

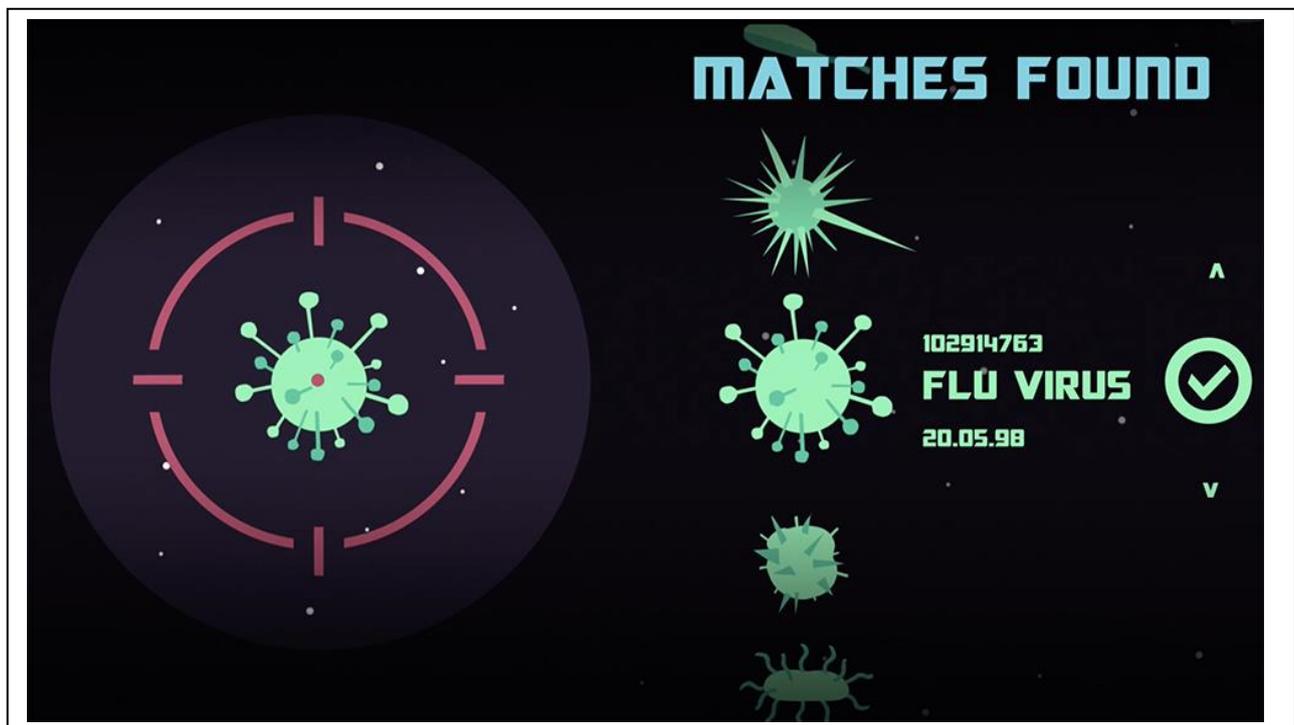


Key Stage 4 – Control of Immunity: Cascades of Shapes

Notes for teachers

At a glance

The following activity encourages students to review the action of the immune system with an emphasis on students considering the importance of shape in the activation and action of phagocytes and lymphocytes. In so doing, students will review the action of enzymes and the importance of shape in protein interactions.



Learning Outcomes

- Review the lock and key mechanism of enzyme action.
- Review the activation and action of phagocytes and lymphocytes.
- Identify and explain differences between the action of the innate and adaptive immune systems.
- Consider the importance of shape interaction in the correct functioning of the immune system.

Each student will need

- A copy of the student worksheet
- Pencil and rubber



Possible Lesson Activities

1. Starter activity

- Students attempt a review of the lock and key action of enzyme action.
- If students require additional support, you may wish to show a short video summary of enzyme action. A good example can be found here: <https://youtu.be/rIH1ym916Fo>.

