A-Level Biology

Immune System

Question Paper

Time available: 66 minutes
Marks available: 51 marks

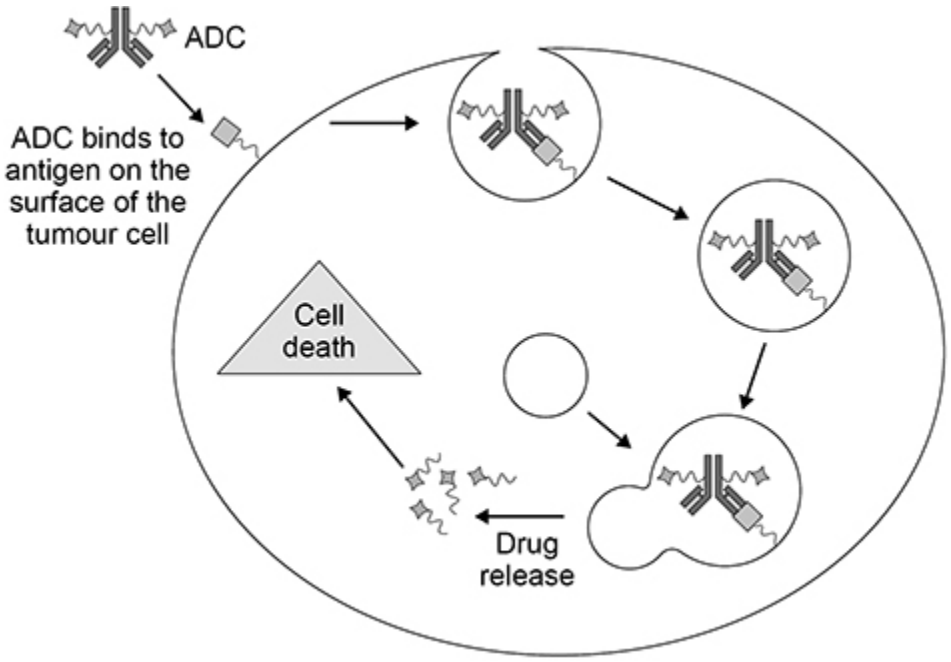
www.accesstuition.com

1. (a) ADCs are molecules made of a monoclonal antibody linked to a cancer drug.

Figure 1 shows how an ADC enters and kills a tumour cell.

The process of entering the cell and the breakdown of the antibody to release the drug is very similar to phagocytosis.

Figure 1



Use your knowledge of phagocytosis to describe how an ADC enters and kills the tumour cell.

(3)

(b) Some of the antigens found on the surface of tumour cells are also found on the surface of healthy human cells.

Use this information to explain why treatment with an ADC often causes side effects.

_____

_____

_____

_____

_____

_____

(2)

Scientists investigated whether one type of ADC could be used to treat human breast cancer.

This ADC is a monoclonal antibody combined with a drug to inhibit mitosis. The monoclonal antibody binds to a protein found on human breast cancer cells.

The scientists placed small pieces of human breast cancer tissue under the skin of mice.

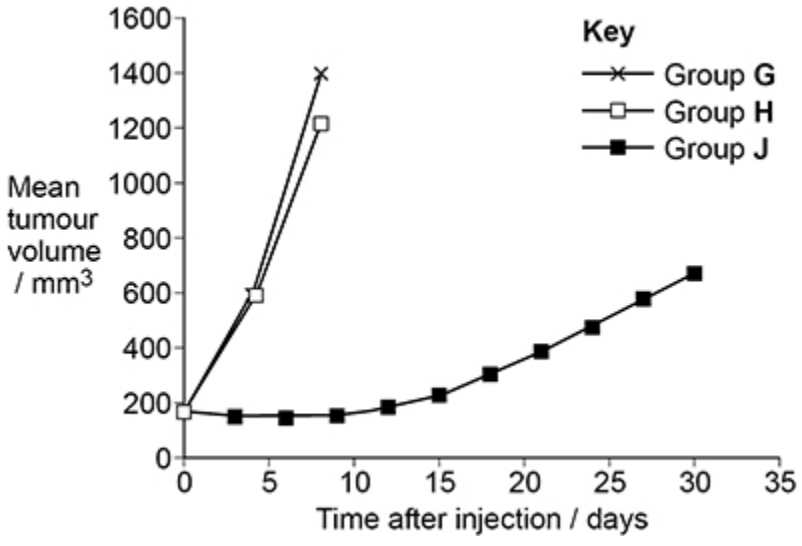
The scientists then randomly divided the mice into three groups. They treated the groups as follows on day 0.

