CAMBRIDGE INTERNATIONAL AS & A LEVEL BIOLOGY · 9700

BIOLOGY



EXAM QUESTION PACK

11 IMMUNITY

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233. 9700_w17_qp_23 Q: 4

Malaria is a disease transmitted by a vector.

(a) (i) State the name of the pathogen that causes malaria.

.....[1]

(ii) State the name of the vector that transmits the pathogen.

.....[1]

In 2014, the World Health Organization (WHO) estimated that 3200 million people were at risk of malaria. This was almost half of the world population in 2014.

Table 4.1 shows the number of cases of malaria and the number of deaths from malaria between 1998 and 2013. The table shows numbers for all the countries of the world and for the countries in the WHO African region.

The table also shows the numbers in the African region as percentages of the numbers for all countries.

Table 4.1

year	number of cases of malaria in millions		cases in the African region as a percentage of all countries	number of deaths from malaria in thousands		deaths in the African region as a percentage of all countries
	all countries	African region		all countries	African region	
1998	272.9	237.6	87.1	1110.0	961.0	90.1
2003	236.0	186.6	79.1	872.0	800.0	91.7
2008	225.1	181.0	80.4	747.0	677.0	90.6
2013	198.0	158.4	80.0	584.0	525.6	90.0

(b) Describe the trends shown in Table 4.1.

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.....[3]

(c) Suggest reasons why the number of cases of malaria and the number of deaths from malaria changed between 1998 and 2013.

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(d) Malaria is very difficult to control even though there is improved understanding of the disease.

Explain why malaria is very difficult to control.

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.....[4]

[Total: 12]

234. 9700_M16_qp_22 Q: 4

Morbillivirus, which causes measles, and the human immunodeficiency virus (HIV) share these common features:

- outer envelope surrounding the protein coat
- RNA as the genetic material
- infect cells of the immune system.

(a) Compare the modes of transmission of *Morbillivirus* and HIV.

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.....[4]

(b) Antibiotics are not used to treat viral infections.

Explain why antibiotics do not affect viruses.

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.....[2]

(c) The structure of *Morbillivirus* is shown in Fig. 4.1.

Haemagglutinin (**H**) and fusion protein (**F**) are glycoproteins embedded in the viral envelope.

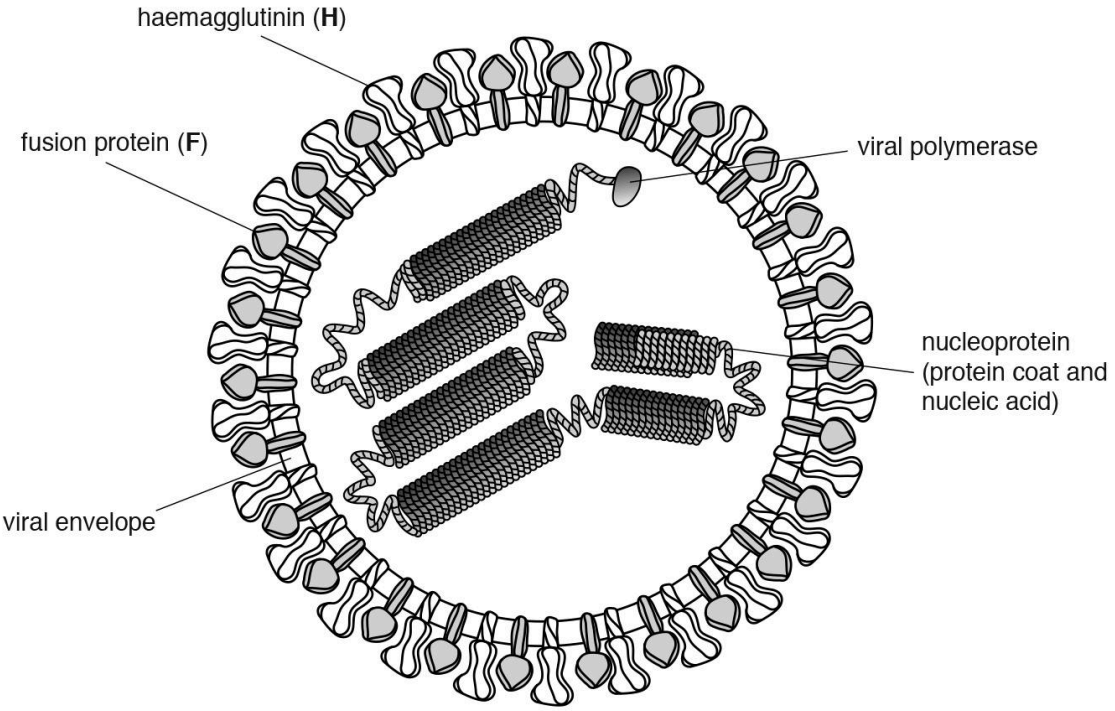


Fig. 4.1

Morbillivirus only infects cells that have a membrane glycoprotein known as signalling lymphocyte activation molecule (SLAM).

When *Morbillivirus* infects a cell, **H** acts before **F**. After the virus binds to the host cell, only the nucleoprotein with the viral polymerase enters the host cell and the virus is replicated.

New viral particles leave the host cell by budding from the cell surface membrane of the cell. This forms the main part of their envelope.

With reference to Fig. 4.1 and the information provided on pages 9 and 10,

(i) outline the structural features of the viral envelope of *Morbillivirus*

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.....[2]

(ii) suggest how *Morbillivirus* infects a cell with SLAM glycoproteins so that only nucleoprotein and viral polymerase enter

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.....[3]

(iii) suggest the role of viral polymerase in *Morbillivirus*.

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.....[2]

(d) HIV has an antigen known as p24.

One test for an early diagnosis of HIV infection uses a monoclonal antibody that identifies antigen p24.

(i) State the type of biological molecule that is represented by antigen p24.

.....[1]

(ii) Outline how the monoclonal antibody against antigen p24 is produced.

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.....[3]

[Total: 17]

235. 9700_s16_qp_23 Q: 3

Rheumatoid arthritis (RA) is a disease of the joints in the human body.

(a) RA is classed as an auto-immune disease where the immune system treats some self antigens as non-self.

Explain what is meant by the term *non-self antigens*.

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.....[3]

(b) The symptoms of RA include inflammation of the joints which causes pain and difficulty in movement of the joint.

The inflammation is triggered by a chemical known as TNF-α, produced by macrophages.

One approach to the treatment of RA is by the use of monoclonal antibody against TNF-α.

Fig. 3.1 is a diagram of an antibody molecule.

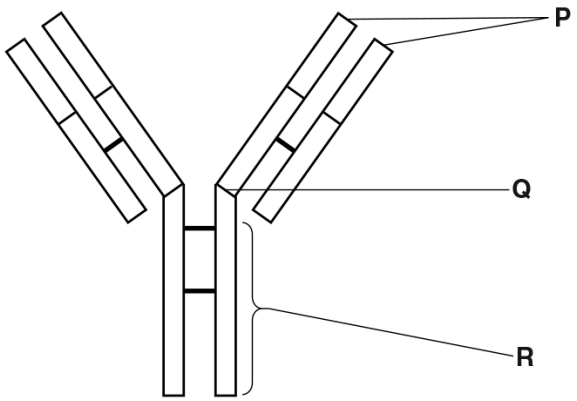


Fig. 3.1

(i) Name the parts of the antibody molecule labelled **P**, **Q** and **R**.

P .....

Q .....

R .....

[3]

(ii) Name the type of bonds that hold the polypeptide chains together in the antibody structure.

.....[1]

(c) (i) Outline how monoclonal antibody against TNF-α is produced.

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.....[3]

(ii) Suggest how monoclonal antibody against TNF-α can reduce the symptoms of RA.

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.....[2]

[Total: 12]

236. 9700_w16_qp_21 Q: 5

(a) Monoclonal antibodies (MAbs) have been used in the treatment of some non-infectious diseases.

MAbs can be designed to bind to a protein on diseased cells, so causing their destruction by cells of the person's immune system.

(i) Name the part of an antibody molecule that will bind to a protein on diseased cells.

.....[1]

(ii) Suggest how the binding of monoclonal antibody to the diseased cells causes their destruction by cells of the person's immune system.

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.....[4]

(b) Myasthenia gravis is an auto-immune disease.

Explain the term *auto-immune disease*.

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.....[1]

[Total: 6]

237. 9700_w16_qp_22 Q: 5

A disease can be described as infectious or non-infectious.

(a) Lung cancer is a non-infectious disease.

(i) Explain the term *non-infectious disease*.

non-infectious .....

.....

.....

disease .....

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.....[2]

(ii) In a person with lung cancer one or more healthy cells undergo changes to produce cancerous cells that can form a tumour.

Suggest **and** explain the cellular changes that occur in the development of lung cancer.

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.....[4]

(b) Fig. 5.1 is a summary of some infectious diseases.

