

OCR A-LEVEL BIOLOGY B • H422

BIOLOGY



EXAM QUESTION PACK

3.2.2 THE IMMUNE SYSTEM

SCORE

/111

PERCENTAGE

%

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1 The Mantoux test is used to test for Tuberculosis (TB).

Which of the statements, **A** to **D**, about the Mantoux test is true?

- A** People who have a strong positive reaction to the test will not need a TB vaccination.
- B** People who have a strong positive reaction to the test will have produced antigens against the TB bacterium.
- C** People who do not have a reaction to the test will have produced antibodies against the TB bacterium.
- D** People who do not have a reaction to the test will be immune to the TB bacterium.

Your answer

[1]

2 Clonal expansion occurs during the specific immune response.

Which of the statements, **A** to **D**, is a description of clonal expansion?

- A** B lymphocytes differentiate into plasma cells.
- B** B lymphocytes differentiate into memory cells.
- C** B lymphocytes divide by mitosis.
- D** B lymphocytes produce large quantities of antibodies.

Your answer

[1]

3 Which of the options, **A** to **D**, is formed by the fusion of a cell membrane around a microorganism?

- A** bleb
- B** phagosome
- C** vacuole
- D** virus

Your answer

[1]

- 4 Diphtheria is a bacterial disease of humans that can be treated by vaccination using an antitoxin. The antitoxin is a solution of antibodies specific to the antigens on the surface of the bacterium.

Which of the options, **A** to **D**, describes the type of immunity provided by the antitoxin?

- A** artificial active
- B** artificial passive
- C** natural passive
- D** natural active

Your answer

[1]

- 5 A 45-year-old patient was admitted to hospital with a lung infection.

The patient was tested for tuberculosis (TB) using a Mantoux skin test. The Mantoux skin test is performed by injecting an extract from the TB pathogen under the skin.

After 48 hours, the patient had developed a large, red lump at the site of the test.

Which of the following statements is / are correct?

- 1: The patient's blood contained antibodies against TB antigens.
 - 2: The patient did not have immunity to TB.
 - 3: The patient had an inflammatory response to live TB pathogens present in the extract.
- A** 1, 2 and 3 are correct
 - B** only 1 and 2 are correct
 - C** only 2 and 3 are correct
 - D** only 1 is correct

Your answer

[1]

- 6 The blood of people living with HIV contains antibodies that can neutralise a range of different strains of the HIV virus.

Researchers combined portions of these antibodies to produce antibodies in the laboratory known as tri-specific antibodies. These can bind to three different sites on the virus. Fig. 4.2 shows the structure of a tri-specific antibody.

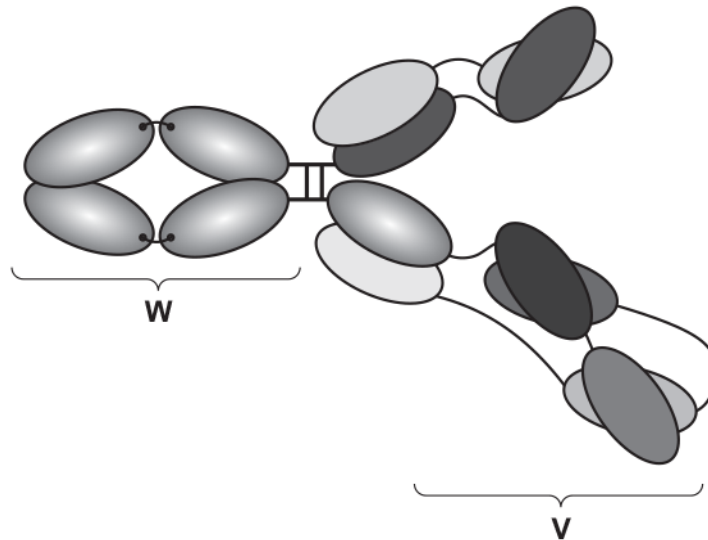


Fig. 4.2

- (i) Name the region of the antibody labelled **W** and state its function.

Name

Function

.....

.....[2]

- (ii) Explain how the structure of the region labelled **V** allows the antibody to bind to different antigens on different viruses.

.....

.....

----- [2] -----

7(a)

Immunity can be categorised as

- active or passive
- natural or artificial.

Complete the following table by putting ticks (✓) in the correct boxes to show whether each example is active or passive **and** natural or artificial.

Example	Active	Passive	Natural	Artificial
Snake antivenoms consist of sheep or horse antibodies to snake venom proteins. They are given to treat snake bite.				
A mixture of proteins purified from the <i>Haemophilus influenzae</i> virus is used to reduce the risk of a person getting the flu.				
Following infection by a pathogen, a person develops memory T and B cells.				
A calf receives antibodies from its mother in colostrum.				

[4]

(b) Scientists investigated the link between breastfeeding in mice and the risk of offspring developing asthma.

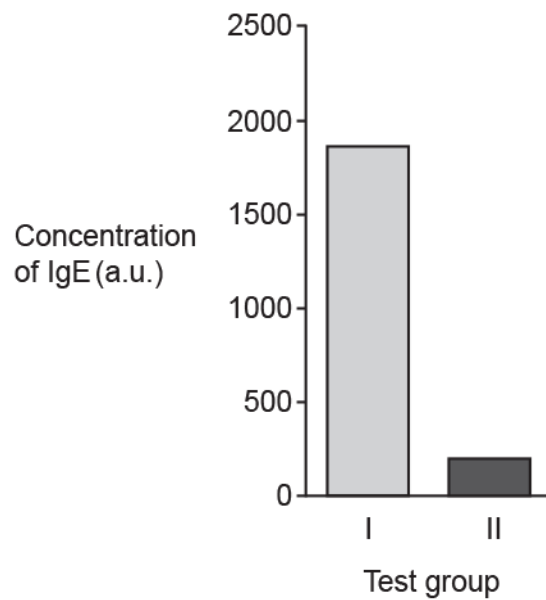
They used a model system of asthma called allergic airway disease (AAD).

Two groups of mice were compared:

- Group I: mice who were born to normal mothers (no AAD) and then breastfed by their own mothers.
- Group II: mice who were born to normal mothers but then breastfed by foster mothers with AAD.

After 4 weeks the offspring were exposed to a protein to induce AAD.

The concentration of IgE in the blood of the offspring was determined. IgE is a type of antibody that increases in concentration during allergic reactions. The results are shown in the graph.



- (i) Name a statistical test the scientists could have used to compare the results of the two groups. Give a reason for your choice.