Group G – control
Group H – injected with monoclonal antibody only
Group J – injected with ADC (monoclonal antibody + drug).

Every few days, the scientists measured the volume of the tumours formed from the human breast cancer tissue.

Figure 2 shows the scientists' results.

Figure 2



(c) Mice in **Group H** were injected with 2 mg kg^{-1} of monoclonal antibody. The monoclonal antibody was in a solution of concentration 500 mg dm^{-3}

Calculate the volume of antibody solution that the scientists would have injected into a 23 g mouse. Give your answer in dm^3 and in standard form.

_____ dm^3

(2)

(d) Suggest **one** reason why there are no data for **Group G** and **Group H** after day 8

_____

_____

_____

(1)

(e) Suggest and explain **two** further investigations that should be done before this ADC is tested on human breast cancer patients.

1 _____

_____

2 _____

_____

(2)

(Total 10 marks)

2. (a) Describe how a phagocyte destroys a pathogen present in the blood.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

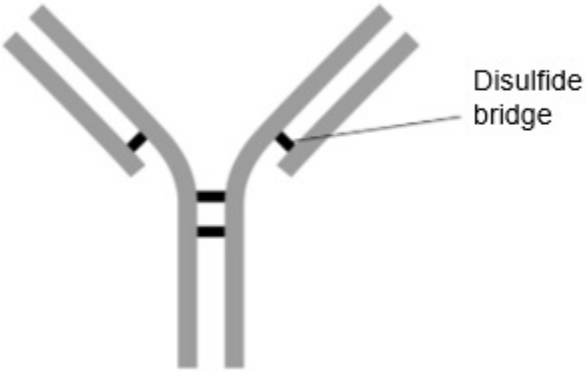
(b) Give **two** types of cell, other than pathogens, that can stimulate an immune response.

1 _____

2 _____

(2)

(c) The diagram below shows the structure of an antibody.



Label the diagram above with an **X** to show where an antigen-antibody complex forms.

(1)

(d) A disulfide bridge is labelled in the diagram above.

What is the role of the disulfide bridge in forming the quaternary structure of an antibody?

_____

_____

_____

(1)

(Total 7 marks)

3. In Europe, viruses have infected a large number of frogs of different species. The viruses are closely related and all belong to the Ranavirus group.

Previously, the viruses infected only one species of frog.

(a) Suggest and explain how the viruses became able to infect other species of frog.

_____

_____

_____

_____

_____

_____

(2)

(b) Name **two** techniques the scientists may have used when analysing viral DNA to determine that the viruses were closely related.

1 _____

2 _____

(1)

(c) Determining the genome of the viruses could allow scientists to develop a vaccine.

Explain how.

(2)

(d) Describe how the B lymphocytes of a frog would respond to vaccination against Ranavirus.

You can assume that the B lymphocytes of a frog respond in the same way as B lymphocytes of a human.

Do **not** include details of the cellular response in your answer.

(3)

(Total 8 marks)

4. (a) What is a **monoclonal** antibody?

(1)

(b) After a disease is diagnosed, monoclonal antibodies are used in some medical treatments.

Give **one** example of using monoclonal antibodies in a medical treatment.

_____

_____

_____

(1)

(c) Describe the role of antibodies in producing a positive result in an ELISA test.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

