materials Needed:

- Printer
- Whiteboard/equivalent
- Highlighters
- Powerpoint presentation and screen

Introduction:

Starter Discussion: *"What would happen if you got the same cold again a few months later?"*

Encourage students to explore the idea that the body can fight off a second infection more quickly. Guide the discussion with questions like:

- "Why don't we always get sick again after recovering from an illness?"
- "If one person in a family gets ill, why don't *all* of them always catch it?"
- "Why is the second time often milder or shorter?"

Activity 1: Pathogen Match & Memory Chart (LO1)

Objective: Understand immune responses across different pathogen types

Instructions: Explain to students that pathogens are microorganisms that cause disease:

Bacteria
- Single-celled living organisms.
- Some can cause disease by releasing toxins that damage body tissues.
- They can multiply quickly by splitting in two.
- Example: Salmonella (food poisoning).

Fungi
- Can be single-celled or grow as long threads (hyphae).
- Some cause disease by growing on the skin and damaging it.
- They often spread by releasing spores.
- Example: Athlete's foot.

Protists (Protozoa)
- Single-celled organisms that live in water or inside other organisms.
- Some cause disease by invading and damaging body cells.
- They are often spread by insects.
- Example: Malaria (spread by mosquitoes).

Viruses
They invade your body's cells and take over to make more viruses.

These are covered in the following videos which can be played: https://youtu.be/WsZS4RCWpcE?si=XPPP4oMc2YEbTpas and https://youtu.be/vO51sFre6fg?si=fd2cifj1Ecfnvc98—if so, ask students to mind-map 3 key points about each video while watching.

Then, ask students to match each pathogen example with its correct type, the damage it causes to the body, its symptoms, how it reproduces, and how the immune system responds, using the activity 1 Match and Memory chart provided. Correct table below.

After students have matched the chart, ask them to check their charts with a partner. Then, ask students to pick an example from the table and write in their own words the process and timeline of the immune response on their worksheet. Students must use at least 4 of the Word Bank of key terms at the top of their worksheets:

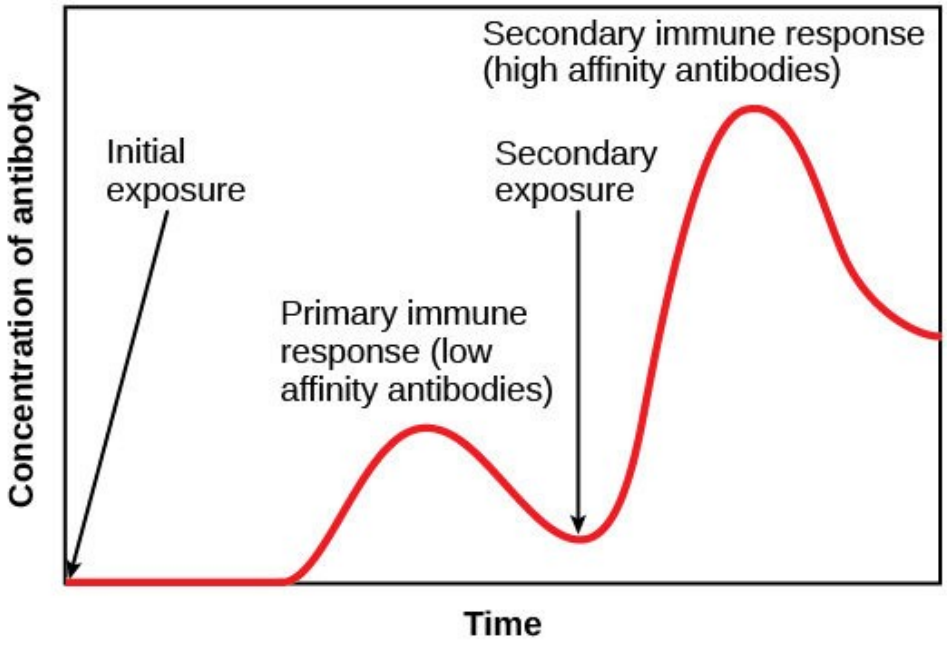
Pathogen, Antigen, Antibody, Lymphocyte (B-cell, T-cell), Phagocyte, Memory Cell, Immune Response, Vaccination)

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

Correct table:

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.

After completing Activity 1, introduce the concept of immune memory using this video (https://youtu.be/AARuqMu65oM?si=UeiEg3wU3yjIhr_D). Ask students to mind-map 3 points about immune memory while watching the video. Then, ask students to draw and annotate a graph showing the immune response to a first and second infection, using the below graph as an example, before moving on to Activity 2.



Activity 2: First vs Second Infection – Storyboard (LO2 + LO3)

Objective: Visualise how the immune system responds differently the second time.

Instructions: Students create a 4-6 panel storyboard showing:

1) Entry of a pathogen

2) First immune response (slow, symptoms occur)

3) Memory cell formation

4) Second exposure to same pathogen

5) Fast immune response (no symptoms or mild)

6) Recovery

Explain to students the following success criteria for the storyboard:

1. Scientific Accuracy. The storyboard correctly shows the stages of immune response (pathogen → antibodies → memory cells → faster response next time). Top tip: Use key words like antigen, antibody, phagocyte, lymphocyte, memory cell, immunity.

2. 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").