[2]

- (ii) State which group of offspring showed more AAD. Give a reason for your choice.

[2]

- (iii) The statistical analysis showed there was a significant difference in the concentrations of IgE antibodies in the two groups.

Breastfeeding is associated with a reduced risk of asthma in children.

Explain whether the results support the conclusion that breastfeeding could reduce the risk of asthma in children.

[3]

- 8 Please refer to the Advance Notice article 'Do Pathogens Gain Virulence as Hosts Become More Resistant?' in Insert H422-02 October 2021.

The article describes the interactions between pathogen virulence and host resistance to infection.

- (i) Explain how immunological and genetic factors would allow a population of wild rabbits to become more resistant to infection by MYXV.

----- [2]

- (ii) The article discusses how resistance to infection can be affected by two common agricultural practices: vaccination and selective breeding.

Explain how vaccination is used to protect poultry against pathogens such as Marek's disease virus (MDV).

----- [3]

- (iii) Explain why vaccination might **not** prevent epidemics of Marek's disease in poultry.

[2]

(iv) Evaluate the suggestion that birds should be bred for susceptibility to MDV rather than resistance.

[4]

- 9 It has been hypothesised that there is a causal relationship between sensitivity to allergens and the development of asthma.

One study measured allergic responses in a group of young people from infancy to early adulthood to see if sensitivity to allergens increased the risk for developing asthma.

- (i) Explain what is meant by an allergic response.

----- [2]

- (ii) Five allergens, including cow's milk and pollen, were used during the study to test for sensitivity.

Name **two** other allergens that could have been used to trigger an allergic response.

1 -----

2 -----

- 10 Which of the cell types, A to D, initiates the secondary immune response? [1]

- A helper T cell
B memory B cell
C plasma B cell
D regulatory T cell

Your answer

☐

[1]

11 Which of the following statements is/are true of herd immunity?

- 1: Herd immunity can protect against all diseases.
- 2: Herd immunity may eventually eradicate a disease from a population.
- 3: The more infectious the disease, the higher the proportion of individuals that must be vaccinated.

- A 1, 2 and 3 are correct
- B Only 1 and 2 are correct
- C Only 2 and 3 are correct
- D Only 1 is correct

Your answer

☐

[1]

12 The human immunodeficiency virus (HIV) is spread through direct contact with body fluids.

Untreated HIV infection causes progressive destruction of the immune system. This leads to acquired immunodeficiency syndrome (AIDS).

HIV testing can prevent the spread of infection. In the UK, HIV testing must be carried out with consent from the patient. The results must be treated in a confidential manner.

Suggest **two** other ethical or social concerns associated with receiving an HIV positive test result.

1 -----

2 -----

[2]

- 13 An initial exposure to an allergen prepares the immune system for a rapid response upon repeated exposure. This process is known as sensitisation.

Which of the options, **A** to **D**, results in sensitisation to an allergen?

- A** binding of IgE to mast cells
- B** differentiation of B cells into plasma cells
- C** recognition of allergenic antigen by B and T cells
- D** secretion of IgE by plasma cells

Your answer

[1]

- 14 Antimicrobial peptides (AMPs) are peptides found in animals and plants that destroy a wide range of pathogenic bacteria, fungi and viruses.

The α -defensins are a group of AMPs that contain 18–45 amino acids.

* AMPs are produced by epithelial cells in the intestines, respiratory tract, urinary tract and vagina.

The actions of AMPs include:

- destruction of many pathogenic bacteria, fungi and viruses
- stimulation of mast cells
- attraction and activation of phagocytes
- aggregation of pathogens (bacteria, fungi, viruses).

Use this information to explain how AMPs play an important role in the body's **non-specific** defence mechanisms.

[illegible]

[6]

15(a) The Mantoux test is used to check if a person is immune to tuberculosis (TB) to decide whether they need a BCG vaccination.

A red inflamed lump (induration) may appear three days after the injection of tuberculin.

A person is considered to be immune to TB if they develop an induration that has a diameter of at least 10 mm.

For an induration of 10 mm the percentage error is 10%.

- (i) Explain how this percentage error could lead to incorrect decisions about whether a BCG vaccination is needed.

[2]

- (ii) A health professional measures the diameter of the induration using a ruler marked in millimetres.

Suggest one way this method for measuring indurations could be improved. Explain your answer.

[2]

(b) The Mantoux test requires:

- a solution of tuberculin kept away from the light between 2 °C and 8 °C
- a sterile needle and a sterile syringe.

An alternative to the Mantoux test is a more accurate antibody test called ELISA which requires:

- a fresh blood sample
- full laboratory facilities.

The Mantoux test was used on a sample of 89 people and was followed up with an ELISA.
The results are shown in Table 4.1

	Number of people		
	ELISA positive	ELISA negative	Total
Mantoux positive	22	6	28
Mantoux negative	18	43	61
Total	40	49	89

Table 4.1

* Evaluate the use of the Mantoux test and ELISA for testing whether people are immune to TB.

In your answer you should refer to the data in Table 4.1.

[6]

16(a) The human papillomavirus (HPV) can infect the skin and mucous membranes of the body.

Most cases of HPV infection are eradicated naturally by the immune system.

(i) Statements A to F below summarise, in random order, the stages of an immune response to the virus.

A	T helper cells are activated and divide by mitosis.
B	B cells are activated, divide by mitosis and then differentiate.
C	Viral antigens are presented.
D	T helper cells release cytokines.
E	Plasma cells synthesise and release antigen-specific antibodies.
F	The virus is engulfed and digested.

Place the letters A to F representing the statements into the correct order in the boxes below. Statement D has been done for you.

			D		
-------------	-------------	-------------	--------------	-------------	-------------

[2]

(ii) Describe the role of T killer cells in the immune response to HPV.

[1]

- The results are summarised in Table 34 below.

Data group	Number of subjects	HPV-16 antibody level (mMU dm ⁻³)		HPV-18 antibody level (mMU dm ⁻³)	
		Median	Range	Median	Range
Two-dose regime after one month	102	830	761–882	812	704–866
Two-dose regime after three years		739	729–755	214	101–483
Three-dose regime after one month	116	829	781–893	820	794–860
Three-dose regime after three years		731	718–754	747	709–773

Table 34

- (i) Using the information in Table 34, evaluate the effectiveness of different vaccination regimes.

