

# Communicable diseases,disease prevention & the immune system

## Model Answers 1

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Biodiversity, evolution and disease
Topic	Communicable diseases, disease prevention & the immune system
Booklet	Model Answers 1

**Time allowed:** 54 minutes

**Score:** /40

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

## Question 1

Lymphocytes form an important part of the specific immune system in humans. They can be classified into B lymphocytes and T lymphocytes.

(a) For each of the statements in the table below, use **ticks or crosses** to identify whether the statement belongs to B lymphocytes, or to T lymphocytes, or to both B and T lymphocytes.

The first one has been done for you.

Statement	B lymphocytes	T lymphocytes
Matured in bone marrow	✓	✗
Form part of immune response	✓	✓
Differentiate into memory cells	✓	✓
Produce chemicals that can cause lysis of infected cells	✗	✓
Form plasma cell clones	✓	✗

[4]

It seems obvious, but many students fail to put both ticks and crosses

(b) Fig. 4 shows the concentration of antibodies in a patient's bloodstream following an influenza (flu) vaccination, and then a subsequent infection with the influenza virus.

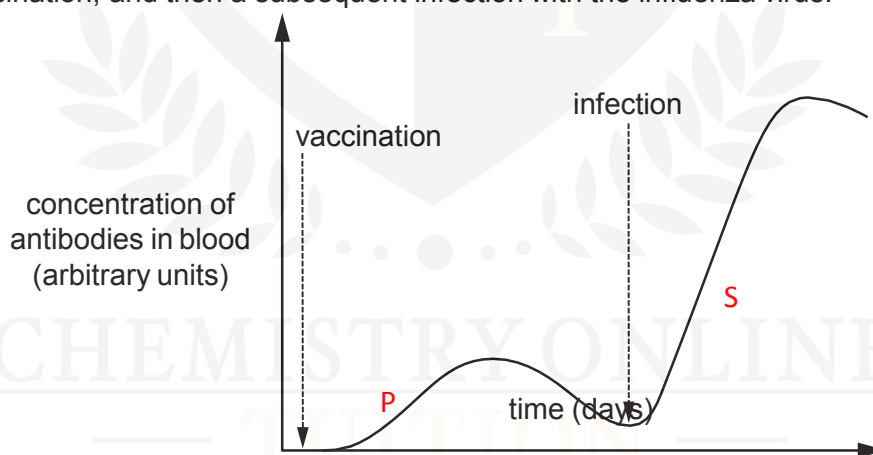


Fig. 4

Describe where the primary and secondary immune responses are taking place on Fig. 4 and explain the differences between the two processes.

[3]

- Primary response is slower as time is spent clonal selection and expansion
- Secondary response is faster as memory cells are present

Memory cells are made as a result of active immunity, to gain this your body must receive the antigens. Passive immunity is short term and gained by receiving antibodies from

another source

(c) \* In West Africa during 2015 there was a serious outbreak of the viral disease Ebola which spread by contact with infected bodily fluids.

- At the start of the outbreak there was a severe lack of trained health workers in the affected areas and much of the nursing was carried out in the family home or at local clinics.
- Many residents lived in close proximity to one another and sanitation was often of a poor standard.
- In times of illness it was common for people to travel to stay with close relatives, often in nearby villages or towns.
- As the outbreak spread, some residents left their villages to flee from the disease.
- Local mourning and burial practices involved gathering at the family house to pay respects to the deceased. Prior to burial the deceased was usually bathed by close family members.

A number of common factors affect the spread of communicable diseases in humans and some of them are relevant to the spread of Ebola. From the information above, discuss these factors and suggest what actions could have been put in place to address them. **[6]**

- There is a lack of trained health professionals, so fewer vaccinations and lack of understanding, so increase the number of health professionals or train more up
- The ill are cared for by family so there's a lack of nursing techniques such as gloves so restrict care to hospitals and clinics or train in barrier nursing techniques
- They live in overcrowded conditions so pathogens are spread more easily so have less sharing of rooms or improve ventilation
- Poor sanitation so easy to pick up pathogens from faeces or unwashed hands so education or improved sewage or use hand wash gels
- People can leave the infected area and travel to uninfected areas thus spreading the disease so restrict travel and set up health checks at airports etc
- Mourning and burial practices brings people into contact with the pathogen so try to encourage cremation or involve local leaders to encourage a change in practice

On face value, a very straight forward question as the facts are there. However, it's a 'suggest' question, so **raise the issue**, state **how this would affect** matters then **give an**

**alternative option**

**[Total: 13]**

## Question 2

Vaccinations are effective in preventing the spread of a range of diseases.

