Infection and response

Model answers and marking points

GCSE science 6-mark questions

This topic online

1 A primary school in Leicester has an outbreak of measles. Children who had the MMR vaccine as toddlers did not become ill.

Explain how the vaccine protected these children, and why it matters that most children in the area are vaccinated.

(6 marks)

Model answer

The MMR vaccine contains a weakened or inactive form of the measles virus. This virus cannot cause the disease, but it still has antigens on its surface.

When the vaccine was injected, the children's white blood cells, called lymphocytes, detected these antigens and made antibodies that are specific to the measles virus. Some of these white blood cells became memory cells, which stay in the blood for many years.

During the outbreak, when the live measles virus got into a vaccinated child, the memory cells recognised its antigens straight away. Antibodies were made much more quickly and in much larger amounts than the first time. The antibodies helped destroy the virus before it could reproduce enough to cause symptoms, so these children did not become ill.

If most children in the area are vaccinated, the virus has very few people it can infect and spread through. This means it is much less likely to reach people who cannot have the vaccine, such as young babies or children with weak immune systems. So high vaccination rates help protect the whole community, not only the vaccinated child.

Marking points (credit any 6 relevant points, linked in a sensible order)

- the vaccine contains a dead or inactive form of the measles virus
- the virus has antigens on its surface
- white blood cells (lymphocytes) detect the antigens and produce specific antibodies
- memory cells are made that stay in the body
- when the live virus enters later, memory cells cause antibodies to be made much faster and in greater numbers
- the virus is destroyed before the child shows symptoms
- if most people are vaccinated, the virus has few people to pass between
- this protects people who cannot be vaccinated, such as very young babies, so the spread of the disease is reduced (herd immunity)

How it is marked

- 5-6 marks: explains the sequence from inactive virus to antigens, antibodies and memory cells, the faster secondary response, and the wider benefit of most people being vaccinated.
- 3-4 marks: explains that the vaccine causes antibodies to be made and gives immunity, with a limited mention of memory cells or the wider benefit.
- 1-2 marks: states that the vaccine stops you getting ill or contains the virus, with little explanation.

What loses marks

- saying the vaccine contains antibodies
- saying white blood cells remember the virus without mentioning memory cells or antibodies
- saying vaccines kill the virus directly

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2 Salmonella food poisoning is caused by a bacterium. HIV is caused by a virus.

Compare these two diseases. Include how each is spread, how each affects the body and how each is controlled or treated.

(6 marks)

Model answer

Salmonella is caused by a bacterium, whereas HIV is caused by a virus that lives and reproduces inside the body's cells.

Salmonella is spread in food, for example in undercooked chicken or food prepared in unhygienic conditions. HIV is not spread in food. It is spread by sexual contact or by exchanging body fluids such as blood, for example when drug users share needles.

The Salmonella bacteria produce toxins in the gut, which cause fever, stomach cramps, vomiting and diarrhoea within a few days. HIV first causes a mild flu-like illness. The virus then attacks the body's immune cells, and if it is not treated it can reach late-stage HIV, called AIDS, when the immune system is so damaged that other infections can kill the person.

Salmonella is controlled in the UK by vaccinating poultry against the bacterium and by cooking food properly. HIV is controlled by using condoms and not sharing needles. Antibiotics can be used for a serious bacterial infection like Salmonella, but they do not work against viruses, so HIV is treated with antiretroviral drugs. These keep the virus under control but do not cure it.

Marking points (credit any 6 relevant points, linked in a sensible order)

- Salmonella is a bacterium; HIV is a virus
- Salmonella is spread in food, such as undercooked chicken, or food prepared in unhygienic conditions
- HIV is spread by sexual contact or exchange of body fluids such as blood, for example sharing needles
- Salmonella bacteria produce toxins, causing fever, stomach cramps, vomiting and diarrhoea
- HIV causes a flu-like illness at first, then attacks the immune system cells
- late-stage HIV (AIDS) means the immune system is badly damaged and other infections take hold
- Salmonella is controlled by vaccinating poultry and cooking food thoroughly
- HIV is controlled with condoms and not sharing needles
- antibiotics can treat bacterial infections but do not work on viruses
- HIV is treated with antiretroviral drugs, which do not cure it

How it is marked

- 5-6 marks: compares the two diseases on spread, effects and control or treatment, with a direct comparison in each area.
- 3-4 marks: gives correct facts about both diseases in at least two areas, but comparison is mostly implied.
- 1-2 marks: gives one or two facts about one disease.

What loses marks

- saying HIV can be treated with antibiotics
- describing each disease separately with no comparison
- saying Salmonella is spread through the air

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3 A pharmaceutical company in Cambridge has discovered a chemical that might treat migraines.

Describe the stages the new drug must go through before doctors can prescribe it. (6 marks)

Model answer

First the drug goes through preclinical testing. It is tested in the laboratory on cells and tissues, and then on live animals. These tests check its toxicity, which means whether it is harmful, its efficacy, which means whether it works, and the dose needed.

If the drug passes preclinical testing, it moves on to clinical trials. It is first given to a small number of healthy volunteers at a very low dose, to check that it is safe and to look for side effects.

If it is safe, it is then tested on people who suffer from migraines. Different doses are tried to find the optimum dose.

Large trials are often double blind. The patients are split into groups. One group is given the drug and another is given a placebo, which looks the same but contains no drug. Neither the patients nor the doctors know who has which, so the results are not affected by bias.

Finally the results are checked by other scientists through peer review before they are published. Only if the drug is shown to be safe and effective will it be approved for doctors to prescribe.