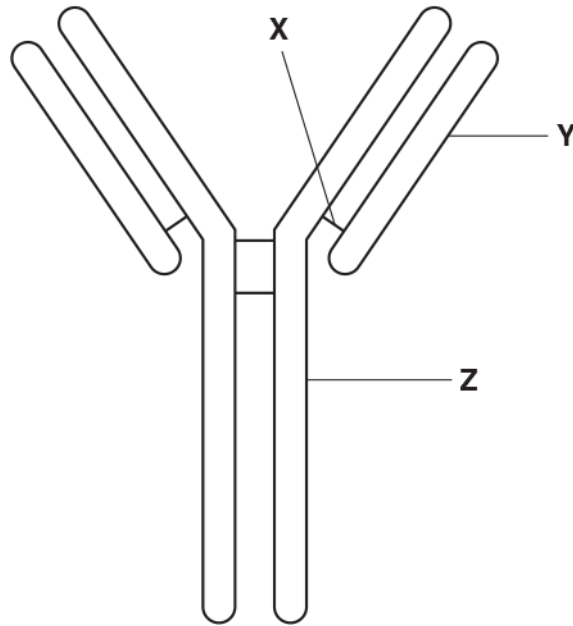
[4]

- Explain why.

[3]

17 The general structure of an antibody is shown below.

Three features are labelled X, Y and Z.



Which of the statements, A to D, is correct?

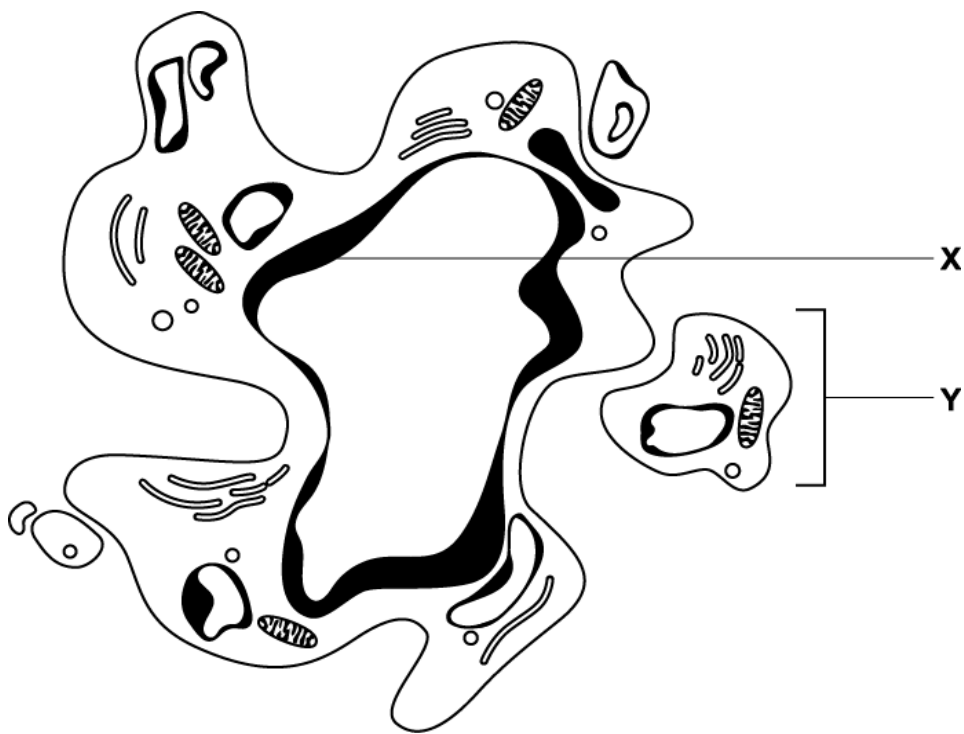
- A X is a disulfide bond that connects the constant region of Y and the variable region of Z.
- B X is a disulfide bond that connects the constant regions of Y and Z.
- C X is a hydrogen bond that connects the constant region of Y and the variable region of Z.
- D X is an ionic bond that connects the constant regions of Y and Z.

Your answer

[1]

18 The diagram below shows a cell in a late stage of apoptosis.

Two features are labelled X and Y.



Which of the following statements is/are correct?

- 1 X is a complex of DNA and protein.
- 2 Phosphatidylserine is present on the surface of Y.
- 3 The contents of Y are digested in a lysosome.

- A 1, 2 and 3 are correct
- B Only 1 and 2 are correct
- C Only 2 and 3 are correct
- D Only 1 is correct

Your answer

[1]

19 Which of the options, **A** to **D**, could provide artificial **and** passive immunity to a baby?

- A injection of antibodies from another individual
- B injection of a pathogen that has been weakened
- C passage of maternal antibodies across the placenta
- D production of antibodies following an infection

Your answer

[1]

20 An allergic reaction involves a series of events that are mediated by the immune system.

Which of the options, **A** to **D**, is a result of **initial** exposure to an allergenic antigen?

- A activation of complement
- B division of mast cells
- C presentation of antigen
- D release of histamine

Your answer

[1]

21(a) Asthma and asbestosis are both chronic inflammatory diseases that affect the respiratory system.

(i) Name **two** cells other than macrophages that are responsible for the inflammatory response occurring in diseases such as asthma.

1

2

[2]

(ii) Explain why asthma could be considered an example of a specific immune response.

[1]

- (b) Diseases that involve chronic inflammation, such as asthma, are treated with steroids. Steroids reduce the transcription of the genes coding for molecules that produce an inflammatory response.

Steroids affect structural cells and cells involved in the inflammatory response. Structural cells form the tissues of the respiratory system.

- (i) Suggest what effect steroids have on histones such that gene transcription is reduced.

----- [1]

- (ii) Steroids can suppress the production of certain molecules by cells in the respiratory system.

Suggest one molecule released by a cell involved in an inflammatory response **and** one released by a structural cell for which production is suppressed by steroids.

molecule in inflammatory response -----

molecule released by structural cell -----

[2]

- (iii) Acute asthma attacks are treated using beta-agonists.

Name the tissue targeted by beta-agonists **and** state the location of this tissue in the airways.

tissue -----

location of tissue -----

[2]

22 The successful outcome of fertility treatment is pregnancy. If a woman suspects that she may be pregnant, a pregnancy test stick may be used to confirm the pregnancy.

The test stick contains free molecules of an antibody attached to coloured beads containing a dye. The antibodies are specific to the hormone Human Chorionic Gonadotrophin (HCG), which is produced during pregnancy.

- (i) State the region of the antibody molecule that is attached to the coloured bead **and** state the region that will bind to HCG.