2. Main activity: Introduction to the immune system

- Show Oxford Sparks video outlining the action of the innate and adaptive immune systems (see web links below).
 - Highlight that this video goes into more detail than is required at KS4 and they only need to categorise white blood cells as either phagocyte or lymphocyte.
- Students attempt questions aimed at eliciting the key information within the animation.

3. Main activity: Cascades of shapes – a story of the immune system

- Students work through the worksheet section by section, using the information given to answer questions about the immune system and to draw summarising cartoons.
- Written question answers:
 - Q - Outline the key differences between the innate and adaptive immune systems. Be sure to state which category of white blood cell is associated with each and to contrast their specificities (how many different pathogens they can attack) and mechanisms by which they neutralise pathogens.
 - A – The innate immune system is a non-specific defence system that can attack a range of pathogens which share generic antigens. Phagocytes are the main immune cell associated with the innate immune system. The adaptive immune system, by contrast, generates an antigen specific immune response in which cells are created in response to a specific antigen and act against that same antigen. Lymphocytes are the main immune cells associated with the adaptive immune system.
 - Q - Using your understanding of the importance of shape in enzyme action, suggest why many different enzymes are required to break down a single ingested pathogen within the phagosome.
 - A – Pathogens are likely to be made of many different molecules. This means many different substrates of many different shapes. As enzymes are specific and complimentary to their substrates, only one substrate is likely to be complimentary to the enzyme's active site. Only the substrate that is complimentary to the enzyme active site will form an enzyme-substrate-complex and be acted on. The other substrates will each need their own specific and complimentary enzyme and so many different enzymes will be required.
 - Q - Suggest why pathogen digestion must occur within a phagosome (a special membrane bound organelle).
 - A – Without containment in a phagosome, the digestive enzymes would also digest the contents of the phagocyte.
 - Q - Some diseases such as type 1 diabetes are autoimmune diseases in which the body's own immune system misidentifies its own cells (in this case insulin producing cells in the pancreas) as non-self and starts attacking them. Use your



understanding of the shape of antigens and immune cell activation to suggest what has happened to cause this.

- A – Key idea here is that something has happened that causes the WBCs to be activated by proteins expressed on the beta cells of the pancreas. In reality this is due to the expression of a combination of genes that heighten the sensitivity of the immune system, and an environmental trigger, such as a virus that might mimic proteins in the beta cell.
- Q - Suggest why patients who have recently undergone organ transplants need to take immunosuppressants (drugs which dampen the action of the immune system).
 - A – Transplanted organs have come from a different individual. As such, the cells of the transplanted organ are likely to present different cell surface proteins. There is a chance that the cells of the immune system will recognise these cell surface proteins as non-self antigens and start an immune response against them. Immunosuppressants inhibit the action of immune cells and make them less likely to attack the transplanted organ.
- Q - We have seen that the shape of molecules is very important in allowing the correct functioning of the immune system. Many of the molecules discussed here are proteins. Using your knowledge of protein structure, suggest why proteins are good molecules for a system that relies on the specific interaction of shapes.
 - A – Proteins are made from long strings of amino acids which, once assembled in a precise order, fold in a specific shape due to bonding between amino acids. There are 20 different amino acids and so there is a huge variety of combinations of amino acids that can be produced when they are assembled. Each different combination of amino acids will produce a different pattern of bonding and so fold into a different shape. The massive variety of possible combinations of amino acids means that there is a vast number of possible shapes. This is useful for a system that relies on shape because recognition and responses can be very specific as shapes are likely to be unique.

4. Plenary

- Immune system and enzyme true or false questions. Examples may include:
 - Enzymes are types of proteins which act as catalysts
 - Enzymes work by increasing activation energy
 - Lymphocytes are associated with the innate immune system
 - Phagocytes are quicker to react to pathogens than lymphocytes
 - Both phagocytes and lymphocytes respond to antigens

Web links

- Oxford sparks animation: Our immune system – the battle within
<https://www.oxfordsparks.ox.ac.uk/content/our-immune-system-battle-within>