Marking points (credit any 6 relevant points, linked in a sensible order)

- preclinical testing in the laboratory on cells and tissues
- then tested on live animals
- preclinical tests check for toxicity, efficacy and dose
- clinical trials then use healthy volunteers at very low doses to check safety and side effects
- if safe, trials move to patients with the condition to find the optimum dose
- double blind trials: some patients get a placebo, and neither patients nor doctors know who gets which
- this avoids bias and allows a fair comparison
- results are checked by other scientists (peer review) before publication
- only when the drug is shown to be safe and effective is it approved for use

How it is marked

- 5-6 marks: describes preclinical and clinical stages in the correct order, with what is tested at each stage and the use of placebos and double blind trials.
- 3-4 marks: describes most stages but with gaps in order or in what is being tested.
- 1-2 marks: states that drugs are tested on animals or people with no sequence.

What loses marks

- putting human trials before animal testing
- saying a placebo is a weaker dose of the drug
- not saying what is being tested at each stage

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4 A hospital is considering treating some patients' cancer with monoclonal antibodies attached to an anti-cancer drug, instead of standard chemotherapy, which affects all dividing cells in the body.

Evaluate the use of monoclonal antibodies to treat cancer. Give a justified conclusion.

Separate science only

(6 marks)

Model answer

Monoclonal antibodies are identical copies of one type of antibody, made from a single clone of cells. Each one is specific to one antigen, so it can be made to bind only to a protein found on the surface of the cancer cells.

The anti-cancer drug is attached to the antibody, so the antibody carries the drug straight to the cancer cells. This means the drug builds up in the tumour and far fewer healthy cells are harmed. Standard chemotherapy damages all dividing cells, such as those in hair follicles and bone marrow, so monoclonal antibodies should cause fewer side effects like hair loss and infections. Some monoclonal antibodies can also stop cancer cells growing or help the immune system destroy them.

However, when monoclonal antibodies were first used they caused more side effects than expected, such as fever and allergic reactions. They are also very expensive to produce, so a hospital could treat fewer patients for the same money. Each antibody only works against cancers with the right antigen.

Overall I think monoclonal antibodies are a better choice where a suitable one exists, because targeting the cancer cells reduces harm to the rest of the body, but cost means standard chemotherapy will still be needed for many patients.

Marking points (credit any 6 relevant points, linked in a sensible order)

- monoclonal antibodies are identical antibodies made from one clone of cells
- they are specific and bind only to one antigen, such as a protein on cancer cells
- a drug or radioactive substance can be attached to the antibody
- the drug is delivered to the cancer cells and fewer healthy cells are harmed
- this means fewer side effects than standard chemotherapy
- monoclonal antibodies can also block receptors or trigger the immune system to attack cancer cells
- when first used they caused more side effects than expected, such as fever or allergic reactions
- each antibody only works against cancers that carry its antigen
- they are expensive to develop and produce
- a justified conclusion

How it is marked

- 5-6 marks: explains how the antibodies target cancer cells, weighs at least two benefits and two drawbacks and reaches a reasoned conclusion.
- 3-4 marks: gives a benefit and a drawback with some explanation, conclusion weak or missing.
- 1-2 marks: states a simple point such as they target cancer cells.

What loses marks

- saying monoclonal antibodies have no side effects
- saying the antibodies kill all cells or act like a vaccine
- no conclusion or a conclusion with no reason

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5 Fatima grows roses in her garden in Bristol. This year some leaves have purple or black spots and turn yellow, and the plants are growing slowly. She also finds small green insects on the young shoots.

Suggest what might be wrong with the roses, how Fatima could find out, and how she could help the plants.

Separate science only

(6 marks)

Model answer

The purple or black spots with yellowing suggest that the roses have black spot, which is a fungal disease. The yellow areas have lost chlorophyll and the leaves often drop off early, so the plant can photosynthesise less and grows slowly. The fungal spores are spread to other plants by wind and by water splashing.

The small green insects are probably aphids. Aphids feed on the sugary sap in the phloem, which takes food away from the plant, and they can also spread diseases from plant to plant.

To find out, Fatima could compare the symptoms with a gardening manual or website, or send a sample to a lab or testing service that can identify the pathogen.

To help the roses, she should pick off and destroy the infected leaves, including any that have fallen, so the spores cannot spread. She could spray the plants with a fungicide. For the aphids, she could use an insecticide or introduce ladybirds, which eat aphids, as a biological control.

The slow growth could also be partly caused by a lack of mineral ions, such as magnesium, so she could add fertiliser too.

Marking points (credit any 6 relevant points, linked in a sensible order)

- black spots with yellowing leaves suggest rose black spot, a fungal disease
- the yellow leaves have less chlorophyll and often fall early, so less photosynthesis happens and growth is slow
- the fungal spores are spread by wind and water splashing
- the green insects are probably aphids
- aphids feed on sap from the phloem, taking sugars, and can spread disease
- she could identify the problem with a gardening manual or website, or a testing service or lab
- remove and destroy infected leaves so spores cannot spread
- spray with a fungicide
- use insecticides or ladybirds (biological control) to reduce aphids
- slow growth or yellowing could also be due to a lack of nitrate or magnesium ions

How it is marked

- 5-6 marks: suggests black spot and aphids with reasons, gives a sensible way of identifying the problem, and suggests treatments linked to how each problem spreads or causes harm.
- 3-4 marks: identifies one problem with some explanation and suggests at least one method of identification or control.
- 1-2 marks: makes a simple suggestion such as spraying the plants.

What loses marks

- saying black spot is caused by a virus or bacterium
- suggesting antibiotics for a plant disease
- saying aphids eat the leaves rather than feeding on phloem sap

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