Region attached to coloured bead _____

Region that will bind to HCG _____

[1]

- (ii) Fig. 1.1 shows a pregnancy test stick and four possible results, W, X, Y and Z, that could appear in the oval result window.

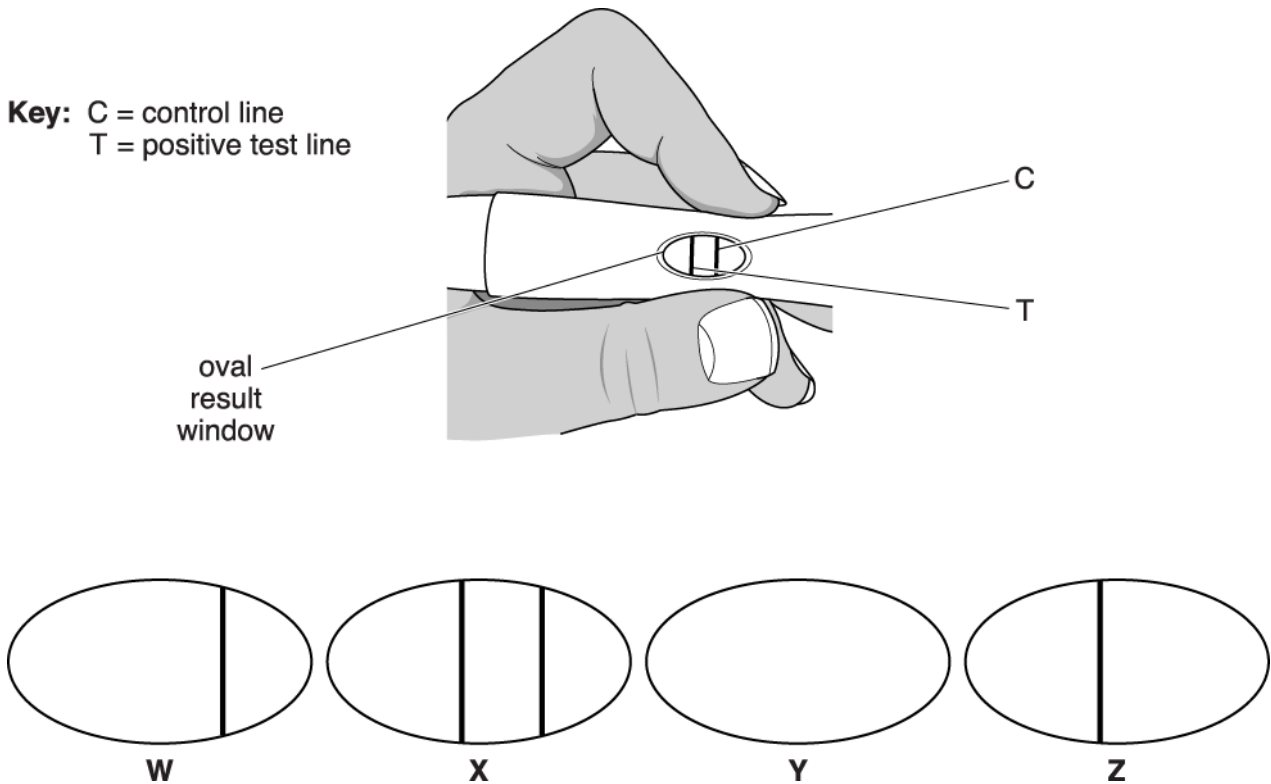


Fig. 1.1

Complete the table below to indicate which conclusions can be drawn from the results shown in windows W

to Z in Fig. 1.1.

Choose from the following:

- pregnant
- not pregnant
- result not valid.

Result window	Conclusion
W	
X	
Y	
Z	

[2]

23 As part of antenatal care, a pregnant woman will be tested for the presence of **atypical** red blood cell antibodies such as antibodies to the Rhesus antigen.

- (i) If a pregnant woman is blood group O, which blood group antibodies would be **expected** in her blood plasma?

[1]

- (ii) Rhesus antibodies in maternal blood plasma can cross the placenta and enter the fetal circulation. The antibodies can cause fetal red blood cells to agglutinate.

How do antibody molecules cause agglutination of red blood cells with the Rhesus antigen on their cell surface membrane?

[2]

24 Hormones such as luteinising hormone (LH) and human chorionic gonadotrophin (hCG) play a key role in the control of the menstrual cycle and in the establishment of a pregnancy.

LH and hCG are large glycoproteins each consisting of two protein subunits.

- The alpha subunit is identical in both hormones and is a chain of 92 amino acids.
- The beta subunit of LH contains 121 amino acids.
- The beta subunit of hCG contains 145 amino acids.
- LH can be detected in urine using a test strip containing monoclonal antibodies.
- Monoclonal antibodies are complementary to one specific area on a large antigen molecule. This area is known as an **epitope**.

(i) Suggest which part of the LH molecule acts as an epitope for the production of the monoclonal antibodies in urine testing kits. Explain your reasoning.

[2]

(ii) Fig. 6.1 is a diagram of an LH testing strip.

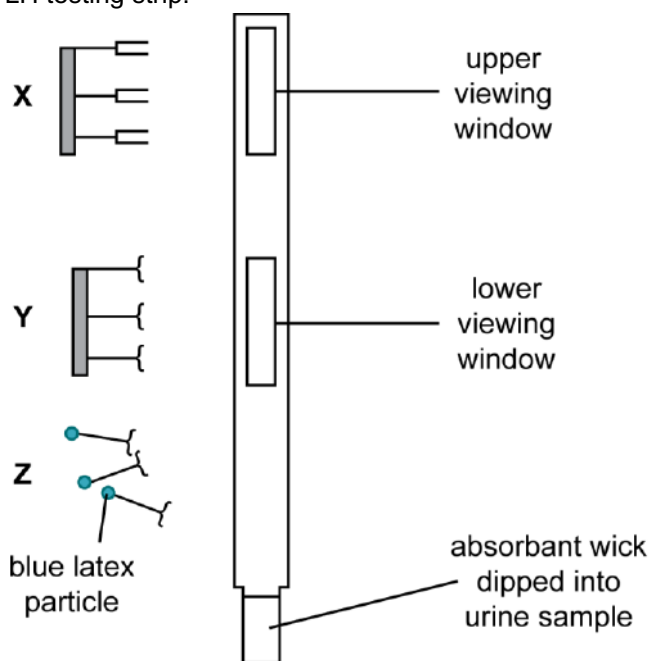


Fig. 6.1

The molecules X, Y and Z represent the monoclonal antibody molecules used in the test strip.