(a) Explain why vaccinations are an example of active immunity.

[2]

- They lead to the production of antibodies
- They stimulate the proliferation of lymphocytes
- Memory cells remain

Reword this question to 'Define the term active immunity'. Remember that it's the antigens on the pathogen that stimulate an immune response and the activation of lymphocytes which in turn produce antibodies

(b) Measles is a potentially fatal disease.

- Since 1988 children in the UK have been vaccinated against measles using the MMR vaccine.
- In 1998 a study was published which linked the MMR vaccine to the development of a condition known as autism. Some parents refused to have their children vaccinated with MMR.
- The study linking MMR to autism has since been discredited.

**Table 3.1** shows some data about the percentage of children vaccinated with MMR and the incidence of measles in England and Wales.

Year	Proportion of children vaccinated with MMR (%)	Confirmed cases of measles
1997	92	177
1998	91	56
1999	88	92
2000	88	110
2001	87	70
2002	84	319
2003	82	437
2004	80	188
2005	81	78
2006	84	740
2007	85	990
2008	85	1370
2009	85	1144
2010	88	380

**Table 3.1**

- (i) Between 1997 and 1999 the mean percentage of children vaccinated with MMR was 90.3.

Calculate the mean number of confirmed cases of measles between 1997 and 1999.

Give your answer to one decimal place.

[1]

108.3

$$(177+56+92) \div 3 = 108.3$$

- (ii) In 2005, despite relatively low vaccination rates, the number of confirmed cases of measles was only 78.

Use your answer to part (i) to calculate the percentage change in the number of confirmed cases of measles from the mean value of 1997–1999 to 2005.

Give your answer to one decimal place.

[2]

28%

It was 108.3 in 97 – 99 and dropped to 78 in 2005.

A drop of 30.3 from an original of 108.3

$$30.3 \div 108.3 \times 100 = 27.9 \text{ or to one dp } 28\%$$

- (iii) In early 2006, a newspaper claimed that the drop in MMR vaccination rates had not led to the predicted increase in measles cases.

Evaluate the validity of the newspaper's claim. Use processed data to support your argument.

[3]

- The newspaper has picked out the lowest value
- The average value would have been a better indicator
- Use of figs: since 1998 the number of cases has increased to an average of 205.6

(c) The MMR injection is actually a combination of three different vaccines.

It protects children against measles, mumps and rubella pathogens.

Explain why it is not possible to protect against the different pathogens using only one vaccine.

[3]

- Different pathogens have different antigens
- Antigens have a specific shape
- The antibodies have a complementary shape to the antigen
- Different antibodies are needed for different antigens

It's the variable region of the antibody which has a complementary shape to the antigen.

This variable region has a different primary structure so its 3D shape is unique and specific to the antigens on the pathogen

[Total: 11]

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### Question 3

There will be outbreaks of new infectious diseases in the future. They will arise from mutations in the genomes of existing organisms. The mutating organisms may not at present be pathogenic, or they may be animal pathogens that mutate to become able to infect humans.

- (a) What feature of a pathogen such as *Mycobacterium tuberculosis* could be altered by a mutation, making a vaccine ineffective?

[1]

- The shape of antigens / proteins / glycoproteins on the cell surface membrane

Vaccines would stimulate the wrong B lymphocytes or T lymphocytes

- (b) (i) Outline the processes that lead to the production of antibodies against an unfamiliar bacterium.

[3]

- B cells have antigen receptors which are complementary / specific to one antigen
- When the B cell is activated by combining with the antigen it divides by mitosis
- The B cells then differentiate into plasma cells
- Plasma cells secrete antibodies which are specific to the antigen

