11. Immunity

11.2 Antibodies and vaccination

Paper 1

Question Paper

1 Whooping cough is a highly infectious disease of the gas exchange system, caused by the bacterium *Bordetella pertussis*.

Which method provides protection to infants against whooping cough and reduces the chance of developing this disease later?

A a short course of more than one type of antibiotic

B a six-month course of one type of antibiotic

C injections of antibodies specific to *Bordetella pertussis*

D injections of antigens from *Bordetella pertussis* bacteria

2 What is fused with a B-lymphocyte to form a hybridoma cell in monoclonal antibody production?

A antigen

B clone

C macrophage

D myeloma cell

3 Which statement about the properties of the antigen-binding sites in different antibody molecules is correct?

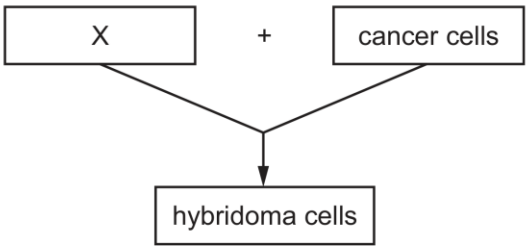
A They are located on the light chains only.

B They have a hinge region to give flexibility for different antigens.

C They have binding sites for receptors on phagocytes.

D They have variable amino acid sequences for different antigens.

4 The diagram shows a stage in monoclonal antibody production.



What is represented by X?

A T-lymphocytes

B B-lymphocytes

C antigens

D antibodies

5 A vaccine is used to give immunity to the virus that causes the disease influenza.

A new influenza vaccine is needed every year because the virus mutates regularly.

What is the reason for needing a new influenza vaccine every year?

A Memory cells become less effective as they age.

B The primary immune response does **not** produce enough antibodies.

C The secondary immune response does **not** produce enough antibodies.

D The virus antigens change and are **not** recognised by the immune system.

6 A bacterial pathogen produces a protein that acts as a toxin. This toxin is harmful to humans.

Scientists are developing monoclonal antibodies that can be used to detect the presence of the toxin in the body so that early treatment can be given.

Which statements describe steps in the development of these monoclonal antibodies?

1 The toxin protein is injected into a mouse and triggers mitosis of specific B-lymphocytes.

2 Antibodies are collected from the spleen of the mouse and fused with myeloma cells.

3 A hybridoma cell produces many antibodies with a variety of different variable regions.

A 1 and 2 **B** 1 only **C** 2 and 3 **D** 3 only

7 Why is passive immunity effective for only a short time?

A Antibodies are rapidly broken down.

B Antigens are rapidly broken down.

C Memory cells soon die.

D Phagocytes soon die.

8 Repeated infections with malaria result in more effective immunity to malaria.

Which type of immunity is responsible for the more effective immunity?

A artificial active

B artificial passive

C natural active

D natural passive

9 A successful vaccination programme provides a level of immunity where the majority of a population is protected.

There are several factors that can affect the success of a vaccination programme.

Which row correctly shows the factors that can affect the success of a vaccination programme?

	frequent mutation of the pathogen	vaccination from eight weeks old	pathogen is able to invade T-cells	booster vaccinations needed frequently
A	✓	✓	✗	✓
B	✓	✗	✓	✓
C	✗	✓	✓	✗
D	✓	✗	✓	✗

key

✓ = affects

✗ = does not affect

10 Which statements about uses of monoclonal antibodies are correct?

1 Monoclonal antibodies can be injected into patients to give active immunity.

2 Monoclonal antibodies can be injected into patients to treat viral infections.

3 Monoclonal antibodies can be used as diagnostic tests for specific pathogens.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

11 Which statement explains how a vaccination programme can control the spread of an infectious disease in a population?

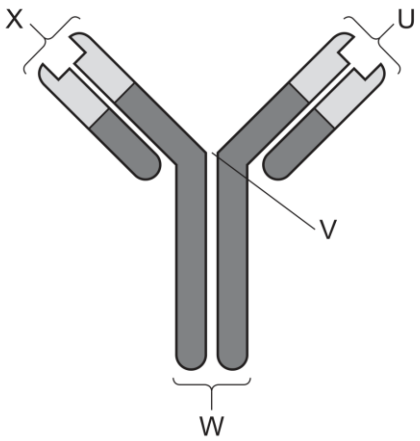
A Unvaccinated individuals are less likely to meet a vaccinated individual.

B Unvaccinated individuals are less likely to meet an infected individual.

C Vaccinated individuals cannot catch the disease.

D Vaccinated individuals have natural active immunity.

12 The diagram shows the simplified structure of an antibody.



Which statement is correct?

A U and X allow the antibody to bind to two different antigens.

B V allows the antibody to be flexible to bind to two antigens.

C W can bind to one specific antigen.

D X can bind with a specific phagocyte receptor.

13 T-lymphocytes have a protein, PD-1, on their surface. Some cancer cells have a receptor molecule on their surface which binds with PD-1, inactivating the T-lymphocyte.