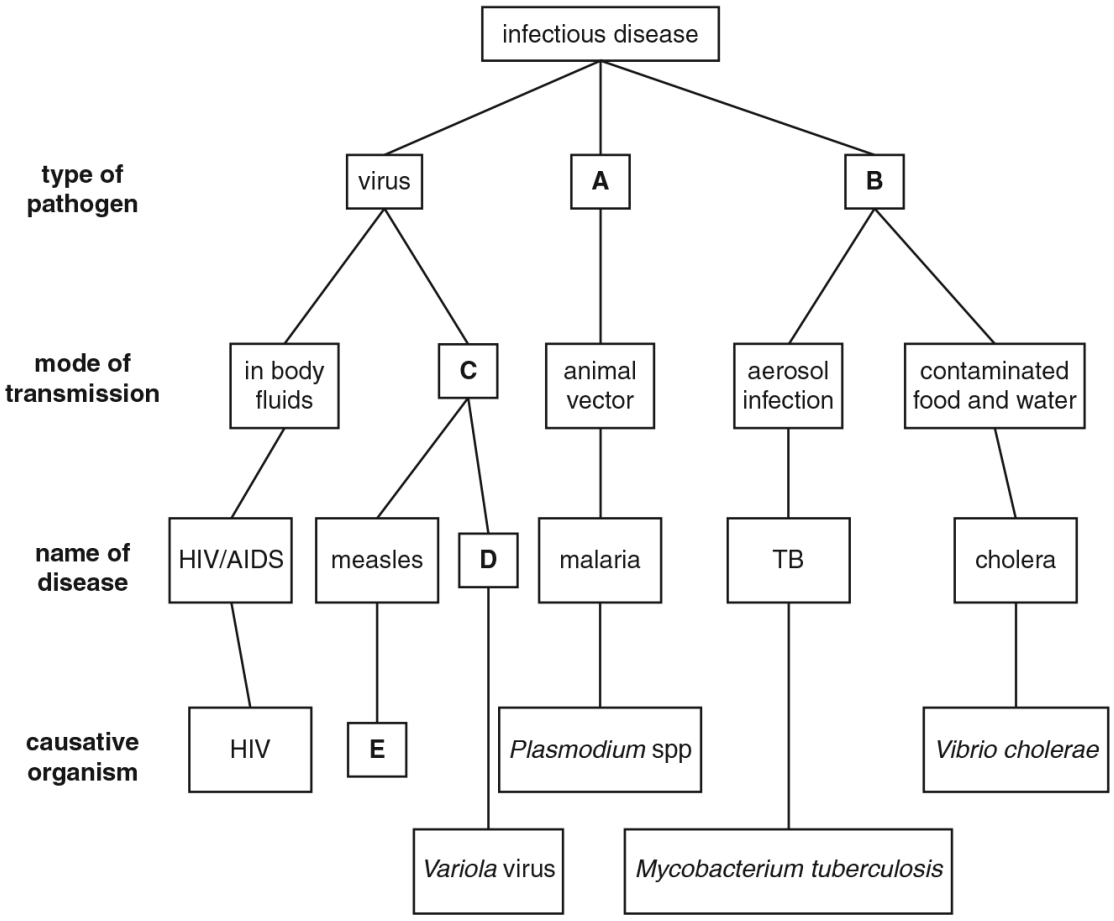


Fig. 5.1

Use the information in Fig. 5.1 to answer parts **(i)** to **(iv)**.

(i) Name the type of pathogen represented by **A** and **B**.

A .....

B ..... [2]

(ii) State the mode of transmission represented by **C**.

.....[1]

(iii) Name the disease represented by **D**.

.....[1]

(iv) Name the causative organism represented by **E**.

.....[1]

(c) Explain how vaccination can control infectious diseases.

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.....[3]

[Total: 14]

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238. 9700_w16_qp_23 Q: 6

Measles is a highly infectious disease.

(a) Name the pathogen that causes measles.

.....[1]

The number of cases of measles is reported to the World Health Organization (WHO) by countries throughout the world so that global data are collected.

Fig. 6.1 shows the global data collected between January 2008 and December 2012.

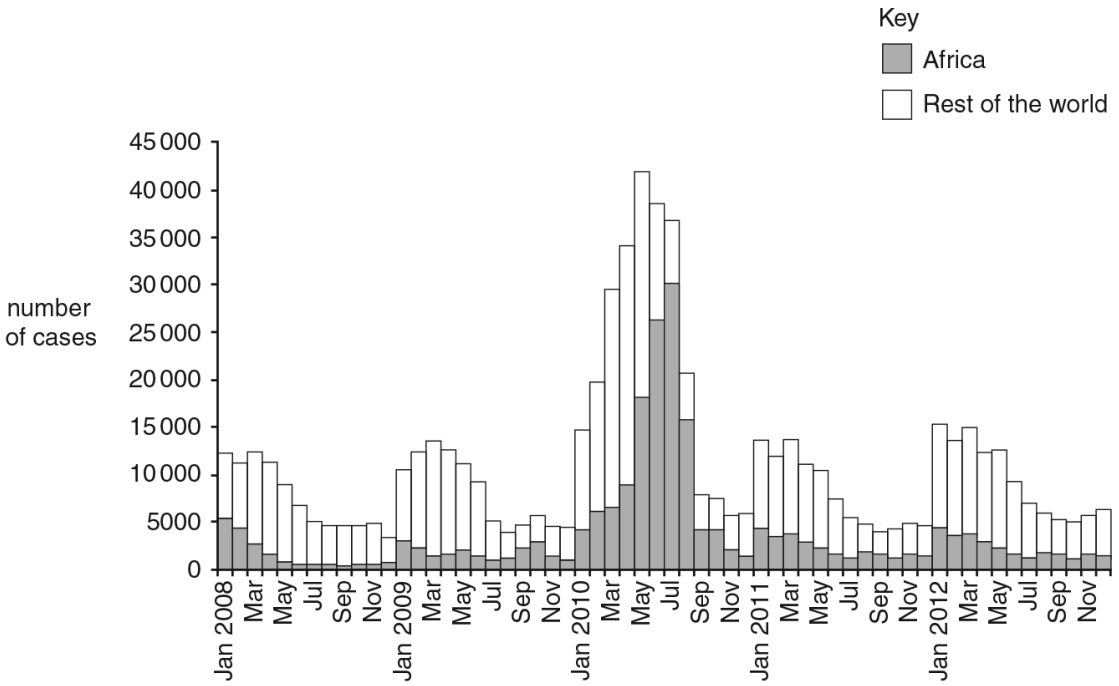


Fig. 6.1

(b) Use the data in Fig. 6.1 to describe the pattern shown in the number of cases of measles reported to the WHO between January 2008 and December 2012.

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.....[3]

(c) The WHO is coordinating a vaccination campaign to reduce the number of cases of measles. Between seven to ten days after receiving the vaccination for measles the concentration of antibodies in the blood begins to increase.

Describe what happens in the body after the injection of a measles vaccine until the concentration of antibodies in the blood begins to increase.

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.....[4]

(d) Explain why countries that have established vaccination programmes still have cases of measles.

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.....[2]

[Total: 10]

239. 9700_s15_qp_22 Q: 5

(a) Natural immunity and artificial immunity can both be acquired in a passive or in an active manner.

Table 5.1 shows information about immunity acquired by two individuals, **P** and **Q**.

Complete Table 5.1.

Table 5.1

description of event	outcome for the individual	production of memory cells / yes or no	type of immunity acquired by individual
individual **P** is injected with a live, weakened disease-causing organism	individual **P** does not become ill from the disease and has long-lasting protection from the disease	.....	....
individual **Q** is injected with antibody against a specific disease-causing organism	individual **Q** does not become ill from the disease but is ill with the disease a year later	.....	....

[2]

Fig. 5.1 is a light micrograph of a sample of blood. Cell **X** is a phagocyte.

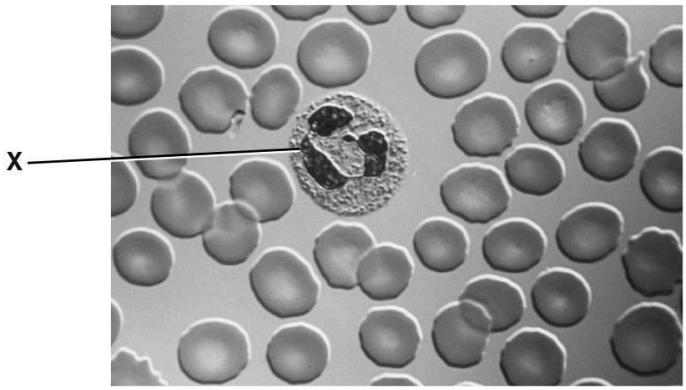


Fig. 5.1

(b) State the origin of the blood cell labelled **X**.

.....[1]

(c) Phagocytes play an important role when an immune response is initiated against cancerous tumour cells.

(i) Suggest how phagocytes can recognise the difference between healthy body cells and cancerous tumour cells.

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.....[2]

(ii) Outline briefly how a tumour forms.

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.....[2]

[Total: 7]

240. 9700_s15_qp_23 Q: 3

Fig. 3.1 is an electron micrograph of a type of B-lymphocyte called a plasma cell.

Plasma cells secrete antibody molecules.

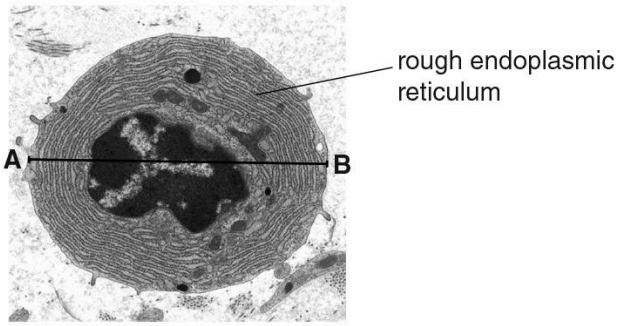


Fig. 3.1

(a) Suggest why plasma cells contain a large quantity of rough endoplasmic reticulum.

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.....

.....

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.....[2]

(b) The diameter **A** – **B** of the plasma cell in Fig. 3.1 is 15 μm.

Calculate the magnification of Fig. 3.1.