Which molecule(s) would be specific to LH?

-----[1]

25 In Extract 4 of the Advanced Notice article you were told that the immune response to tumour cells can be enhanced by improving the expression, processing, and presentation of TAAs (Tumour Associated Antigens).

(i) State the precise location of TAAs on tumour cells.

-----[1]

(ii) An anticancer vaccine would lead to the production of antibody molecules that recognise TAAs in the host.

Explain how the structure of the antibody molecule would enable it to recognise only TAAs.

-----[2]

26(a) This question is based on the Advanced Notice article **MYOKINES**, which is an insert.

IL-6 is produced by muscle cells in response to physical exercise.

(i) Using the data in **Table 1.1**, determine the mode and mean IL-6 increase after a 1.5 hour cycle ride.

Determine the mode to **one** significant figure and the mean to **three** significant figures.

mode _____ mean _____

[3]

(ii) Based on the data in **Table 1.1**, how valid are the following conclusions?

The duration of exercise affects IL-6 concentration in blood.

Running has a greater influence than cycling on IL-6 concentrations.

[4]

(i) Suggest how IL-6 increases the uptake of glucose from the blood plasma to muscle cells **and** how it increases glucose production in the liver.

[3]

Evaluate the evidence that supports or contradicts the above statement.

[6]

(c) Studies F and H in **Table 1.2** both used knockout mice.

(i) Outline **one** way in which a gene can be inactivated in the knockout procedure.

----- [1]

(ii) Suggest **one** reason why mice are used as the model organism in the knockout procedure.

----- [1]

(d) Cytokines produced in muscles are called myokines. IL-6 is an example of a myokine.

Cytokines can act as chemical signals between immune cells.

Describe **one** specific role of cytokines in the immune system.

----- [2]

27 The gene, *FOXP3*, encodes a transcription factor that drives the differentiation of immature T cells into a specific cell type.

Mutations in *FOXP3* can interrupt the function of the transcription factor and lead to autoimmunity.

Which of the options, **A** to **D**, is the T cell type driven by this transcription factor?

- A T helper cell
- B T killer cell
- C T memory cell
- D T regulatory cell

Your answer

[1]

28 The average heart rate at rest is 72 beats per minute and the average stroke volume is 70 cm^3 .

Assuming a total blood volume of 5 dm^3 , what is the shortest time it would take for the heart to pump the total volume of blood in the body?

- A between 10 and 20 seconds
- B between 30 and 40 seconds
- C between 50 and 60 seconds
- D between 60 and 70 seconds

Your answer

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			A	1(AO1.2)	
			Total	1	
2			C	1(AO1.1)	
			Total	1	
3			B	1(AO1.2)	
			Total	1	
4			B	1(AO1.1)	
			Total	1	
5			D	1(AO1.1)	
			Total	1	
6		i	constant region ✓ allows antibody to bind to phagocyte / mast cell ✓	2(AO1.1)	
		ii	sequence of amino acids is different ✓ tertiary structure is different ✓ charges on the R-groups are different ✓ complementary to different antigens ✓	max 2(AO1.2)	
			Total	4	

Mark Scheme

Question			Answer/Indicative content					Marks	Guidance																					
7	a		<table><tr><th>Example</th><th>Act.</th><th>Pass.</th><th>Nat.</th><th>Art.</th></tr><tr><td>Snake anti venoms consist of sheep or horse antibodies to snake venom proteins. They are given to treat snake bite.</td><td></td><td>✓</td><td></td><td>✓</td></tr><tr><td>A mixture of proteins purified from the <i>Haemophilus influenzae</i> virus is used to reduce the risk of a person getting the 'flu.</td><td>✓</td><td></td><td></td><td>✓</td></tr><tr><td>Following exposure to a pathogen, a person develops memory T and B cells.</td><td>✓</td><td></td><td>✓</td><td></td></tr><tr><td>A calf receives antibodies from its mother in colostrum.</td><td></td><td>✓</td><td>✓</td><td></td></tr></table>	Example	Act.	Pass.	Nat.	Art.	Snake anti venoms consist of sheep or horse antibodies to snake venom proteins. They are given to treat snake bite.		✓		✓	A mixture of proteins purified from the <i>Haemophilus influenzae</i> virus is used to reduce the risk of a person getting the 'flu.	✓			✓	Following exposure to a pathogen, a person develops memory T and B cells.	✓		✓		A calf receives antibodies from its mother in colostrum.		✓	✓		4 (AO1.1)	1 mark per correct row
			Example	Act.	Pass.	Nat.	Art.																							
			Snake anti venoms consist of sheep or horse antibodies to snake venom proteins. They are given to treat snake bite.		✓		✓																							
			A mixture of proteins purified from the <i>Haemophilus influenzae</i> virus is used to reduce the risk of a person getting the 'flu.	✓			✓																							
			Following exposure to a pathogen, a person develops memory T and B cells.	✓		✓																								
A calf receives antibodies from its mother in colostrum.		✓	✓																											
	b	i	(Student's) t-test ✓ (because they have) mean data / (are) testing the difference between means ✓					2(AO2.8) (AO2.8)																						