A monoclonal antibody, lambrolizumab, has been produced against this receptor.

Trials showed that in 54 of 135 people with advanced skin cancer who were given lambrolizumab the tumours more than halved in volume. In six of the 57 people who were given the highest dose the tumours disappeared.

What may be correctly concluded from this information?

1 Lambrolizumab binds with a receptor on the surface of skin cancer cells.

2 Cancer cells to which lambrolizumab is bound cannot inactivate T-lymphocytes.

3 Lambrolizumab targets and kills skin cancer cells.

4 Lambrolizumab allows a patient's own immune system to kill cancer cells.

A 1, 2, 3 and 4

B 1, 2 and 4 only

C 1 and 3 only

D 2, 3 and 4 only

14 Rabies is a viral disease which can be spread to humans by a bite from an infected animal.

One method of treatment is to inject the patient with antibodies specific to the rabies virus.

Which statements about this treatment are correct?

1 The patient will have natural passive immunity to rabies.

2 The injected antibodies will be broken down by the patient.

3 The patient's memory cells will be able to produce this antibody more rapidly in the future.

4 The immunity provided will only last a short time.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

15 Which statements explain why some vaccines can be taken by mouth but tuberculosis (TB) vaccine has to be injected?

1 Macrophages present antigens in vaccines to stimulate an immune response.

2 The TB antigens necessary to produce an immune response are proteins which would be digested in the stomach and small intestine.

3 There are no B-lymphocytes and T-lymphocytes in the stomach.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 only

16 A student wrote the following statements about the production of monoclonal antibodies.

Which statement is **not** correct?

A Non-self antigen is injected into a mammal.

B Plasma cells secrete the specific antibody in response to a non-self antigen.

C Selected hybridoma cells divide by mitosis to form a clone.

D T-lymphocytes are fused with cancer cells to form hybridoma cells.

17 Immunity to certain pathogens develops when a person is given a vaccination.

Which effects of vaccination are correct?

1 production of antibodies to protect against future infections

2 results in artificial active immunity

3 stimulation of appropriate lymphocytes

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

18 A student wrote three statements about antibodies.

1 Their structure depends on peptide, hydrogen and disulfide bonds.

2 They are protein molecules with both tertiary and quaternary structure.

3 Four polypeptides provide four antigen binding sites.

Which statements are correct?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

19 Which events result in a person developing actively acquired immunity?

1 becoming infected by TB bacteria

2 drinking breast milk

3 receiving an injection of antigens

4 receiving an injection of antibodies

A 1, 2 and 3 **B** 1, 3 and 4 **C** 1 and 3 only **D** 2 and 4

20 Which statement explains why a one-dose vaccination programme for measles has not yet eliminated the disease?

A Many infants under the age of eight months have passive immunity.

B Some children need several booster doses to develop full immunity.

C The one-dose measles vaccine has a success rate of 93%.

D The virus does not often change its antibodies.

21 What explains why monoclonal antibodies can be used to target cancer cells?

A Cancer cells have different antigens from normal body cells.

B Specific cancer drugs can be attached to the monoclonal antibody.

C They secrete a type of antigen that binds to a specific antibody.

D They are secreted by hybridomas of cancer cells and B-lymphocytes.

22 Where are antibodies found during an immune response?

	on the surface of memory cells	in blood plasma
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

key

✓ = antibodies found

✗ = antibodies not found

23 Monoclonal antibodies are used in the diagnosis and treatment of disease. They are produced using a technique known as cell fusion.

Which two structures are fused together in this technique?

A antigens and hybridoma cells

B T-lymphocytes and cancer cells

C cancer cells and plasma cells

D hybridoma cells and antibodies

24 Which row correctly describes the type of immunity gained from being injected with an antitoxin?

	active	artificial	passive	natural
A	✓	✓	✗	✗
B	✓	✗	✗	✓
C	✗	✓	✓	✗
D	✗	✗	✓	✓

key

✓ = correct

✗ = not correct

25 Where are antibodies found during an immune response?

	on surface of pathogen	in blood plasma
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

key

✓ = antibodies found

✗ = antibodies not found

26 A monoclonal antibody, specific for a virus, was treated with an enzyme to break the bonds between the variable and constant regions.

The separated variable and constant regions were then added to cells infected with the virus.

Which statements are correct?

1 The constant regions would bind to different parts of the virus antigens.

2 The viruses could be engulfed by phagocytes if they were present.

3 The variable regions would all bind to the same part of the virus antigens.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

27 Monoclonal antibodies are produced for use in diagnosis or treatment of disease. To obtain the antibodies for an antigen, a mouse is injected with the antigen.

Some of the events in the production of the monoclonal antibody are listed.

1 Plasma cells are fused with cancer cells to form a hybridoma.

2 Hybridomas that secrete the required antibody are identified and cloned.

3 B-lymphocytes that recognise the antigen multiply and become plasma cells.

4 Hybridomas divide by mitosis and secrete antibodies.

5 Plasma cells are removed from the mouse spleen.

What is the sequence of the first four events in the production of the monoclonal antibody?