Show your working.

magnification × ..... [2]

(c) Smallpox was the first disease to be eradicated by vaccination. The vaccine was effective for up to 10 years after one dose and did not require boosters within this time.

Name the causative organism (pathogen) of smallpox.

.....[1]

(d) When a person received the smallpox vaccine, the numbers of plasma cells specific for the smallpox pathogen were measured from blood samples taken over a period of 35 days.

Fig. 3.2 shows how the numbers of smallpox-specific plasma cells changed during 35 days after vaccination.

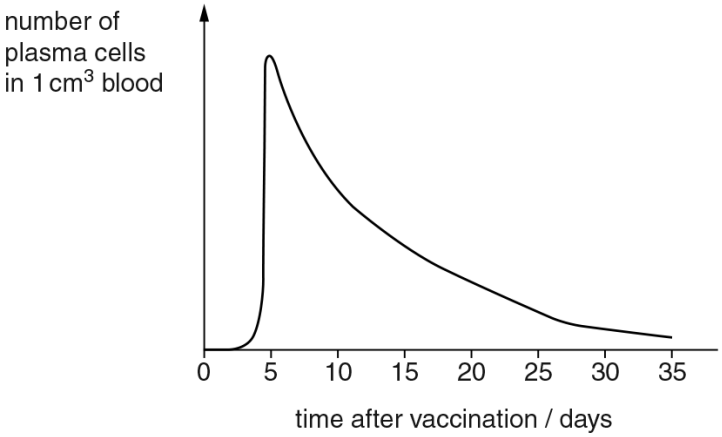


Fig. 3.2

Fig. 3.2 shows that the number of smallpox-specific plasma cells increases and then decreases within 35 days of vaccination.

Explain how a single dose of this vaccine can provide immunity for up to 10 years when the plasma cells are short-lived.

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.....[3]

(e) State two reasons why the vaccination programme was successful in eradicating smallpox.

1 .....

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2 .....

.....

[2]

(f) State the type of immunity provided by the smallpox vaccine.

.....[1]

[Total: 11]

241. 9700_w15_qp_23 Q: 1

Antibodies are secreted by activated B-lymphocytes known as plasma cells.

Fig. 1.1 is a diagram showing the cellular processes involved in the production of a polypeptide of an antibody molecule (not drawn to scale).

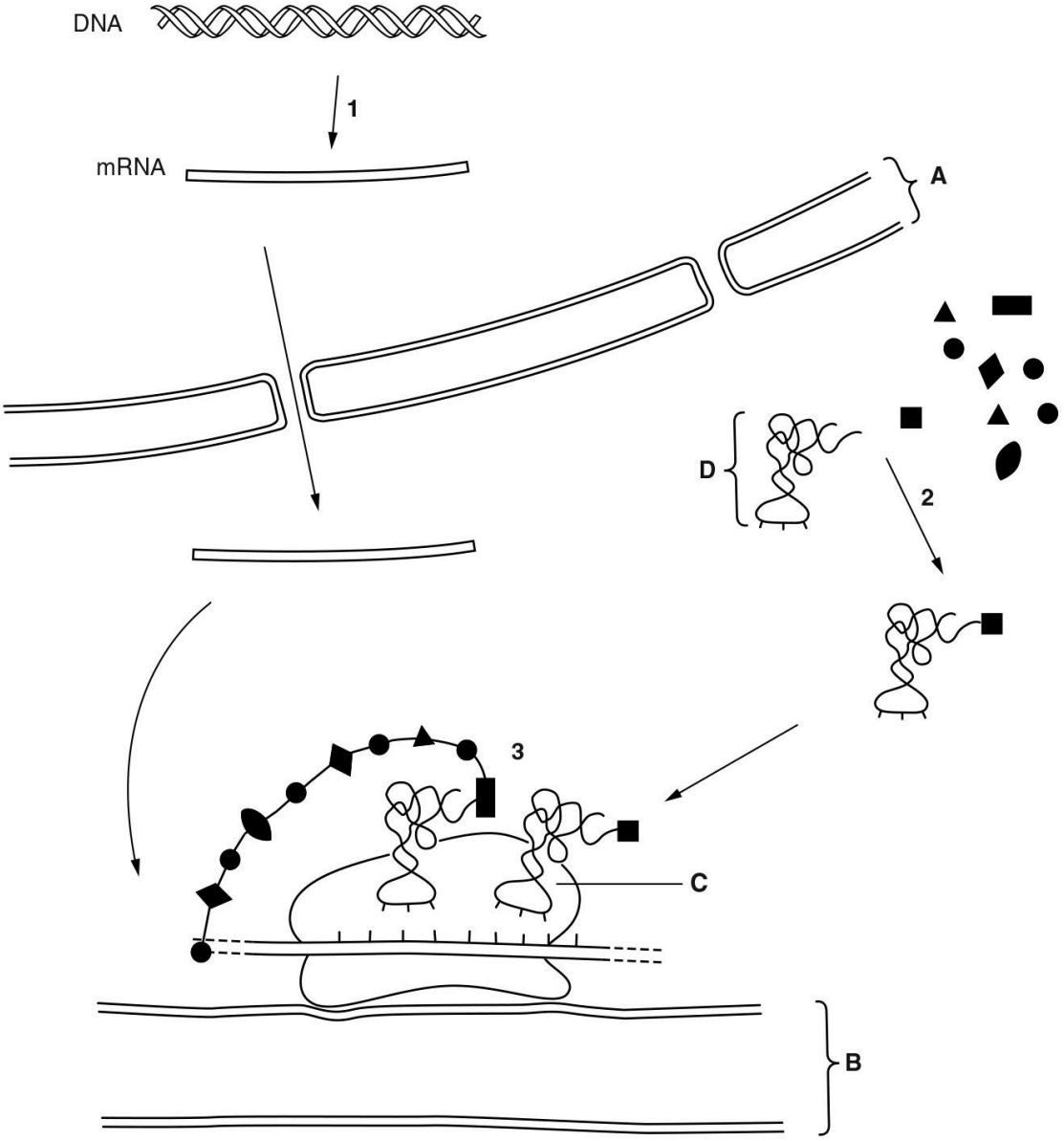


Fig. 1.1

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(a) **(i)** Name structures **A**, **B** and **C**.

A .....

B .....

C ..... [3]

(ii) Name molecule **D**.

D ..... [1]

(iii) State what is occurring at **1**, **2** and **3**.

*at **1*** .....

.....

*at **2*** .....

.....

*at **3*** .....

..... [3]

(b) Antibodies are glycoproteins.

State what is meant by the term glycoprotein.

.....

.....

..... [1]

(c) The genes responsible for antibody production are found on different chromosomes, such as chromosomes 2 and 14 in humans.

Explain how one antibody molecule is the product of more than one gene.

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..... [2]

(d) Describe **and** explain how the structure of an antibody molecule is related to its functions.

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..... [4]

[Total: 14]

200. 9700_s19_ms_22 Q: 3

(a)	**C** =neutrophil ; **A** polymorphonuclear leucocyte **A** basophil **A** eosinophil **D** = lymphocyte ; B / T *is neutral* **E** = monocyte ; **A** macrophage ***I*** *leucocyte / white blood cell, throughout*	**3**
(b)(i)	*any two from:* lymphocytes / blood cells, produced in / originate from, bone marrow ; *ref. to* stem cell(s) ; *ref. to* cell division ; e.g. bone marrow has cells that can carry out, mitosis / cell division **A** (stem cells are) multipotent	**2**
(b)(ii)	*any three from:* *measles* immune response stimulated ; detail ; e.g. **either** antigen recognition / presence / binding **or** lymphocyte / white blood cell, stimulated / triggered **plus** clonal, expansion / proliferation / cell division / mitosis } **or** clonal selection / AW **R** incorrect pathogen name **R** bacteria *CLL* result of, uncontrolled mitosis ; **A** uncontrolled, division / cell cycle **I** rapid mitosis detail ; owing to, mutation / named mutation **or** cell cycle checkpoints not working **or** cells don't respond to signals to control division	**3**
(c)(i)	*any two from:* (passive / simple) diffusion (of oxygen) across the phospholipid bilayer ; **A** movement from a higher to a lower concentration *for diffusion* **A** between phospholipids / between fatty acid chains / across hydrophobic core / across bilayer / AW, *for phospholipid bilayer* small size ; non-polar / uncharged ;	**2**
(c)(ii)	*any three from:* less oxygen in inhaled air / AW ; **A** less oxygen taken up from alveoli low(er) saturation of haemoglobin (with oxygen) ; **A** Hb for haemoglobin **A** haemoglobin carries less oxygen *must be the context of oxygen* **R** saturation, with air / carbon dioxide haemoglobin has lower affinity for oxygen ; (so) more haemoglobin required (so more red blood cells) / (more red blood cells) so more haemoglobin ; AW compensation / compensates ; **A** so same, volume / quantity / amount, of oxygen reaches body cells (compared to lower altitude)	**3**