3. Creativity and Presentation. Aim for drawings that are neat, colourful, and help explain the science. Top tip: Use arrows, labels, and different colours for cells, pathogens, and antibodies.

4. Explanation / Captions. Each panel includes a short sentence or caption describing what's happening. Example: "Memory cells remain in the blood, ready to respond quickly next time."

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

After the students have drawn out the storyboard, ask students to annotate it with descriptions and explanations of how the immune system responds to first and second infections.

Example ideas/captions that could be shared with students:

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."

Plenary: Quick Quiz

Quiz Questions (on whiteboards):

- 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.*
- 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.*
- 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.*

Summary

Ask students to write down everything they know about vaccinations on your worksheets.

Lesson 2, Activity 1 resource: Pathogen Match & Memory Chart

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.

Lesson 2, Activity 2 resource: First vs Second Infection – Storyboard

1) Entry of a pathogen	2) First immune response
3) Memory cell formation	4) Second exposure to same pathogen
5) Fast immune response (no symptoms or mild)	6) Recovery

Creation of Immune Memory

Learning Outcomes:

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

Lesson Key Words:

Pathogen - a microorganism that causes disease

Antigen - a protein on the surface of a substance (often a pathogen) that triggers an immune response

Antibody - a protein produced by the immune system in humans (and other animals) that attacks antigens that get into the body

Lymphocyte (B-cell or T-cell) - white blood cells which attach pathogens by producing antibodies

Phagocyte - white blood cells that engulf and absorb harmful microorganisms, waste material, or other foreign bodies in the bloodstream and tissues

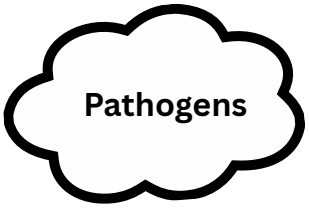
Memory Cell - a lymphocyte (B-cell or T-cell) that remains in the bloodstream after an infection, allowing the immune system to respond faster and more effectively if the same pathogen invades again

Primary/secondary infection - the first/second time an organism becomes infected by a particular pathogen

Vaccine - Substances containing dead or altered form of the disease-causing pathogen antigens, to stimulate the body to produce antibodies to provide immunity against that disease

Videos

While watching each video, mind-map 3 key points about pathogens:



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

Creation of Immune Memory

Activity 1

Pick a pathogen example from your finished Match and Memory chart, and describe in your own words how it affects the body and how the immune system responds. You must use at least 4 words from the Key Words list above!

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Extension: Think of another pathogen that isn't listed in the table, and explain how it affects the body and how the immune system responds.

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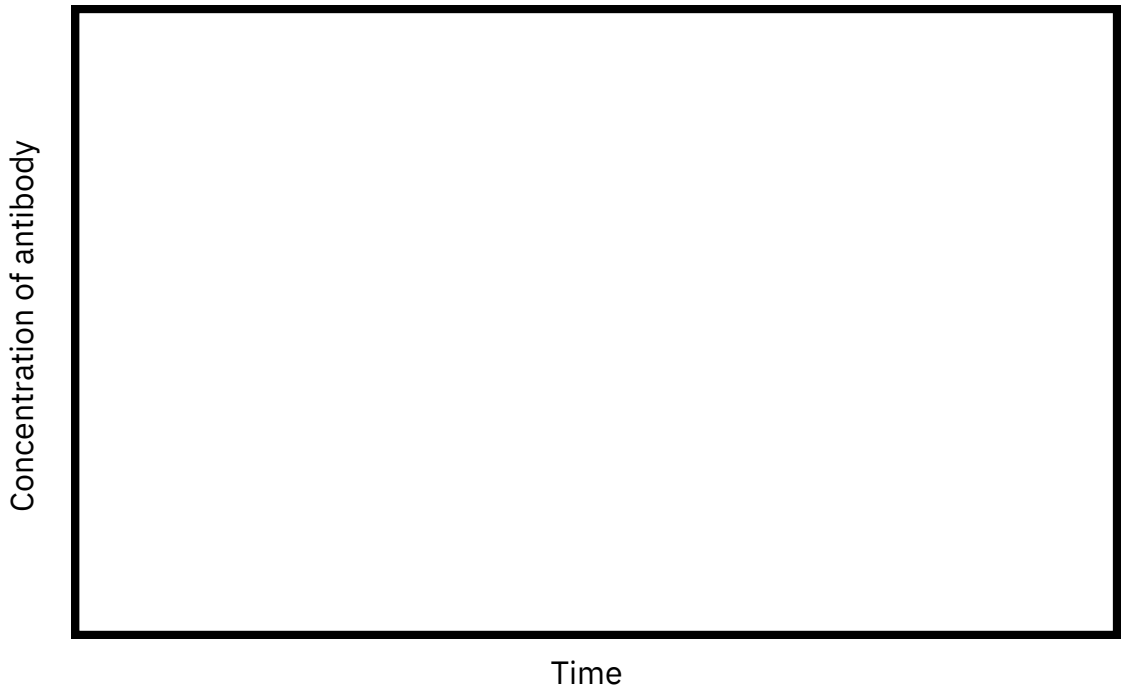
Video

While watching the video, mind-map 3 key points about immune memory:

Creation of Immune Memory

Graph

Draw and annotate a graph showing the immune response to a first and second infection.



Reflection

1. Write down everything you know about vaccination and how it works.

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2. And one question you still have!

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