Antibodies and vaccination

Question Paper 2

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Immunity
Sub Topic	Antibodies and vaccination
Booklet	Theory
Paper Type	Question Paper 2

Time Allowed : **74 minutes**

Score : **/ 61**

Percentage : **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 Malaria is a disease caused by the parasite, *Plasmodium*. The parasite has a complex life-cycle, part of which involves development within the gut of the female mosquito which is responsible for the transmission of the disease.

Fig. 5.1 shows part of the life-cycle of the malarial parasite.

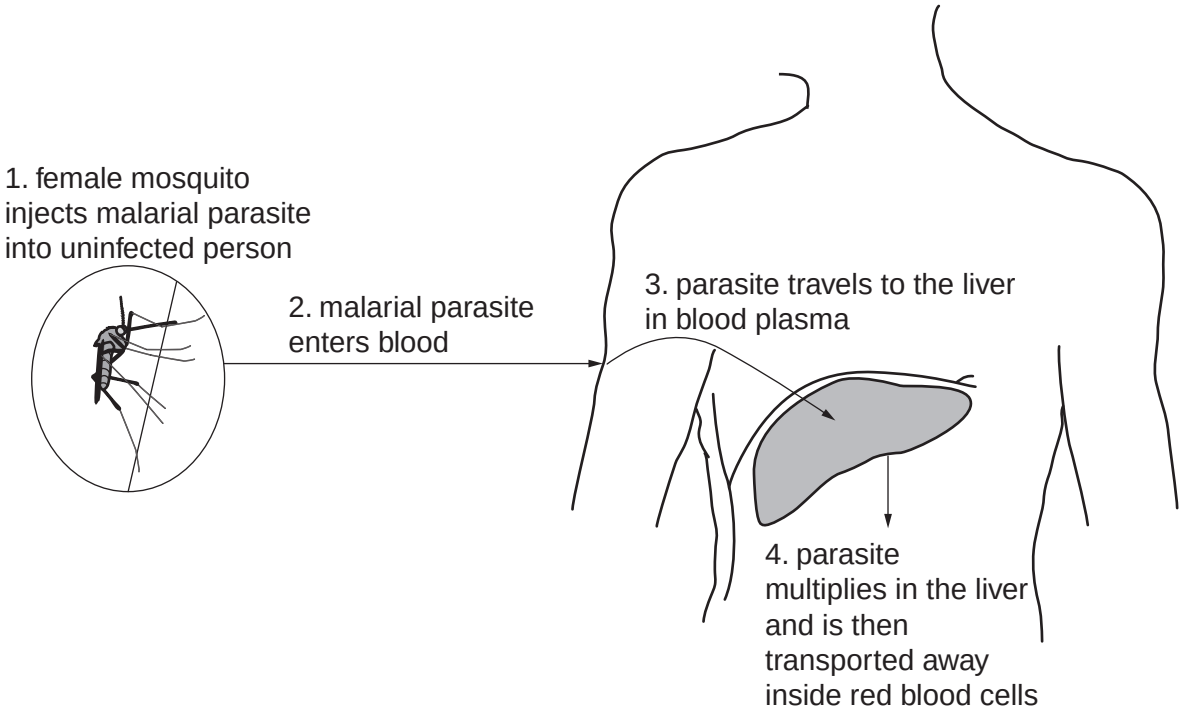

Fig. 5.1

Research has been directed towards the development of a malarial vaccine. Much of this research relies on the fact that *Plasmodium* has different forms in its life cycle.

During trials of a malarial vaccine, the parasites were killed using radioactivity and then injected into volunteers. This method provided some protection against malaria.

(a) Explain why the parasites were killed using radioactivity and not by using high temperatures.

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(b) With reference to Fig. 5.1, explain why the researchers decided to use the form of the parasite which is injected by mosquitoes and not the form which leaves the liver.

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(c) The volunteers who were injected with the killed parasites produced antibodies, which provided some protection against the disease.

Outline the events that occur following injection of the parasites, which lead to the production of antibodies.