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(d)	*any four from:* **1** (alleles have) different nucleotide sequences ; **A** different base sequences **2** base substitution / substitution of a base ; **A** T replaced by A **3** (alleles have) different mRNA codons ; **A** altered mRNA codon **R** altered genetic code **4** (results in) one amino acid change **or** change from, glutamic acid / glutamate / glu, to, valine / val **or** changed primary structure ; **A** changed sequence of amino acids **R** *if implies whole sequence changes* **5** AVP ; e.g. Hb^A = CTC and Hb^S = CAC (on template strand) **A** Hb^A = GAG and Hb^S = GTG (on non-template strand) **or** Hb^A = CTT and Hb^S = CAT (on template strand) **A** Hb^A = GAA and Hb^S = GTA (on non-template strand) *this is **not** also mp2* *ref. to* amino acid substitution at position 6 (*this is **not** also mp4*) **A** 6th, codon / triplet, changed **6** changed, (β-globin / Hb) tertiary structure ; **A** polypeptide / (Hb molecule) quaternary structure **R** β-globin / polypeptide **7** *ref. to* loss of globular structure / hydrophobic amino acid faces outside (instead of towards centre) ; **A** described e.g. (val) amino acid with hydrophobic R-group instead of (glu) amino acid with hydrophilic R-group *accept hydrophilic / polar, amino acid* *accept hydrophobic / non polar, amino acid*	**4**
(d)	**8** sticky (haemoglobin) molecule formed / forms fibres with other haemoglobin molecules ; **9** oxygen taken up less easily / less oxygen carried by haemoglobin / AW ; **A** β-globin takes up oxygen less easily / AW **10** AVP ; (sickle cell) haemoglobin / β-globin, less soluble / AW **I** insoluble	

201. 9700_s19_ms_23 Q: 3

(a) *one mark each row* — **4**

cell structure	*V. cholerae*	epithelial cell from the human intestine
cell wall	✓	✗
cell surface membrane	✓	✓;
ribosomes	✓	✓;
large permanent vacuole	✗	✗;
organelles surrounded by a double membrane	✗	✓;

(b) — **5**

I better sanitation unqualified
I *ref. to* unclean water

any five from :

ref. to treat drinking water ;
A clean / sterilised / chlorinated / safe / bottled / boiled
A *ref. to* water treatment plants
provide sewage treatment plants ; **A** treat waste water / containment of sewage / provide latrines (in temporary camps) ;
ref. to keeping sewage and (drinking) water sources separate ;
A examples e.g. avoid swimming downstream of sewage outlets
avoid defaecating near rivers used for washing
water treatment plants upstream of sewage disposal
bury faeces

ref. to vaccination / providing vaccines ;

ref. to education in ways to prevent spread ;

ref. to (encourage) hand washing ;

ref. to food hygiene ; e.g. use of clean cooking utensils / covering food to prevent flies landing / washing food in treated water / cook food thoroughly / peel fruit and vegetable washed in (suspected) contaminated water

discourage use of human faeces for fertiliser / use fertiliser other than human faeces / do not irrigate plant food with contaminated water;
control breeding of, vectors / flies ;

rapid diagnosis ;
rapid treatment (for earlier recovery to minimise risk of spreading) ;
ref. to oral rehydration, salts / therapy ;
use of antibiotics ;
ref. to isolation / quarantine ;

(c)(i) — **2**

to, bind / attach / AW, HIV / virus / pathogen, to, host cell / T-lymphocyte / T-cell ;
(because it) binds / is complementary, to, CD4 receptor proteins / AW ;

ref. to binding leads to, entry of virus into cell / endocytosis / fusion of viral envelope with host cell (surface) membrane ;

(c)(ii) — **2**

ref. to less cytokine (released) ; *in context of fewer helper T-lymphocytes*

any one from:

(so) fewer B-lymphocytes divide by mitosis / AW ; **A** humoral response decreased

(so) fewer B -lymphocytes stimulated to differentiate into plasma cells / AW ;

(so) fewer plasma cells to, produce / secrete antibodies ;

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202. 9700_m18_ms_22 Q: 2

(a)(i)	bone marrow ;	**1**
(a)(ii)	*accept points from a diagram* *max **three** from:* 1 detection / recognition ; e.g. detects (named type of) pathogen recognises, (foreign) antigens / antibodies complexed to antigens has receptors (for antigens) 2 engulfs / envelops, pathogen / bacterium / AW ; **A** phagocytosis occurs **A** endocytosis occurs **A** pseudopodia form 3 forms, vacuole / vesicle / phagosome ; 4 ref. to lysosome fusion ; 5 ref. to hydrolytic / digestive, enzymes ; **A** named examples **A** hydrolases 6 ref. to antigen presentation ; 7 AVP ; e.g. (response is) non-specific / innate	**3**
(a)(iii)	*any **one** valid suggestion from:* produces inhibitors for / deactivates, lysosomal enzymes ; escapes out of phagosome ; forms resistant spore / is resistant to digestive enzymes ; AVP ; e.g. suggestion of macrophage malfunction	**1**
(b)	*any **three** from:* 1 production of mucus by, mucous glands / goblet cells ; 2 sticky / AW, mucus **or** mucus traps, pathogens / bacteria / microorganisms ; 3 mucus acts as a barrier (to prevent entry) ; 4 mucus increases distance to reach cells ; 5 cilia on ciliated epithelial cells ; **A** ciliated epithelium 6 cilia, waft / move, mucus / AW ; 7 *idea that* (contaminated) mucus is moved, away from alveoli / away from lung tissue / towards back of mouth / AW ;	**3**
(c)	*any **one** suggestion from:* blood / plasma / circulatory system ; lymph / lymph system ; within, neutrophils / macrophages / phagocytes ; **A** white blood cells / leucocytes	**1**
(d)	*any **one** from:* from infected, cows / cattle ; eating contaminated, meat / beef (from infected cattle) ; drinking, raw / unpasteurised, milk (from infected cows) ;	**1**

(e)	*any **two** from:* increases chances of, killing / AW, all bacteria ; **I** will kill all bacteria (unqualified) **A** will kill all bacteria if bacteria are, susceptible / not resistant if bacteria are resistant to one antibiotic, then still susceptible to other antibiotics / AW ; reduces chance of mutations arising / (if bacteria susceptible) mutations unlikely to occur against all antibiotics ; AVP ; e.g. antibiotic can be stopped because of side effects idea that more effective because different antibiotics will work on different targets (in the bacteria)	**2**
(f)	*any **two** from:* overall trend for both is increase ; rate of increase in cases of MDR-TB greater than rate of increase in cases of TB / AW / ora ; ref. to fluctuations / detail of fluctuations / periods of decrease ;	**2**
(g)	*any **three** from:* *overall increase in TB cases:* 1 ref. to problems with people living in, poorly ventilated accommodation / close proximity to each other / AW ; 2 vaccination programmes not able to prevent increase / herd immunity insufficient / AW ; *decrease / numbers fairly constant:* 3 ref. to (some) success of, prevention / treatment programme ; **A** described examples *increase in MDR-TB:* 4 people fail to finish course of treatment for normal TB / AW ; 5 ref. to ease of transmission of TB means easy to transmit *MDR-TB ;* *decrease in 2014 for MDR-TB:* 6 suggestion for decrease ; e.g. better, surveillance / cooperation, in completion of drug therapy more successful antibiotics used people better educated about preventing spread *for either increase in TB cases or increase in MDR-TB:* 7 qualified ref. to link between, HIV / HIV/AIDS, and TB ; 8 less money available for, longer drug treatment / vaccination, by, health authorities / governments ; 9 AVP ; e.g. balance between new cases and successfully treated cases means problem still exists in prevention ref. to changes in population size ref. to improvements in data collection ref. to immigration	**3**

203. 9700_s18_ms_21 Q: 5

(a)	*five from:* **A** 'cells' for 'lymphocytes' throughout 1 ref. to antigen presentation ; **A** macrophage presents antigen 2 recognition / binding (in context of B-, or T-lymphocytes) ; e.g. cell surface receptor specific to toxoid / clonal selection **A** immunoglobulin / antibody on surface of B-lymphocytes 3 T-lymphocytes or B-lymphocytes, divide by mitosis / clonal expansion ; 4 (some) plasma cells, formed / AW ; **R** if in context of T-lymphocytes 5 antibody molecules / antibodies, secreted / produced / released ; **R** if in context of T-lymphocytes 6 T helper cells secrete, cytokines / interleukins ; 7 ref. to action of cytokines / interleukins ; e.g. to stimulate, humoral response / B-lymphocytes / to stimulate macrophages / angry macrophages 8 formation of memory cells ; *only in context of B- / T-lymphocyte activation*	**5**
(b)(i)	*three from:* 1 failure to distinguish between self and non-self / AW ; 2 specific B-,lymphocytes / cells, are not destroyed (during development) ; 3 antibodies are produced against, cell surface / ACh, receptors on, muscle cell / neurones / nerve cells ; 4 antibodies, bind to / block, receptors ; **A** antibody–antigen, binding / complex *if receptors already given* 5 AVP ; any detail related to the disease e.g. (chemical) transmitter molecules / acetylcholine, cannot bind (to receptor) impulses are not transmitted across synapse / neurones cannot send impulses ref. to causing, muscle weakness / muscle fatigue ref. to neuromuscular junction does not function	**3**
(b)(ii)	*two from:* so immune response, occurs all the time / recurs ; (defective) B-lymphocytes still being produced / AW ; **I** T (helper) cells **A** not destroyed / remain plasma cells / B-lymphocytes, continue to release antibodies against receptors ; memory cells / immunological memory, present ; receptors are always present (on neurones / nerve cells) ; AVP ; e.g. no cure	**2**