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	group I ✓ (because they had the) highest concentration of IgE / highest allergic response ✓	2 (AO2.7) (AO2.7)	
		iii	breastfeeding by mothers with AAD reduces degree of AAD in offspring ✓ something / antibodies , in breast milk must protect against allergic reactions ✓ (but) humans may not respond in the same way as mice ✓ results may only apply to allergic mothers passing on immunity to allergy ✓	max 3(AO2.7)(AO2.7)(AO2.7)(AO2.7)	ALLOW 'allergic mothers' for 'mothers with AAD'
			Total	11	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8		i	(surviving rabbits produce) memory (T / B) cells ✓ <u>alleles</u> for resistance (to MYXV) would be selected for ✓ (so the) <u>allele frequency</u> increases (in the population) ✓	max 2(AO2.2)(AO2.2)(AO2.2)	ALLOW advantageous allele(s) passed on
		ii	(vaccination involves) giving pathogen antigens ✓ (formation of) memory (T / B) cells ✓ exposure to pathogen leads to secondary immune response ✓ (which) destroys / kills, pathogen before it can cause, disease / death ✓	max 3(AO1.2)(AO1.2)(AO1.2)	ALLOW any correct example of vaccine, e.g. live-attenuated, subunit vaccines, pathogen fragments ALLOW rapid production of antibodies
		iii	vaccinated hosts can still transmit virus ✓ (so) unvaccinated, birds / flocks, could become infected ✓ OR (high) mutation rate leads to antigen variability ✓ so antibodies produced by vaccination no longer specific ✓	2(AO2.5)(AO2.5)(AO2.5)(AO2.5)	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iv	<i>for</i> susceptible birds would die before they could infect other birds ✓ resistant birds (are more likely to) encourage evolution of more virulent pathogens ✓ <i>against</i> (but) evolution of virulence may not matter for resistant birds ✓ hypervirulent pathogens could threaten, non-resistant / non-GMO, flocks ✓ ethical issues if industrial practices threaten organic producers ✓ susceptible birds may also be susceptible to, related / similar, pathogens	max 4(AO3.2)(AO3.2)(AO3.2)(AO3.2)(AO3.2)	ALLOW other unambiguous term for birds throughout
			Total	11	
9		i	immune system responds to harmless substance ✓ produces antibodies to , allergen / antigen ✓ inflammatory response triggered ✓	2 max AO1.1	ALLOW harmless antigen ALLOW e.g. causes itching / inflammation
		ii	Any two for 1 mark: dust mites ✓ animal hair ✓ mould / fungal spores ✓ (named) food ✓	1 max AO1.1	
			Total	3	
10			B	1 AO1.2	
			Total	1	
11			C	1 AO1.2	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
12			stigma/responsibility associated with informing, sexual partner(s) / children / health professionals ✓ discrimination from insurers / employers ✓ distress caused by false positive result ✓ conflict for health care professionals between confidentiality and right for sexual partner to be protected from infection ✓ affects decision to have children/continue with pregnancy ✓ additional valid points, e.g. restriction to travel to some countries ✓	max 2 AO2.1	ALLOW reference to any individual that may have been infected. <u>Examiner's Comments</u> In this question candidates should be referring to specifically social or ethical concerns about a positive test. Any form of discrimination that might occur would be credited as would the idea of the responsibility of the patient/health carers to inform others who might be at risk. Candidates did however need to develop their answers e.g. discrimination alone would not be credited but discrimination from insurance companies would.
			Total	2	
13			A	1 AO1.2	
			Total	1	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
14	<i>Summary of instructions to markers:</i> <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> <i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.</i> <i>Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics):</i> <i>award the higher mark where the Communication Statement has been met.</i> <i>award the lower mark where aspects of the Communication Statement have been missed.</i> <i>The science content determines the level.</i> <i>The Communication Statement determines the mark within a level.</i> Level 3 (5–6 marks) A comprehensive explanation that describes the role of phagocytes and mast cells in the body's non-specific defence mechanisms, with reference to first defence <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) A simple explanation for the role of phagocytes and mast cells in the body's non-specific defence mechanisms. OR A detailed explanation for the role of phagocytes or mast cells in the body's non-	6 AO2.1	Indicative scientific points may include <i>Pathogenic bacteria, fungi, virus in first defence</i> Barrier AMP destroy pathogen before , entry (into intestines, respiratory tract etc) / can spread Skin / mucus NK cells APC's / dendritic cells Complement proteins Acidic pH (of vagina) <i>Mast cells</i> inflammation vasodilation / redness swelling /increased blood flow / oedema histamine / serotonin / prostaglandins <i>Phagocytes</i> macrophages / neutrophils aggregation attracts phagocytes cytokines engulf pathogen phagolysosome / phagosome, formation (hydrolytic) enzymes destroy pathogen monocyte differentiation IGNORE reference to the specific immune response <u>Examiner's Comments</u> This was a well answered level of response. Candidates identified the role of phagocytes and mast cells, often in great detail. Some candidates didn't connect this to the role of AMP's and they often referred to AMP's as antibodies and described antibody functions. Candidates clearly understood the use of the term 'non-specific' as few candidates referred to T and B cells. Exemplar 1

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	specific defence mechanisms. <i>There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) A simple explanation for the role of phagocytes or mast cells in the body's non-specific defence mechanisms. <i>There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>		~~AMPs are non-specific defence mechanisms on the same segment of the type of pathogen or whether it is the primary or secondary infection. AMPs stimulate mast cells, which promotes inflammation. Mast cells secrete histamines, prostaglandins and serotonin which causes the vasodilation of arterioles and capillaries become more leaky, so there is a greater seepage of tissue fluid and phagocytes, which ensures that specific T helper and B lymphocytes are attracted to the site of infection. AMPs act as cell signalling markers that attract phagocytes to the origin and pathogen, promoting an immune response in the form of general phagocytosis. AMPs also take part in positive chemotaxis, attracting phagocytes. Phagocytes engulf the pathogen by endocytosis, fuse with a lysosome to use the hydrolytic enzymes to digest the pathogen and then releasing the cellular debris by exocytosis. Specific, complementary receptors on the surface of the phagocyte may bind to the AMP, activating phagocytosis. AMPs are produced by epithelial cells of the respiratory tract, where they may bind to glycoproteins to form a sticky glycoprotein mucus that traps microorganisms. Furthermore, AMP may be a form mucus with in the vagina to inhibit microbial growth. AMP also aids the aggregation of pathogens by clumping them together.~~ This is a full mark response. The last part of the answer illustrates how Level 3 is achieved with a clear indication of the role of AMP's beyond that inferred in the question stem.
	Total	0	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a	i	could lead to, false positives / false negatives ✓ if false negative (AW) / has immunity, people receive vaccination when it is not required OR if false positive (AW) / has no immunity, may lead to people not receiving vaccination when it is required ✓ correct use of data to demonstrate percentage error ✓	2 max	IGNORE any reference to vaccination rate or cost of vaccination <i>e.g. 9mm induration is measured (incorrectly) as 9.9mm → recorded as 10mm → leading to false positive result</i> <i>e.g. 10mm induration is measured (incorrectly) as 9.1mm → recorded as 9mm → leading to false negative result</i> <u>Examiner's Comments</u> This question expected candidates to refer to false positives and/or false negatives. Able candidates used data to support their answer and went on to explain the impact of this error in terms of vaccinating people who were already immune (in the case of a false negative) and vice versa. Other candidates gave vague answers stating answers such as "some people may be vaccinated when they don't need it which is a waste of money".