A $3 \rightarrow 5 \rightarrow 1 \rightarrow 2$

B $3 \rightarrow 5 \rightarrow 1 \rightarrow 4$

C $5 \rightarrow 1 \rightarrow 2 \rightarrow 4$

D $5 \rightarrow 1 \rightarrow 4 \rightarrow 2$

28 Which row describes passive immunity?

	triggered by an antigen	involves an immune response	memory cells produced	permanent protection
A	✓	✓	✓	✓
B	✓	✓	✗	✗
C	✗	✗	✓	✓
D	✗	✗	✗	✗

key

✓ = correct

✗ = not correct

29 Rabies is usually a fatal disease. Rabies is transmitted to people in the saliva of infected animals.

A person who has been bitten by an infected animal needs immediate treatment.

The treatment is a vaccination against rabies **and** an injection containing antibodies to the rabies antigen.

What type of immunity is given by the injection of antibodies?

A artificial active

B artificial passive

C natural active

D natural passive

30 Which row shows the cells that are able to divide continuously and are involved in monoclonal antibody production?

	cancer cells	mouse B-lymphocyte plasma cells	hybridoma cells
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✓

key

✓ = correct

✗ = not correct

31 Newborn babies have natural passive immunity.

What is correct for this type of immunity?

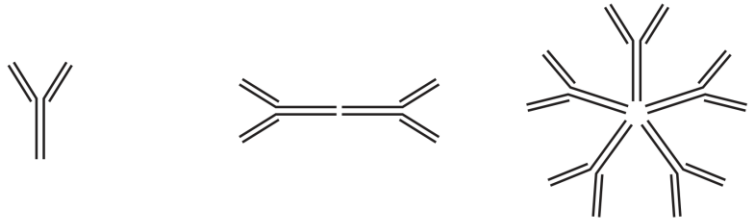
	immunity is temporary	antibodies are broken down
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

key

✓ = correct

✗ = not correct

32 The diagrams show three different types of antibody structure.



IgG IgA IgM

Which row is correct?

	IgG	IgA	IgM
A	one binding site for an antigen molecule	two light chains	two heavy chains
B	two heavy chains	four binding sites for antigen molecules	five hinge regions
C	two hinge regions	four heavy chains	five light chains
D	two light chains	four hinge regions	ten binding sites for antigen molecules

33 Which sequence summarises the hybridoma method for the production of monoclonal antibodies?

A	**B**	**C**	**D**
inject mammal with antibodies	inject mammal with antibodies	inject mammal with antigens	inject mammal with antigens
↓	↓	↓	↓
harvest antibodies from blood	harvest B-lymphocytes from spleen	harvest antibodies from blood	harvest B-lymphocytes from spleen
↓	↓	↓	↓
test for wanted antibody	fuse with cancer cells	test for wanted antibody	fuse with cancer cells
↓	↓	↓	↓
fuse with cancer cells	test for wanted antibody	fuse with cancer cells	test for wanted antibody
↓	↓	↓	↓
large scale culture	large scale culture	large scale culture	large scale culture

34 The vaccination programme for smallpox was a medical success story which resulted in the World Health Organisation finally declaring the world free from smallpox in 1980.

Which statement correctly identifies the reasons for the success of the smallpox vaccination programme?

A The virus also infected animals making it easy to stop the transmission cycle.

B The virus remained in the body following infection and could become active later.

C The virus was stable and not prone to mutations.

D The virus was unstable and prone to mutations.

35 Which features of monoclonal antibodies make them useful in the diagnosis and treatment of disease?

1 A particular monoclonal antibody attaches to a specific antigen.

2 Identical monoclonal antibodies can be produced in large numbers.

3 Binding a monoclonal antibody to its specific antigen may mark that antigen for destruction by white blood cells.

4 Fluorescent or radioactive markers can be attached to a monoclonal antibody to show where the antigen is in the body.

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 2 and 3 only

D 3 and 4 only

36 Hybridomas are used as a basis for the production of large numbers of monoclonal antibodies.

Which statement describes how hybridomas are made?

A fusing activated T-lymphocytes with cancer cells

B fusing B-lymphocytes with cancer cells

C fusing memory cells with cancer cells

D fusing T-lymphocytes with cancer cells

37 Which statement about the properties of the antigen binding sites in antibody molecules is correct?

A They are located on the light chains only.

B They have a hinge region to give flexibility for different antigens.

C They have binding sites for receptors on phagocytes.

D They have variable amino acid sequences for different antigens.

38 The statements describe ways in which different types of monoclonal antibodies can work.

1 binding to proteins on cell surfaces and triggering the immune system

2 blocking molecules on cell surfaces that inhibit T-cells

3 blocking cell signalling receptors that trigger cell division

4 blocking cell signalling receptors that trigger the immune response

Which types of monoclonal antibody could be used to treat cancer?

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1 and 4 only

D 2, 3 and 4 only

39 How many variable regions are there on a typical Y-shaped antibody molecule?

A 2 **B** 3 **C** 4 **D** 6