204. 9700_s18_ms_22 Q: 3

(a)	**A** antibiotic for penicillin throughout *three from:* 1 (penicillin) weakens / AW, the cell wall ; **I** punches holes / holes made 2 (penicillin) acts, on growing cells / when cell wall being synthesised (during growth) ; 3 inhibits / binds to / AW, enzymes / transpeptidases (for cross linkage formation) ; **I** ref. to synthesis of peptidoglycan 4 prevents formation of cross, links / linkages (between, peptidoglycan / murein, molecules) / AW ; *suggestions why antibiotic is less effective on Gram negative* 5 outer membrane, prevents / interferes with / protects from / AW, entry (of penicillin) ; **A** idea of, more difficult / further, to reach peptidoglycan layer 6 proteins in outer membrane may pump out antibiotic ; **A** presence of efflux pumps 7 enzymes may be present (in periplasm) to degrade antibiotic / AW ; 8 suggestion that antibiotic cannot cross hydrophobic region of (outer) membrane ; 9 AVP ; e.g. proportionately, less / lower concentration of, penicillin reaches murein for, enzyme / transpeptidase, inhibition	**3**
(b)(i)	ATP not required ; **A** (metabolic) energy not required	**1**
(b)(ii)	*four from:* 1 channel protein ; **A** pore protein / has a pore / has a channel 2 channel / pore, can form from polypeptides **or** (protein) has quaternary structure ; 3 hydrophilic R-groups, on amino acids lining channel / face inwards (towards channel) ; **A** hydrophilic, lining / channel **A** water-filled, channel / AW **A** idea that passage is through hydrophilic region of protein 4 allows facilitated diffusion ; **A** diffusion alone if in context of through the protein but **R** if via phospholipid bilayer 5 increases permeability for, movement of water / osmosis ; **I** faster 6 no (specific) binding sites / (channel) not specific / not selective / allows more than one type of substance through / AW ; 7 globular ; 8 AVP ; e.g. ref. to hydrophobic part of protein, faces / interacts with, hydrophobic, region / core / fatty acid tails ref. to hydrophilic parts of, protein / polypeptide, extend into, external environment / periplasm / aqueous regions / AW	**4**

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(b)(iii)	*two from:* translation, cannot / does not, begin / occur **or** polypeptide / protein, synthesis, cannot occur / decreases ; **I** ompF not made **A** chain of amino acids **R** transcription does not occur so translation does not occur **R** if in context of mutation or enzyme inhibition mRNA cannot attach to, ribosome / small subunit / ribosomal subunit ; (first) tRNA (with UAC anticodon) / tRNA carrying met, cannot bind (to START codon) ;	**2**
(c)(i)	(composed of) many / chain of / polymer of / AW, monosaccharides / sugar monomers / sugar units ; **A** glucose, molecules / residues **A** more than two / many sugars further detail ; e.g. carbohydrate may be, branched / unbranched *in context of polysaccharide* macromolecule *in context of polysaccharide* glycosidic bonds *in context of between sugar monomers* (sugar monomers) joined by condensation reactions	**2**
(c)(ii)	*three from:* 1 <u>specificity</u> / <u>specific</u> (in correct context) ; 2 (B / T, -) lymphocytes have receptors complementary to antigen ; **A** immunoglobulins / antibody *as receptors for B-lymphocyte* **A** surface molecules *as receptors for T-lymphocytes* 3 (different) antigens, stimulate / activate / AW, (different) B-lymphocytes / T-lymphocytes ; **A** antigens stimulate an immune response 4 *idea that* different antibodies, synthesised / produced / AW, for different (O) antigens / O polysaccharides / lipopolysaccharides ; 5 memory cells will, not respond to different antigen / only respond to same antigen / AW ; 6 different O-antigens can, be composed of different sugars ; **A** can have different shapes	**3**

205. 9700_w17_ms_22 Q: 4

(a)	*two from* (loss of ions) increases / AW, water potential within cell **;** **ora, A** Ψ for water potential, **I** *ref. to* solutes / solute potential water moves out of cell, down water potential gradient / from high(er) to low(er) water potential **;** **R** from high to low water potential gradient (out) by <u>osmosis</u> / through the partially permeable membrane **;** **A** selectively permeable membrane **I** osmotic gradient	**2**
(b)	*four from* *capillary side sodium ions* 1 sodium ions out (of cell), by active transport / with use of ATP **;** **A** sodium ions pumped out 2 (so) lowers concentration of sodium ions within cell **or** sodium ion concentration gradient, set up / maintained **;** *intestinal lumen sodium ions and glucose* 3 sodium ions enter by facilitated diffusion **;** **A** diffusion / high to low concentration, through, SGLT1 / cotransporter **I** glucose enters by facilitated diffusion 4 glucose, cotransported with sodium ions into cell (through SGLT1) **;** **A** sodium ions cotransported with glucose **A** glucose enters by secondary active transport, **A** *idea of* glucose only able to enter if moving with sodium ions (i.e. sodium drives the process) 5 (cotransport means) glucose enters against concentration gradient **;** *capillary side glucose* 6 glucose out of cell (towards capillary) by <u>facilitated</u> diffusion **;** **A** by diffusion if stated through, membrane protein / GLUT2 *water uptake from lumen* 7 (higher concentrations of) sodium ions / glucose / solutes, within cell lowers water potential **;** 8 water follows, sodium ions / glucose / solutes (osmotically) **or** so water enters cell (down water potential gradient) **;** *must have idea that it follows inward movement of solutes*	**4**
(c)	*any one valid e.g.(if not stated artery or vein, assume vein)* high(er) pressure of artery (will not allow drip) **or** artery may be deeper to reach to insert needle for drip / easier to find vein **A** vein more, visible / superficial **or** greater risk / more complications / greater blood loss, associated with intra arterially AW	**1**
(d)	*one from* no / reduced, polypeptide / protein, synthesis **or** <u>mRNA</u> not translated / no translation / reduced translation **;** **A** detail of translation e.g. tRNA cannot bind **R** DNA not translated no / few, enzyme-catalysed reactions **;**	**1**
(e)(i)	*three from* 1 volume / AW, decreases over time for all groups **;** 2 *compared to no antibiotic* antibiotic groups, steep(er) / faster, decrease to, 32 / 48 hours **;** 3 *idea that* diarrhoea, stops / is 0 dm^3, at / after, 64 hours, for one dose 1 g / **A**, **or**, multiple dose / **C** **;** **A** recovers after 64 hours / AW 4 after 48 hours, one dose 2 g / **B**, fluctuation / decreases then (slight) increase then decrease / AW **;** 5 no antibiotic / **D**, higher volumes diarrhoea than antibiotics (to approx. 110h) **or** no antibiotic / one dose 2 g / **B**, took 128 hours (for diarrhoea) to, reach 0 dm^3 / stop **;** 6 multiple dose / **C**, higher volumes than, **A** (all readings) / **B** (to 48 hours) **ora or A** has steepest decrease *in context of 16–32 hours or overall*	**3**

<table>
<tr><td>(e)(ii)</td><td>alternative ways to refer to decrease in volumes of diarrhoea may be in terms of recovery, destroying bacteria, decreasing loss of glucose and salts

two from

support treatment
there is a difference between antibiotic and no antibiotic treatment or fast(er) decrease in volume of diarrhoea with antibiotics / AW or (generally) faster recovery with antibiotics ; I ref. to one dose 2 g

use of Fig. 4.3 to support ;
e.g.
use (1 dose) 1 g or multiple dose
time, to recover / reach 0 dm^3, is halved
use of numerical data from Fig. 4.3

does not support treatment
(in all cases) volume decreased to, same level / zero or all patients recovered ;

use of Fig. 4.3 to support ;
e.g.
by 128 hours all patients 0 dm^3
one dose of 2 g same trend from 112 hours as no antibiotic
one dose of 2 g patients relapse after 64 hours
one dose of 2 g took 128 hours (for recovery)

not able to say
limited information available / small number of patients ;

ref. to one dose of 2 g antibiotic ; e.g. does not reach 0 dm^3 until same time as no antibiotic
also see arguments above – allow once only here or for does not support</td><td>2</td></tr>
<tr><td>(f)</td><td>answer may be from point of view of single dose or multiple dose
allow AW – note mp 3 is for starting with susceptible bacteria and mp 4 is for starting with resistant bacteria

penalise once if use virus throughout
<table>
<tr><th></th><th>single dose</th><th>multiple dose</th><th></th></tr>
<tr><td>1</td><td>easier to be sure patient has taken complete dose</td><td>course may not be completed</td><td>;</td></tr>
<tr><td>2</td><td>if (bacteria are all susceptible and) treatment completed, all bacteria killed / no reservoir of bacteria</td><td>treatment may not be completed so some (susceptible) bacteria survive</td><td>;</td></tr>
<tr><td>3</td><td>(susceptible so) no bacteria survive to,
<u>mutate</u> / become resistant</td><td>(bacteria replicating so) increased chance of,
<u>mutation</u> / becoming resistant</td><td>;</td></tr>
<tr><td>4</td><td>idea that (if resistance is already present) single stronger dose has greater chance of killing resistant bacteria</td><td>weaker dose spread over time, resistant bacteria, more likely to survive / have less chance of being killed</td><td>;</td></tr>
<tr><td>5</td><td>(if all killed with single dose) idea that resistance not transferred (if all killed) e.g. no vertical / horizontal, transmission
this could be suggested as follow up to mp 2 / 4</td><td>if resistant / if develop resistance, this could be transferred
A vertical / horizontal, resistance</td><td>;</td></tr>
<tr><td>6</td><td colspan="2">AVP
e.g.
one dose may mean, no / less, antibiotic enters environment (in faeces)
(more effective so) bacteria passed out for shorter time, so reduces risk of transmission (of pathogen)
idea that multiple low dose antibiotics may increase mutagenesis
suggestion that if resistant and not killed by antibiotic, there may be less of an effect on (good) gut bacteria with single dose</td><td>;</td></tr>
</table></td><td>2</td></tr>
<tr><td>(g)</td><td>three from
1 ref. to different antigens (in context of, flagellum / whole cell / toxin) ; A ref. to epitopes instead of antigens