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		ii	suitable suggestion for improved measuring method ✓ valid / appropriate reasoned argument ✓	2	IGNORE references to 'reduce percentage error' e.g. • callipers ◦ give greater degree of precision • use scaled photograph of induration ◦ give greater degree of precision • cut-out stencil/ overlay / AW, used as a standard placed on induration ◦ more objective • take multiple readings (minimum of 3) ◦ calculate mean value <u>Examiner's Comments</u> Candidates who did not perform well in this question focussed on the use of the ruler and suggested more 'accurate' rulers which was not accepted. Candidates who had used or observed the use of (vernier) callipers in their practical skills were able to access this question. Some candidates suggested the use of a photograph but without the use of a scale on the photograph this would not in itself result in an improvement,

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	b	Summary of instructions to markers: <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i> Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer. Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics): ◦ award the higher mark where the Communication Statement has been met. ◦ award the lower mark where aspects of the Communication Statement have been missed. • The science content determines the level. • The Communication Statement determines the mark within a level. Level 3 (5–6 marks) Advantages and disadvantages of both tests discussed. Use of data from Table 4.1 to support a conclusion. <i>There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.</i> Level 2 (3–4 marks) Advantages and/or disadvantages of both tests mentioned. A relevant reference to Table 4.1 is made. <i>There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.</i>	6	Indicative scientific points could include: Advantages of Mantoux test: • results easy to measure • portable Disadvantages of Mantoux test: • requires sterile equipment • requires correct storage of tuberculin • subjectivity involved in measuring induration • gives, significant / AW, number of false results • requires longer period before test results are obtained

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Question	Answer/Indicative content	Marks	Guidance
	Level 1 (1–2 marks) Advantages and/or disadvantages of at least one test mentioned. No relevant, correct reference to Table 4.1. <i>There is an attempt at a logical structure with a line of reasoning The information is in the most part relevant.</i> 0 marks No response or no response worthy of credit.		<i>Advantages of ELISA test:</i> • enables measurement of antibody concentration (in response to administered antigen) • results are objective / more accurate • quicker test <i>Disadvantages of ELISA test:</i> • requires (more) specialist training • more expensive • not portable • more specialist equipment required Use of Table 4.1 to support conclusion • 65/ 89 samples give the same result with both tests • 73% ($65/89 \times 100$) of the results are the same (in agreement) in both tests • 24 results are false results • 27% ($24/89 \times 100$) are false results • ELISA have 45% testing positive (40/89) • ELISA have 55% testing negative (49/89) <u>Examiner's Comments</u> The command word in this question is 'evaluate' and to that end candidates were expected to give advantages and disadvantages of both the Mantoux test and the ELISA test. Candidates should be encouraged to give a balanced discussion. Candidates who did not perform well on this question tended to focus on either just advantages or just disadvantages or focus on one type of test. Also in this question candidates were instructed to refer to data in table 4.1. This was not done by a many candidates.

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					Exemplar 5 From the table, it appears that the ELISA test identifies 40 positive results, which is ~~more~~ over 25% more than the Mantoux test. This would suggest ~~to~~ that it is better at giving an accurate, definite result, than the Mantoux test which has a higher number of negatives (61) than ELISA (49), which could perhaps be due to the uncertainty of the health professional when measuring the induration, however, to be on the safe side they have diagnosed them as negative for immunity. ~~As~~ ELISA is useful because it could prevent people who may already be immune from receiving unnecessary vaccines, which would be economically beneficial to the NHS. However, ELISA requires fresh blood so must be carried out immediately, and the full lab facilities suggest it is more complicated and expensive than the Mantoux test. This wouldn't be ideal in developing countries where these facilities and funding aren't available. In these circumstances, Mantoux would be more useful. Mantoux is quicker and cheaper, however there could be a risk of catching TB from the tuberculin if the person isn't already immune. Furthermore, the tuberculin requires ~~on~~ good storage, which could be the fridge, although this may not be possible world-wide.
			Total	10	

Mark Scheme

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16	a	i	F C A D B E ✓✓	2	2 correct = 1 mark Examiner's Comments (a)(i) tended to be either completely correct or wrong, very few candidates achieving partially correct responses.
		ii	kill / destroy, infected (host) cells ✓	1	Examiner's Comments (a)(ii) was not answered well with many candidates thinking that T killer cells killed the virus rather than the virus infected host cells. References to the cell membrane and various other cellular features indicated that candidates had a poor understanding of the nature of viruses.
	b	i	3 FROM <i>Idea that:</i> for HPV 16, no significant difference between the 2 dose and the 3 dose regime ✓ for HPV18, two-dose less effective than three-dose ✓ for both HPV16 and HPV18, both regimes produce similar antibody levels at 1 month / 3 years (3 dose) – equally effective ✓ comparison of median or range values in support of one of the above statements ✓ 1 FROM EITHER: top of range for HPV18 antibody levels at 3 years in two- dose schedule does not overlap with ranges in other datasets ✓ OR very large range for HPV18 antibody levels at 3 years in two-dose schedule ✓	4	Examiner's Comments (b)(i) was a demanding question with many candidates not understanding that each dosage regime was one experiment and that the number of antibodies was measured after one month and then after 3 years. The question asked candidates to compare the 2-dose regime with the 3-dose regime for both viral strains. It was common for candidates to focus on the differences in the data instead of explaining how similar most of the data was. Many candidates highlighted tiny differences in median antibody levels despite the extremely large and overlapping ranges. The only candidates to gain full marks were those who appreciated that the 2-dose regime after 3 years was the only data set that had a significantly different median antibody level to all other data because the range did not overlap with any other.