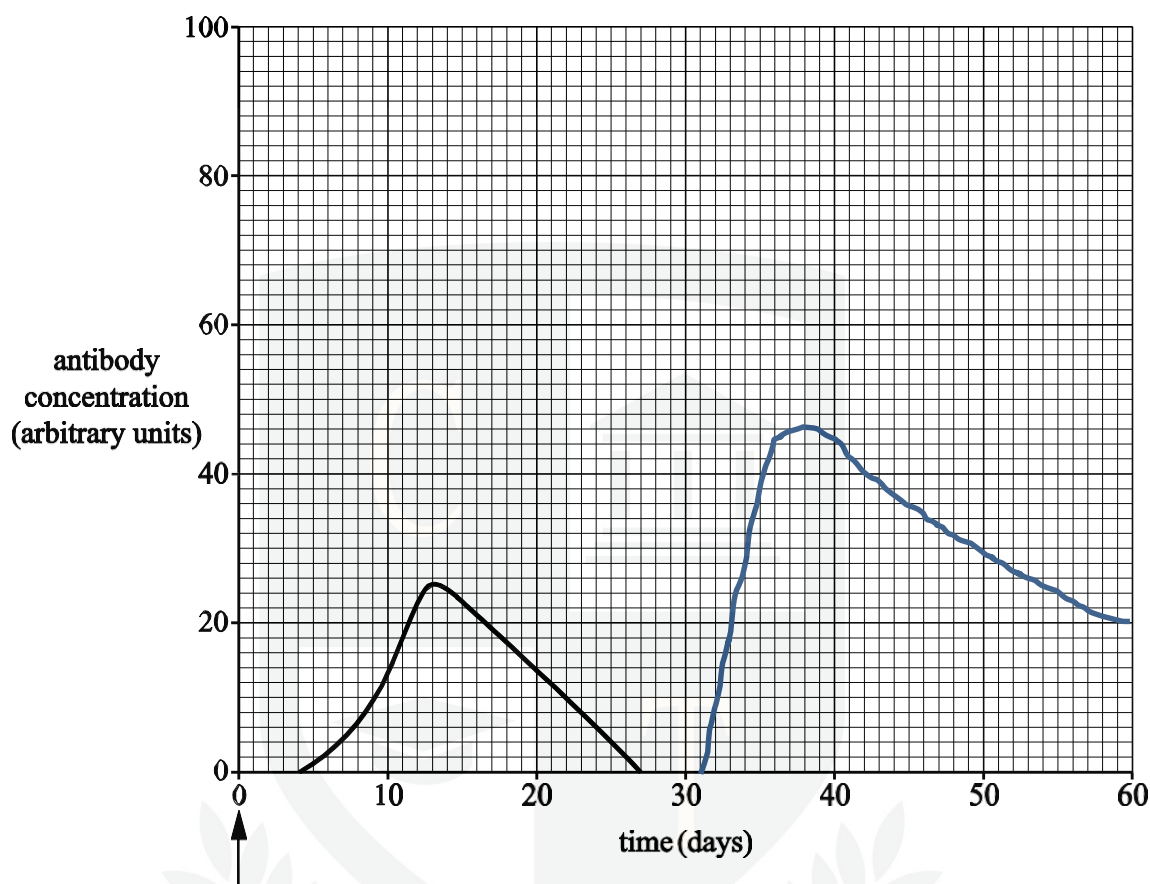
Clonal selection is when the antigens on the pathogen combine with the receptors on the B lymphocyte. Clonal expansion is when the B lymphocyte differentiates into plasma cells which are adapted to make, and secrete, lots of protein

- (ii) Explain how helper T cells act to speed up these processes.

[2]

- Helper T cells are activated by antigen presenting cells (APCs)
- T cells secrete cytokine
- Cytokine stimulates B cells to divide / clonal expansion

- (c) **Fig. 16.1** shows the concentration of new antibodies in the blood of a person infected for the first time by a pathogen, on day 0. This is their 'primary response'.



**Fig. 16.1**

- (i) On day 30, this individual was again infected with the same pathogen. Sketch a line on **Fig. 16.1** to show the antibody concentration from day 30 onwards.

[2]

The rate should be steeper than before and reach higher levels

The graph should not start rising straight away but between 30 and 35 days

- (ii) Explain how memory cells caused the differences between the two lines on the graph.

[2]

- Memory cells are not involved in the primary response
- Memory cells remain in the blood after the primary response
- No or faster clonal selection

This is the basis of active immunity but you must acquire the antigen first before you can become actively immune



- (d) (i) It takes time for an effective vaccine to be prepared in quantity for a new strain of bacterium.

List two vulnerable groups of people for whom you would advise doctors to prescribe antibiotics although they are **not** yet showing symptoms of the new disease. [2]

- Infants and babies
- The elderly
- HIV positive individuals
- Those with a compromised immune system

- (ii) Discuss the implications of the over-use of antibiotics when people do not show symptoms. [4]

- Antibiotics are the selection pressure
- Bacterial population has genetic variation
- Some bacteria are resistant or more resistant than others
- Exposure to the antibiotic results in most resistant bacteria surviving
- They pass on their alleles to the next generation
- Over many generations the proportion of resistant bacteria increase
- The normal antibiotics become ineffective

Better answer in terms of natural selection and evolution would be, the frequency of the beneficial allele would increase in the gene pool

[Total: 16]