2 specificity ; in correct context (B-lymphocytes / plasma cells / antibodies /antigen binding sites)

3 detail of B-lymphocytes ; e.g. specific B-lymphocytes activated (by each different antigen) A clonal selection form plasma cells that release specific antibody, A B-lymphocytes release specific antibody

4 detail of antibody ; I ref. to receptor
e.g. antibody complementary (shape) to antigen, antigen binding sites on antibody, variable regions different for each antibody</td><td>3</td></tr>
<tr><td>(h)</td><td>passive natural / natural passive ;</td><td>1</td></tr>
</table>

206. 9700_w17_ms_23 Q: 3

(a)	(cell) thin / squamous / flat / pavement ; **R** cell wall **I** one cell thick short distance for, diffusion of (named) gases / gas exchange ; **A** diffusion between (air in) alveolus and (blood in) capillary	**2**
(b)	*two from* phosphate / 'heads', are, polar / hydrophilic **and**, fatty acids / hydrocarbon chains / 'tails', are, non-polar / hydrophobic ; **A** hydrophilic / polar, heads **and** hydrophobic tails tails, face away from fluid *or* water / project into air ; **A** diagram heads form hydrogen bonds with water ; *max 1 if answer is about a bilayer*	**2**
(c)	*three from* 1 prevention of infections (of, gas exchange system / named part) ; **A** in context of a named disease (TB, pneumonia, influenza) 2 prevent (named) pathogen entering, rest of body / blood ; *3 idea that macrophages* patrol / move around / AW, alveoli / lungs ; 4 (carry out) phagocytosis / endocytosis ; **A** are phagocytes 5 engulf / remove / destroy / kill / digest , pathogens ; 6 macrophages are, antigen presenting cells / APCs ; **A** description of antigen presentation **A** part of the immune system 7 AVP ; e.g. reduce excess surfactants **I** *ref. to* mucus	**3**
(d)(i)	*two from* breakdown / AW, elastin / elastic fibres / elastic tissue ; makes a pathway, to alveolus / through alveolar wall ***or*** goes through alveolar wall ***or*** to reach, respiratory tract / gas exchange surface / air space ; to reach, pathogens / site of infection, in alveoli / AW / implied ;	**2**
(d)(ii)	*three from* 1 no / less, inhibition of elastase ; 2 too much / more, elastin / AW, is broken down ; 3 *ref. to* lack of elastin so, no / less, recoil (during expiration) ; 4 alveoli, over expand / overstretch / increase in size ; 5 alveoli burst ;	**3 max**

207. 9700_s16_ms_21 Q: 2

(a) (i) phagocytosis / endocytosis **;** **R** pinocytosis **I** engulfing [1]

(ii) **E** transcription **;**
F translation **;** **A** post translation(al) modification [2]

(iii) **B** (phagocytic / endocytic) vacuole / phagosome **;** **A** vesicle
R incorrectly qualified vacuole or vesicle (e.g. permanent / large / secretory / Golgi / excretory)
I food / pathogenic
G (80S) ribosome **;** **A** rough endoplasmic reticulum **R** RER / rough ER
I 70S or any other type of incorrect S as a qualification
H Golgi (body / apparatus / complex) **;**
J mitochondrion **;** **A** mitochondria [4]

(b) **I** *fusion of lysosomes with phagosome and diffusion of products of digestion*

1 bacteria are, killed / destroyed / broken down / digested **;** **A** hydrolysed
A cell wall broken down
R bacteria are cut up
2 (by hydrolytic) enzymes **;**
3 any example, e.g. carbohydrase / lysozyme / protease / nuclease **;**
4 killed by, hydrogen peroxide / H_2O_2 / free radicals / AW **;**
5 AVP **;** e.g. correctly named substrate for enzyme
murein / peptidoglycan, polysaccharide(s), polypeptides, nucleic acids, lipids
e.g. correctly named bonds broken
glycosidic, peptide, ester, phosphodiester [max 3]

(c) **1** *idea that* only, a few / some / small number / AW, with correct specificity **;**
2 (different) T-lymphocytes are specific to different antigens **;**
3 (T cell) receptor is, complementary (in shape to antigen) **;**
4 AVP **;**
e.g. this may be during a primary immune response so no memory cells
e.g. disease state (HIV / AIDS and leukaemia) or treatment where few T-lymphocytes in the body [max 2]

[Total: 12]

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208. 9700_s15_ms_21 Q: 2

(a) (i) **X** – (ciliated) epithelium ;
Y – red blood cell / erythrocyte ; [2]

(ii) cilia beat to move mucus (up the bronchiole / towards the mouth / away from the lungs / AW) ;
mucus as a barrier to entry into (epithelial) cells ;
mucus traps, pathogens / bacteria / microbes ; *accept in context of goblet cells*
capillary / blood vessel, brings, phagocytes / macrophages (to engulf bacteria) ; [max 3]

(b) (i) **J** – phagocytosis / endocytosis / described in terms of engulfing *or* forming phagosome ; [1]

(ii) digestion of bacteria / described ;
to destroy bacteria / pathogen ; **A** to prevent spread through the body
antigen, presentation / display on cell surface ;
idea of selection of specific, B cells / T cells ;
A recognition / binding of / activation of, appropriate B / T cells [max 2]

(c) **1** faster ;
in context of whole secondary response

2 memory cells;
in context of production during the first response

3 *idea that* there are many more cells specific for this pathogen ;

4 (so) increases chances of encountering pathogens more quickly / AW ;
5 fast(er) production of, B lymphocytes / plasma cells / antibodies / helper (T) cells / cytotoxic T cells / cytokines ;
6 greater concentration of antibodies (in, blood / lymph) *or* greater numbers of, B / plasma, cells ;
A more, antibodies / plasma cells / B cells

7 pathogen, removed / killed, faster ;
8 person does not become ill / no symptoms ;
A pathogen does not, spread through the body / infect cells / AW [max 3]

(d) (i) little / no / slower / weak, immune response ;
stated function of T-lymphocytes, does not occur / occurs slowly ;
e.g. release of cytokines / stimulating macrophages / stimulating B cells / killing infected cells
high susceptibility to infectious diseases ;
R 'fighting disease' [max 1]

(ii) pathogen **not** recognised, as non-self / foreign ;
pathogen is recognised as self ; **A** non-foreign
ignore antigen concealment [max 1]

(iii) no, antibodies / plasma cells / memory (B) cells, produced ;
no humoral response ;
no antigen presentation by B cells ; [max 1]

[Total: 14]

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209. 9700_w15_ms_21 Q: 5

(a) Morbillivirus ; [1]

(b) *must have one ref. to either infected or uninfected to gain max*
aerosol, infection / route ; **A** droplet infection **I** *ref. to* contact
infected person, sneezes / coughs / talks / spits, to release airborne droplets;
inhaled by, uninfected / healthy, person ; [max 2]

(c) RNA nucleotides ;
contains uracil ; **A** no thymine
ribose (instead of deoxyribose) ;
no (double) helical structure ;
AVP ; e.g. small enough to pass through nuclear pores ; [max 2]

(d) cell has no enzyme for RNA replication ;
ref. to enzyme specificity ;
RNA polymerase (in cell) uses DNA template / not RNA template / AW ; [max 2]

(e) *ref. to* recognition and activation by presence of antigen (on APCs / infected cells) ;
T helper and T killer, lymphocytes / cells ; **A** T cytotoxic
T helper
secrete cytokines ;
(cytokines) stimulate / AW, (specific) B-lymphocytes ; **A** humoral response
stimulate / AW, macrophages / phagocytes / phagocytosis / T killer response ;
T killer
kill infected cells ;
detail of killing ; e.g. perforin / H_2O_2
punching 'holes' in membrane
ref. to T lymphocytes become memory cells (for secondary immune response) ; [max 5]

[Total: 12]

210. 9700_w15_ms_22 Q: 2

(a) **I** *ref. to* other components of tobacco smoke that enter bloodstream

1 contains carbon monoxide and nicotine (which contribute) **;**
R if tar also stated

contribution to atherosclerosis
2 damage to / AW, endothelium / (inner) lining / tunica intima / inner wall **;**
A also as consequence of increased blood pressure *mp8*
3 increased accumulation of LDLs **;** AW *in context of the vessel walls*
A cholesterol / lipids / lipoproteins / fats / triglycerides
4 inflammation **;**
5 more / arrival of / attraction of, phagocytes / macrophages / monocytes / neutrophils **;**
A leucocytes / white blood cells
A phagocytes, have increased adherence / 'stick' more, to lining
6 phagocytes engulf, LDLs / AW, and die (in situe)
or
formation of / presence, foam cells **;**
7 (contributes to) formation of, atheroma / atheromatous plaque **;** **A** plaque
I atherosclerosis

features that may have a consequential effect
8 one risk factor (caused by components of smoke) **;**
one from:
increased blood pressure *must be in context e.g. adrenalin release owing to nicotine* **I** atheroma increases blood pressure
increased stickiness of platelets (promotes clotting)
thrombus formation / thrombosis / (blood) clotting
increased, (serum) cholesterol / triglyceride / LDL, concentration
decreased, HDL / 'good' cholesterol, concentration
increased, oxidation / reactivity / AW, of LDLs [max 3]

(b) **(i)** phagocytosis **;** **A** act as phagocytes

engulf / attack / destroy / AW, pathogens / bacteria / microorganisms **;**
A viruses
A act as, antigen presenting cells / APCs
I antigens / foreign organisms / organisms

remove / engulf / AW, foreign substances / dead cells / cell debris / AW **;** [max 1]

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(ii) *following inhalation* **I** *ref. to* contract / relax