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		ii	first exposure no <u>memory</u> B cells prior to first dose ✓ <i>idea that:</i> it takes time for clonal selection / clonal expansion / small number of plasma cells to produce antibodies ✓ second / third exposure memory cells stimulated to divide rapidly / clonal selection faster / clonal expansion faster ✓ memory cells <u>differentiate</u> into (many) <u>plasma</u> cells ✓ <u>plasma</u> cells produce antibodies faster and in greater numbers ✓	max 3	ALLOW small number of B cells produce antibodies Examiner's Comments (b)(ii) was a stretch and challenge question and the marks reflected this. Many candidates were clearly familiar with the primary and secondary immune response but relatively few could explain this in good biological detail. Few candidates mentioned the lack of memory cells prior to the first dose or the idea that clonal selection / expansion took time. Similarly, after the second exposure many candidates failed to mention memory cells differentiating and the subsequent plasma cells producing antibodies. Overall, answers were too generalised to gain marks.
			Total	10	
17			B ✓	1	Examiner's Comments Most candidates could identify the disulfide bonds on the antibody but some confused the constant and variable regions, thus A was a common incorrect answer.
			Total	1	
18			A ✓	1	
			Total	1	
19			A ✓	1	
			Total	1	
20			C ✓	1	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
21	a	i	B lymphocyte / plasma cell ✓ Mast cell ✓ T-helper lymphocytes ✓	max 2	
		ii	<i>idea that</i> an antigen / allergen triggers the production of an antibody / IgE (antibody)	1	
	b	i	<i>idea that</i> histones are deacetylated / acetyl groups are removed	1	
		ii	<i>inflammatory cell</i> histamine / IgE / cytokine ✓ <i>structural cell</i> mucin / cytokine ✓	2	ALLOW cytokine once only for either type of cell ALLOW a named cytokine
		iii	<i>tissue</i> smooth muscle ✓ <i>location</i> wall of, bronchi / bronchioles ✓	2	
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance										
22		i	(coloured bead to) constant AND (HCG to) variable;	1	BOTH responses required for one mark Examiner’s Comments It was surprising how many candidates did not know the correct names for the constant and variable regions in (i).										
		ii	<table><tr><th>Test strip</th><th>Conclusion</th></tr><tr><td>W</td><td>not pregnant</td></tr><tr><td>X</td><td>pregnant</td></tr><tr><td>Y</td><td>result not valid / AW</td></tr><tr><td>Z</td><td>result not valid / AW</td></tr></table>	Test strip	Conclusion	W	not pregnant	X	pregnant	Y	result not valid / AW	Z	result not valid / AW	2	Mark the first answer in each box. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer = 0 marks 4 correct = 2 marks 3 correct = 1 mark ACCEPT ‘inconclusive’ for ‘result not valid’ IGNORE ‘not clear’ Examiner’s Comments Most candidates were able to interpret the results given in part (ii) correctly.
Test strip	Conclusion														
W	not pregnant														
X	pregnant														
Y	result not valid / AW														
Z	result not valid / AW														
			Total	3											
23		i	(anti) A AND (anti) B antibodies	1											
		ii	(antibody has) two, binding sites / variable regions (1) <i>idea that</i> sites bind to antigens on different blood cells (1)	2	ALLOW an explanation from a diagram										
			Total	3											

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Question			Answer/Indicative content	Marks	Guidance
24		i	(area on) beta subunit (1) <i>Explanation</i> <i>idea that</i> this has different 3D or tertiary structure to hCG OR <i>idea that</i> this has a unique 3D or tertiary structure (1)	2	
		ii	Y AND Z (1)	1	Both letters required for one mark
			Total	3	
25		i	(outer surface of) cell surface membrane	1	
		ii	<i>idea of</i> variable region being complementary to antigen (1) <i>idea that</i> different antigens would have a different (3D) shape (1)	2	
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
26	a	i	mode = 2 mean = 3.11	3	$(2 \times 9) + (2 \times 8) + (3 \times 11) + (6 \times 7) / 35 = 3.11$ Award one mark if a candidate has clearly taken the number of participants into account but has made an error in the calculation
		ii	<i>General points</i> <i>Idea of valid conclusions</i> would require information about the intensity of exercise <i>Idea that</i> (named) statistical test would confirm conclusion <i>Duration (up to a maximum of 2 marks)</i> positive correlation (suggests the conclusion is valid) many studies / repeats / AW, improves validity <i>idea of relationship / correlation</i> , clearer for cycling (than running) <i>Running vs cycling (up to a maximum of 2 marks)</i> <i>idea that</i> (conclusion is valid because) for a given duration, IL-6 increases more with running (than cycling) the number of participants varies, which makes comparison difficult	4	The general point marks can be scored for either section, but can only be scored once ALLOW 'meta-analysis' for 'many studies' ALLOW calculated example
	b	i	Any 3 from: <i>Glucose uptake</i> (IL-6) increases / AW, insulin production (IL-6) increases / AW, insulin receptor sensitivity (on muscle cells) <i>Glucose production</i> (IL-6) increases / AW, glucagon production glycogen converted to glucose (in liver cells)	3	ALLOW acts like a hormone ALLOW glycogenolysis
		ii	* Level 3 (5–6 marks) Candidate's evaluation demonstrates excellent judgement of the data, providing conclusions that address all the significant issues. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i>	6	Examples of relevant scientific points at L3 (in addition to points at L1 and L2) <i>experimental & epidemiological evidence</i> • discussion of <i>in vitro</i> v <i>in vivo</i> experiments (e.g. the conflicting results in A and B; <i>in vitro</i> experiments might lack important factors, for example, found in <i>in vivo</i>) • discussion of the link between TNF and IL-6 (e.g. G and H. IL-6 could, for

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			Level 2 (3–4 marks) Judgement is made on a range of aspects of the data, but conclusions are not comprehensive. <i>There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.</i> Level 1 (1–2 marks) Simple conclusions are made, drawing on limited aspects of the data. <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks No response or no response worthy of credit.		example, be high in certain cases because it has a defensive role against TNF) i.e. detailed links made between studies in Table 1.2 and impact on diabetes risk - in depth discussion of correlation v causation (e.g. C and D show correlation but not causation). <i>biological knowledge</i> - detailed understanding of the causes and symptoms of type 2 diabetes. Examples of relevant scientific points at L2 (in addition to points at L1) <i>experimental & epidemiological evidence</i> - discussion of correlation v causation - linking exercise, low baseline IL-6 and possible effects on diabetes risk - quite detailed links made, some in detail, between studies in Table 1.2 and the impact on diabetes risk. <i>biological knowledge</i> - good understanding of the causes and symptoms of type 2 diabetes. Examples of relevant scientific points at L1 <i>experimental & epidemiological evidence</i> - basic links made between studies in Table 1.2 and the impact on diabetes risk. <i>biological knowledge</i> - some understanding of the causes and symptoms of type 2 diabetes.
	c	i	<i>idea that</i> (gene is) replaced / disrupted / AW, with, artificial / synthetic / AW, DNA	1	

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		ii	Any 1 from: (mice have) similar, genome / DNA sequences, to humans (mice have) similar, metabolism / physiology, to humans (mice are) easy / cheap, to, house / manipulate / breed	1	
	d		chemotaxis attraction of neutrophils (to site of infection) OR cause / stimulate, B cells / T cells, to, differentiate / proliferate cause / stimulate, B cells to release antibodies OR inhibit virus replication activation / AW, of T killer cells	2	ALLOW (undergo) clonal expansion
			Total	20	
27			D	1	
			Total	1	
28			C	1	
			Total	1	