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[Total: 11]

2 Some of the steps in the production of monoclonal antibodies are shown in Fig. 2.1.

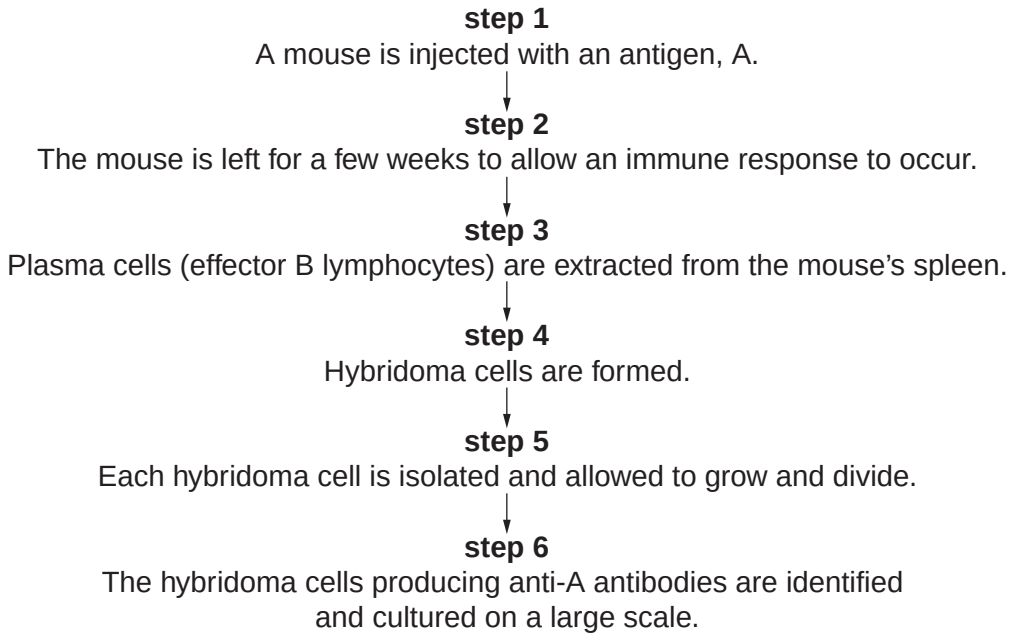

Fig. 2.1

(a) With reference to Fig. 2.1, explain:

(i) what happens during an immune response (**step 2**)

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(ii) what is meant by a hybridoma cell (**step 4**)

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(iii) why hybridoma cells need to be formed (**step 4**)

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(iv) how hybridoma cells producing anti-A antibody can be identified.

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(b) Rheumatoid arthritis (RA) is an autoimmune disease in which T lymphocytes attack the cartilage of joints by secreting a protein, TNFα. When RA is untreated, joint damage increases considerably.

The monoclonal antibody, infliximab, is used to treat RA. Infliximab specifically binds to TNFα.

A trial was set up to compare the effectiveness of infliximab and a standard treatment for RA, the anti-inflammatory drug, MTX.

Five groups of people with RA received the following treatments for one year:

- roup **P** – MTX only
- roup **Q** – MTX plus low dosage of infliximab at intervals of eight weeks
- roup **R** – MTX plus low dosage of infliximab at intervals of four weeks
- roup **S** – MTX plus high dosage of infliximab at intervals of eight weeks
- roup **T** – MTX plus high dosage of infliximab at intervals of four weeks.

At the end of the year's treatment, the proportion of people in each group with increased joint damage was determined.

The results are shown in Fig. 2.2.

The number of people in each group is shown in brackets.

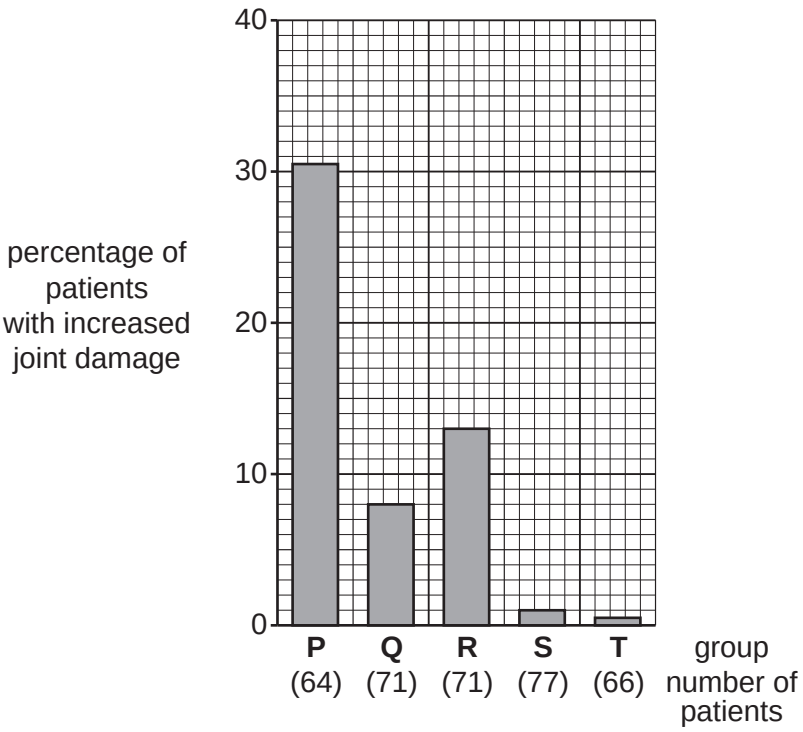

Fig. 2.2

With reference to Fig. 2.2:

(i) describe the effect of infliximab treatment on these people

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(ii) suggest why the results in groups **Q** and **R** do not follow the general trend.

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(c) Explain the advantages of the use of monoclonal antibodies, compared with conventional methods, in the **diagnosis** of disease.

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[Total: 15]

3 The bacterium, *Treponema pallidum*, causes the sexually-transmitted infectious disease, syphilis. If left untreated, the disease can be fatal, but early diagnosis can lead to successful treatment. One of the difficulties of diagnosing this disease in its early stages is the problem of recognising *T. pallidum* among the other species belonging to the genus *Treponema* that live in humans. These other treponemes are harmless.

A mouse was injected with some cells of *T. pallidum*.

(a) Outline the steps that would then be necessary to produce a clone of hybridoma cells secreting an antibody against this bacterium.

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(b) A monoclonal antibody, H9-1, has been developed that is specific to a surface protein on *T. pallidum*, but which is not present on four other species of treponemes found in humans.

Each molecule of H9-1 carries a fluorescent yellow marker.

One of the first visible signs of syphilis is a painless sore.

Suggest how H9-1 is used in the diagnosis of syphilis, using a sample taken from a sore and placed on a microscope slide.

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(c) Before the development of H9-1, two tests for the presence of *T. pallidum* were commonly used:

- dark-field microscopy (in which treponemes could be seen moving against a dark background)
- testing for the presence of anti-treponemal antibodies in the blood plasma.

Suggest why, in the **early** stages of an infection, the presence of *T. pallidum* might not be detected by either of these tests.

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(d) The accuracy of the diagnosis of infection by *T. pallidum* using H9-1 was compared with that using dark-field microscopy and with blood testing. The results are shown in Table 2.1.

A positive test result indicated that *T. pallidum* is present and a negative test result that it is absent.

Table 2.1

test	test results of 30 people later confirmed to have the infection	test results of 31 people later confirmed not to have the infection
H9-1	all positive	all negative
dark-field microscopy	one negative	two positive
blood test	three negative	two positive

With reference to Table 2.1:

(i) compare the accuracy of diagnosis of the presence of *T. pallidum* using the different tests

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(ii) suggest why blood testing for anti-treponemal antibodies gave two positive results in patients later found not to have the infection.

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(e) Describe briefly **one** use of a monoclonal antibody in the **treatment** of disease.

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[Total: 15]

4 Measles is a common viral infection. A vaccine has been available for measles since the 1960s. There are vaccination programmes for many diseases including measles. Babies are born with a passive immunity to measles so the vaccine is not given in the first few months after birth.

(a) Explain how active immunity differs from passive immunity.

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(b) Explain why the vaccine for measles is not given in the first few months of a child's life.

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The World Health Organization (WHO) publishes data on the vaccination programmes for infectious diseases. The WHO recommends vaccination rates of over 90% of children.

Each health authority in a country reports its success in vaccinating children in their district. The WHO uses these figures to estimate the percentage of districts in each country that vaccinate 90% of children against measles.

The WHO also collects statistics on death rates of children under the age of 5 from all causes, including infectious diseases.

Fig. 6.1 shows these statistics for 24 countries for the year 2007.