1 alveoli / air sacs / lungs, over expand / over inflate / over stretch / AW ;

2 (alveoli have) no / poor, recoil ; **A** do not, rebound
A lungs do not, recoil / deflate properly

3 (alveoli / lungs) cannot return to normal size / remain, (fully) stretched ;
A do not, decrease in size after, stretching / inhalation / AW

4 alveoli / air sacs, do not push out air (effectively) / have trapped air / AW ;
I oxygen trapped [max 2]

(c) (i) biological catalyst / described ;
e.g. biological molecule / protein that, increases the rate of / catalyses
speeds up, a reaction
molecule that, increases the rate of / speeds up / catalyses, metabolic / biological / cell(ular) reaction

one of:
globular protein ;
remains unchanged (at end of reaction) / not used up (in reaction) ;
lowers the activation energy (of a reaction) ; [max 2]

(ii) *points can be gained from diagrams if not contradicted in written answer*

1 (shape of) substrate / elastin, complementary to (shape of) active site ;
R matching / same
A description e.g. substrate fits (into) active site
diagram – label active site + substrate (shapes must be complementary)

2 lock is, enzyme / elastase / active site, and key is, substrate / elastin ;

3 formation of, enzyme-substrate complex / ES complex / ESC ;
A successful collision between enzyme and substrate
A substrate, binds / AW, at / to, the active site
diagram – ESC no label required if following on from mp1

4 peptide fragments / peptides / products, released / formed ; **A** amino acids
diagram – allow without label if sequence clear and products shown

following points need to be annotated if shown on diagram

5 hydrogen / temporary, bonds form between, enzyme / active site, and substrate ;

6 detail of how Ea lowered ; *term Ea not required and points can be general*
strain on (peptide) bond
electron transfers
reactants held close for bond forming (i.e. water joining) [max 3]

(d) (i) **I** active site of A1AT changes shape / acts as non-competitive inhibitor
R if <u>macrophage</u> elastase stated

cannot bind / not complementary, to active site **;** **A** elastase / enzyme
H / temporary, bonds cannot form with active site **;**
no longer, prevents entry / binding, of substrate **;** **A** (so) substrate can bind [max 1]

(ii) *consequence must be correctly linked to an event*

1 <u>neutrophil</u> elastase, active / not inhibited / AW **;** **A** increase rate of reaction
2 (so) TIMP-1 inactivated **;** **A** other / macrophage elastase, inhibitor
3 (so) <u>macrophage</u> elastase, active / functioning / not inhibited / not regulated **;**
4 (so) more, macrophage <u>and</u> neutrophil / of both elastases, (to breakdown elastin) **;**
5 *ref. to* consequence **;** e.g. bursting alveoli / breakdown of alveolar walls / formation one large air sac / decrease in surface area for gas exchange [max 3]

(e) 1 mRNA, binds / AW, to ribosome **;** **A** ribosomal RNA **I** rRNA
A mRNA moves to ribosome
2 tRNA with amino acid (to / at, ribosome) **;** **A** aminoacyl / charged, tRNA
3 tRNA / anticodon, specific to an amino acid **;** **A** specific tRNA / anticodon for the amino acid
4 *ref. to* start codon; **A** $AUG^{(met)}$ / first codon is AUG / initiator tRNA **;**
5 (complementary) base pairing / binding, between anticodon and codon **;**
6 first and second tRNAs bind / two tRNAs bound (at a time)
or (tRNAs bring) amino acids, side by side / close **;**
7 peptide bond formation **;**
8 ribosome moves along, one codon / AW **;**
9 next (aminoacyl) tRNA arrives / amino acids added one at a time **;**
10 elastase / polypeptide, released when STOP codon reached **;**
A process continues until a STOP codon reached
11 AVP **;** e.g. *ref. to*, aminoacyl / A, site, <u>and</u>, peptidyl / P, site
<u>small</u> subunit (of ribosome) attaches to mRNA
aminoacyl tRNA synthetase binds amino acid to tRNA
ATP required for tRNA-amino acid binding
peptidyl transferase for peptide bond formation
ref. to, exit / E, site, on ribosome ribosome moves 5' to 3' [max 5]

[Total: 20]

211. 9700_w15_ms_22 Q: 4

(a) *ignore descriptions or further qualification*
no marks for each box if other mechanisms given

active transport **;** **A** active uptake
exocytosis **;** **I** bulk transport / secretion
diffusion **;** **I** passive / simple **R** facilitated diffusion [3]

(b) **I** *ref. to* small increase in partial pressure causes more oxygen to associate
A pp / pressure, for partial pressures

1 this is the range of (partial) pressures occurring in respiring tissues **;**
A (partial) pressures in respiring tissues are low
2 (for a) small / 1.6 kPa, decrease in partial pressure **;**
3 (so) allows, large quantity of / more, oxygen to, be released / dissociate **;**
A oxygen dissociates more, easily / readily
4 affinity of haemoglobin to oxygen decreases **;**
in context of, as oxygen is released / as partial pressure decreases
5 data to support **;** e.g. 60–62% to 28–30% / 30–32% difference [max 2]

[Total: 5]

212. 9700_m20_ms_22 Q: 5

(a)	**A** ref. to receptors (at neuromuscular junctions) for self-antigens *any **two** from:* 1 autoimmune disease ; 2 failure to distinguish self and non-self (antigens) ; **A** foreign for non-self 3 immune response / antibodies produced, against self-antigens ; 4 binding of (specific) antibody to self-antigen (on the external cell surface membranes of muscle cells) ; 5 faulty / AW, lymphocytes not destroyed ;	**2**
(b)	human immunodeficiency virus ;	**1**
(c)	*any **three** from:* *if T_h cell number is low:* 1 low T_h cells means increased risk of developing an infectious disease ; 2 low levels / less, cytokine, secreted / AW ; *role of cytokine:* 3 stimulates activity of macrophages / produces angry macrophages ; 4 stimulates, B-lymphocytes / plasma cells / humoral, response ; **A** activate B-lymphocytes 5 (so lower concentrations / less / no), antibody, produced / secreted ; 6 stimulates, T-cytotoxic / T-killer, cells ; 7 (so) fewer infected cells killed ; 8 more time for pathogens to, reproduce / spread ; 9 fewer memory cells (to fight future infection) ;	**3**
(d)(i)	*any **three** from:* *receiving treatment (max 2):* 1 percentage of people living with HIV receiving treatment increases ; 2 low rate of increase between 2000 and, 2003 / 2004 ; 3 data to support ; e.g. 3% / 4%, in 2000–2003, 45% in 2015 *deaths:* 4 increase in HIV / AIDS-related deaths to, 2004 / 2005, then decrease ; **A** peak in 2004 / 2005 5 data to support ; e.g. *two of:* start at 1.5 million, peak at 2 million, end at 1.2 million (2 of these)	**3**
(d)(ii)	*any **two** from:* 1 lack of trained personnel to deliver treatment ; 2 some people unwilling to take treatment ; 3 isolated areas / difficulty getting treatment to people ; 4 inability to, supply / produce, enough drugs ; 5 not all people living with HIV, know their status / have been diagnosed ; 6 AVP ;	**2**

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213. 9700_s20_ms_21 Q: 5

(a)(i)	*Mycobacterium tuberculosis* or *Mycobacterium bovis* ;	1
(a)(ii)	*max1 if no reference to, infected / uninfected* airborne droplets, breathed / sneezed / AW, out by infected person ; breathed in / inhaled / inspired, by uninfected person ; **or** *in context of M. bovis only* contaminated meat / unpasteurised milk, from infected, cattle / cows ; ingested by uninfected person ;	2
(b)	*max 4 if no ref. to, (mature) B-lymphocytes / plasma cells, producing / secreting, antibodies* *any five from:* *ref. to* fusion of lysosomes releasing hydrolytic enzymes ; intracellular digestion / described ; e.g. hydrolysis of, (named) cell wall components / proteins / nucleic acids / lipids *ref. to* processing antigens to present on, cell surface membrane / cell surface ; **A** macrophage becomes an, antigen presenting cell / APC ; antigen, recognition / binding, by, B-lymphocytes / T-lymphocytes ; detail ; e.g. clonal selection / have receptors complementary to antigen / specificity of, B-lymphocytes /T- lymphocytes to (non-self) antigen ; **A** immunoglobulin / antibody as receptor for B-lymphocytes clonal, expansion / proliferation ; **A** described e.g. divides by mitosis to form a clone of cells B-lymphocytes, mature to / form, plasma cells that secrete antibodies ; T-helper cells release cytokines ; Cytokine action ; e.g. stimulates, humoral / B-lymphocyte, response	5
(c)	*any three from:* long-term immunity ; B and T memory cells remain in the body for, a long time / a lifetime ; memory cells for secondary (immune) response ; secondary response is faster / more effective (than primary immune response) ; (so) higher concentration antibodies / quicker production antibodies ; *Idea of* more (specific) memory cells in the body than (specific) lymphocytes before primary response ; increase chance that pathogen encountered more rapidly (to mount a response) ; AVP ; e.g. pathogen destroyed before symptoms of illness are caused	3
(d)	*any three from:* *Mycobacterium* / TB bacterium, is an intracellular parasite / lives inside host cells ; antibodies have no effect on bacteria inside cells ; only when bacteria are in the, plasma / tissue fluid ; *idea that* vaccination is not a global occurrence ; e.g. not part of vaccination programme in many countries only some countries have as part of their vaccination programme BCG is not very effective (for adults) / some people do not respond to BCG ; BCG does not have the same effectiveness across the world ; many countries, have no herd immunity / do have enough people that are immune, to prevent spread ; ref. *to* civil disturbance / AW, collapse of health services ; AVP ; *idea that* travellers / tourists / immigrants / displaced people, may be infected with TB and transmit it to host population (that does not have, a vaccination programme / herd immunity)	3