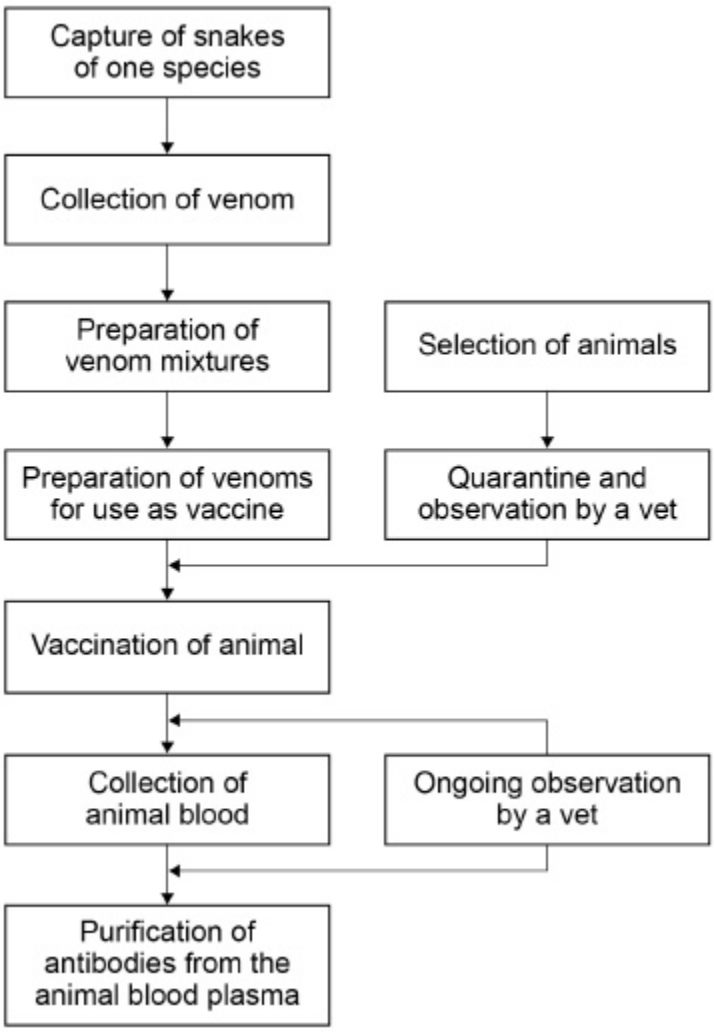
(Total 6 marks)

5. (a) When a person is bitten by a venomous snake, the snake injects a toxin into the person. Antivenom is injected as treatment. Antivenom contains antibodies against the snake toxin. This treatment is an example of passive immunity.

Explain how the treatment with antivenom works and why it is essential to use passive immunity, rather than active immunity.

(2)

The chart shows a procedure used to produce antivenom.



(b) A mixture of venoms from several snakes of the same species is used.

Suggest why.

_____

_____

_____

_____

_____

_____

(2)

(c) Horses or rabbits can be used to produce antivenoms.

When taking blood to extract antibody, 13 cm^3 of blood is collected per kg of the animal's body mass.

The mean mass of the horses used is 350 kg and the mean mass of the rabbits used is 2 kg

Using only this information, suggest which animal would be better for the production of antivenoms.

Use a calculation to support your answer.

(2)

(d) During the procedure shown in the chart the animals are under ongoing observation by a vet.

Suggest **one** reason why.

(1)

(e) During vaccination, each animal is initially injected with a small volume of venom. Two weeks later, it is injected with a larger volume of venom.

Use your knowledge of the humoral immune response to explain this vaccination programme.

(3)

(Total 10 marks)

6.

Ebola is a disease caused by a virus. The Ebola virus has a glycoprotein on its surface which binds to a specific receptor protein in the cell-surface membranes of human cells. When it binds to this receptor protein, the virus can enter the cell. Some people do not produce this receptor protein. These people may become infected with the Ebola virus but do not develop the disease. 5

A blood test can be used to determine whether a person has Ebola. People with Ebola have large numbers of specific plasma cells and a specific antibody in their blood. Some scientists have suggested treating people suffering from Ebola by using transfusions of blood plasma from people who have recently recovered from the disease. 10

The Ebola virus has a high mutation rate. This makes it difficult to develop a vaccine.

(a) People who do not have the specific receptor protein in their cell-surface membranes may be infected with the Ebola virus but do not develop the disease (lines 1–5).

Explain why they do **not** develop the disease.

(2)

(b) Explain the increase in specific plasma cells and antibody in people infected with the Ebola virus.

(2)

(c) Explain how a blood transfusion from a patient recently recovered from Ebola may be an effective treatment (lines 8–10).

(3)

(d) A high mutation rate makes it difficult to develop a vaccine (line 11).
Explain why.

(3)

(Total 10 marks)