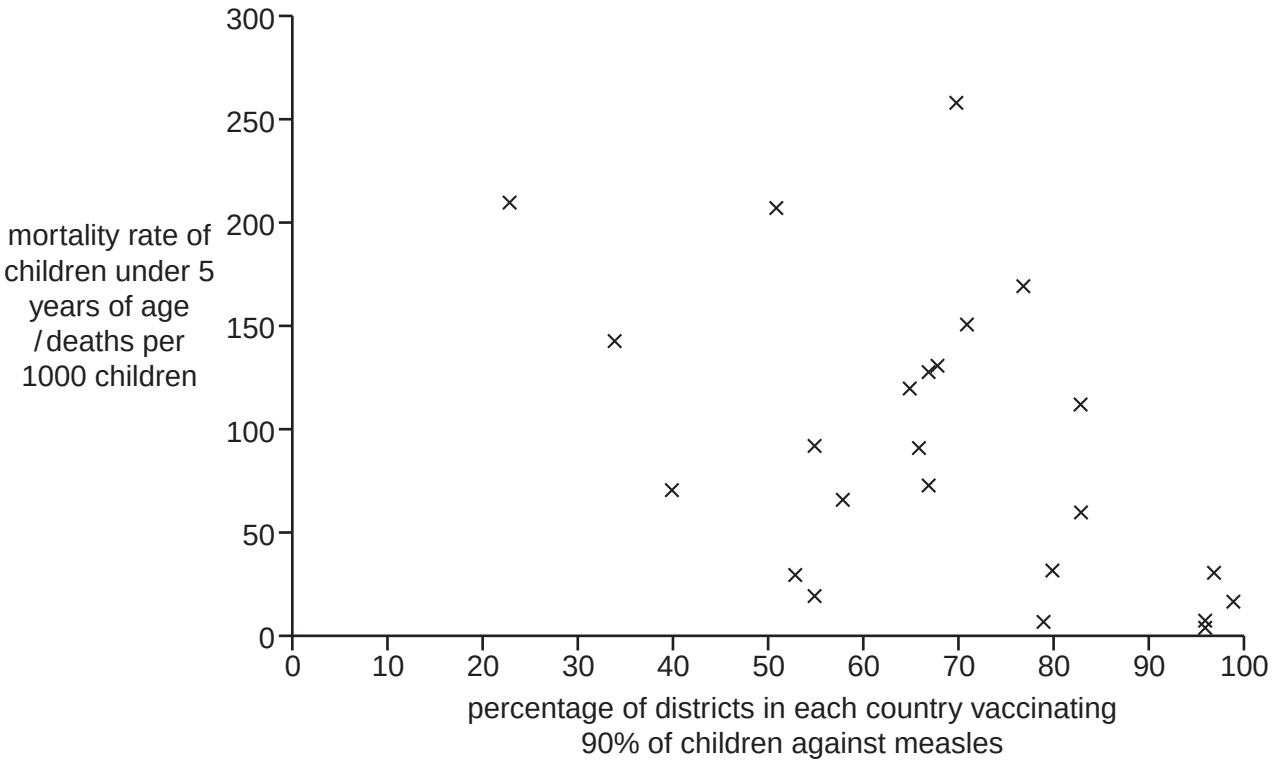

Fig. 6.1

(c) Use the information in Fig. 6.1 to explain why the WHO recommends immunisation of 90% of children.

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[Total: 7]

5 The HIV/AIDS pandemic has had a very large impact on life expectancy in many African countries.

Table 3.1 shows estimated data for seven African countries for

- the average life expectancy of an individual born in 2002
- the percentage of the population testing positive for HIV in 2002
- the average life expectancy of an individual born in 2002 **if there was no HIV/AIDS pandemic**.

Table 3.1

country	life expectancy / years		percentage of population testing positive for HIV
	without HIV/AIDS	with HIV/AIDS	
Botswana	72.4	33.9	35.8
Côte d'Ivoire	55.6	42.8	10.8
Kenya	65.6	45.5	14.0
Malawi	56.3	38.5	16.0
South Africa	66.3	48.8	19.9
Zambia	55.4	35.3	20.0
Zimbabwe	69.0	40.2	25.1

(a) Using the 'without HIV/AIDS' and 'with HIV/AIDS' data shown in Table 3.1, calculate the percentage decrease in life expectancy for Botswana.

Show your working and give your answer to the nearest whole number.

Answer = ... % [2]

(b) Suggest two reasons for the differences shown in estimated life expectancy **without** HIV/AIDS between the different African countries.

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(c) After studying the data in Table 3.1, a student concluded that:

"There is a correlation between the percentage of the population testing positive for HIV and the decrease in estimated life expectancy with HIV/AIDS."

(i) With reference to Table 3.1, explain why the data do **not** fully support the student's conclusion.

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(ii) List two factors in the prevention and control of HIV/AIDS that would help to improve average life expectancy in the African countries shown in Table 3.1.

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(d) A person who is confirmed as HIV-positive has tested positive for the presence of antibodies to HIV.

Outline the events that occur in a newly-infected person, which lead to the production of antibodies to HIV.

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[Total: 13]