214. 9700_s20_ms_22 Q: 3

<table>
<tr><td>(a)</td><td>Mycobacterium tuberculosis ; A Mycobacterium bovis</td><td>1</td></tr>
<tr><td>(b)</td><td>any one from
live in an area that has cases of TB ;
recently returned from countries with TB ;
born in a country with TB ;
parents / grandparents whose origin country has TB ;
contact with a person who has TB ;
AVP ; e.g. ref. to compromised immune system
mother who is HIV-positive</td><td>1</td></tr>
<tr><td>(c)</td><td>any three from
decrease in incidence over time for all groups
or
decrease in incidence over time for low, lower middle, upper middle and plateau for high income group ;

one example of, large / AW, differences in incidence ;
e.g. between, upper middle income and, low / lower middle
between high income and, low / lower middle / low and lower middle ;
between upper middle and high ;

decrease in incidence with income group increase (for each year), generally / overall / except for 2015 / 2016 low to lower middle ;

low and lower middle similar incidence ;

data / manipulated data, to support any of above points ;</td><td>3</td></tr>
<tr><td>(d)</td><td>any two from
max 1 if no ref. to antigens
leprosy bacterium has similar (shaped) antigens ;
memory cells, recognise / bind, antigens on leprosy bacterium ;
anti-TB antibodies also bind to leprosy antigens ;
AVP ; e.g. similar / same, genes so synthesise similar proteins</td><td>2</td></tr>
<tr><td>(e)</td><td>any three from
<table><tr><th>artificial active</th><th>natural passive</th></tr><tr><td>deliberate / AW
A from medical staff</td><td>or not deliberate / from mother / in breast milk / across placenta ;</td></tr><tr><td>vaccine / (foreign) antigens in injection</td><td>or antibodies passed on ;</td></tr><tr><td>immune response</td><td>or no immune response ;</td></tr><tr><td>antibodies / memory cells produced</td><td>or no, antibodies / memory cells produced ;</td></tr><tr><td>longer lasting</td><td>or short-lived ;</td></tr><tr><td>protection not immediate</td><td>or immediate protection ;</td></tr></table></td><td>3</td></tr>
</table>

215. 9700_s20_ms_23 Q: 2

(a)	*allow mosquito for Anopheles throughout* *allow pathogen for Plasmodium throughout* *any three from* role of *Anopheles* in transmission cycle ; e.g. *Anopheles* is, a vector of *Plasmodium* / *Anopheles* passes *Plasmodium* from infected person to uninfected person *insecticide on nets and on surfaces* kills *Anopheles* before it can take blood from an infected person ; kills *Anopheles* before it can transfer blood with *Plasmodium* to uninfected person ; *presence of nets* protect people, when sleeping / at time when *Anopheles* is, active / feeding ; *general* prevent *Plasmodium* from completing its life cycle ; AW AVP ; *idea of* reducing population size of mosquitoes use of different insecticides on net and IRS to avoid insecticide resistance	**3**
(b)(i)	*any one from* increase in the use of ITN over time ; decrease in the use of IRS only ; proportion of population protected by ITN only has increased ;	**1**
(b)(ii)	*any one from* increase is not steep enough, to make a large enough difference / so disease will still be able to spread ; a large proportion of the population is still at risk, so people will still contract the disease ; **A** figures from Fig. 2.1 WHO targets may not be met, so hindering progress in the fight against malaria ; AW AVP ; e.g. suggests that the, provision of / distribution of / access to, ITN is not adequate ;	**1**
(b)(iii)	*any one suggestion from* ITN more effective in control than IRS ; more cost effective to provide ITN ; lack of personnel to carry out work required for IRS ; *ref. to* insecticide on net may be more effective at killing ; AVP ; e.g. outside agencies / AW, provide ITN but do not help with IRS	**1**
(c)	*any three from* higher concentration of antibodies ; faster production of antibodies ; because of presence of memory, B-lymphocytes / B cells ; higher numbers of specific B-lymphocytes, so increased chance of faster recognition / because of clonal expansion in first response ; AVP ; e.g. also more memory T-cells to stimulate B-lymphocyte response *ref. to* higher concentration antibodies in circulation remaining after recovery	**3**
(d)	*any two from* result of an autoimmune disease / AW ; antibodies produced against, self-antigens / antigens on body cells *or* antibodies bind to self-antigens / antigens on (own) body cells ; detail ; e.g. prevents functioning of muscle cells binds to receptors on muscle cells	**2**

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(a)(i)	*any **three** from:* **I** heterochromatin / euchromatin envelope / two membranes / double membrane / inner and outer membrane ; nuclear pores ; **A** pores in nuclear envelope *for two marks* (outer surface of) outer membrane with ribosomes ; *ref. to* (outer nuclear) membrane continuous with RER ; **R** inner membrane AVP ; e.g. perinuclear space **A** intermembranous space pore complexes	**3**
(a)(ii)	*any **two** from:* resolution / resolving power, is, low / lower / poor / AW / 200 nm / 0.2 μm ; (**A** range 100–300 nm) **A** electron microscope has a higher resolution further detail ; e.g. ribosomes / ER, smaller than 200 nm can only see cell structures greater than (limit of) resolution cannot see structures smaller than 200 nm cell structures too small for the resolution (*needs ref. to resolution)* cell structures, too small to / do not, interfere with light waves ; AW	**2**
(b)	if letter used in more than one row, **R** these rows correct interphase knowledge G2 = **A**, S = **B**, G1= **blank** ; *cytokinesis* **blank** ; *prophase* **C** ; *anaphase* **E** ; *telophase* **D** ;	**5**
(c)	*any **three** from:* *large numbers of B-lymphocytes / plasma cells (in primary immune response)* **1** large quantity of (specific) antibody, produced / released **or** (large quantity of) antibody to form antibody-antigen complexes / to bind antigen (for phagocytosis) / AW ; *large numbers of memory B-lymphocytes so* **2** provide long term immunity / memory cells long-lived / provides immunological memory ; **A** remain in, circulation (for a long time) AW **3** able to produce fast(er), secondary (immune) response ; **A** second response will be fast(er) **A** immune response faster on second encounter (with antigen / pathogen) / AW **4** higher concentration / faster production, of antibodies (than primary response) ; **I** 'more' alone **5** person does not have, symptoms / become ill (of / from, same disease) ; **A** presence of same, pathogen / antigen, does not cause disease **6** AVP ; memory cells can (divide to) produce plasma cells more plasma cells present than primary response able to form more memory cells	**3**

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(d)	*any* ***two*** *from:* immune response / antibodies produced, against, self antigens ; **I** immune system attacks self **A** autoimmunity / autoimmune disease *idea that* faulty B-lymphocytes not destroyed ; **A** *ref. to* T-lymphocytes *if in correct context* (specific) antibody, binds to / acts on / AW, self-antigen / receptor, on the (cell surface membranes of) muscle cells / at neuromuscular junction ; **A** antibody binds to acetylcholine receptors *ref. to* consequence to muscle cells ; e.g.(nerve) impulse conduction impaired action of transmitter substance hindered	**2**

217. 9700_m19_ms_22 Q: 3

(a)(i)	***accept*** *ora throughout* *any* ***four*** *from:* *(case) incidence:* 1 only Lao PDR increase in (case) incidence / AW ; 2 Papua New Guinea has greatest reduction ; 3 numerical data extracted from Fig. 3.1 to support ; *mortality (rate):* 4 all countries have a reduction ; 5 Cambodia greatest reduction **A** Cambodia **and** Lao PDR **or** Solomon Islands least reduction ; 6 numerical data extracted from Fig. 3.1 to support ;	**4**
(a)(ii)	*any* ***two*** *from:* nets prevent entry of, mosquito / *Anopheles* ; **A** in context of covering containers with water insecticide, kills / reduces number of, mosquitoes / *Anopheles* ; (female) mosquito / *Anopheles*, is vector / transmits parasite / AW ; feeds / takes blood meal, (mainly) at night / when people sleeping ; (helps to) break the transmission cycle ;	**2**
(b)(i)	*any* ***two*** *from:* 1 testing for the presence of different, antigens / (*Plasmodium*) proteins ; 2 antibodies are, specific / have specific shape ; **A** ref. to complementarity 3 different monoclonal antibodies have, different, variable regions / antigen binding sites ; 4 (pLDH / HRP-2 / *Plasmodium*) protein, binds to / complexes with, (monoclonal) antibody ;	**2**
(b)(ii)	*any* ***two*** *from:* (positive result of test strip 1) pLDH present, (so) the person, has malaria / is infected by *Plasmodium* ; **I** species names (negative result of test strip 2) HRP-2 not present, (so) the cause of malaria is not / the person is not infected by, *P. falciparum* ; (negative result of test strip 2) HRP-2 not present, (so) the person is infected by *Plasmodium* other than *P. falciparum* / AW ;	**2**

218. 9700_s19_ms_21 Q: 1

(a)	*any three from:* *secondary structure* **I** α-helix **1** (many) β-pleated / beta-pleated, sheets ; **R** 'B' **2** random structure / irregular structures / loops / beta turns / AW ; *tertiary structure* **3** folding / coiling, of, (each) polypeptide chain(s) / secondary structure ; **R** *idea of* polypeptide chains interacting (quaternary structure) **4** *ref. to* globular **A** description, e.g. spherical **I** circular / round **or** *ref. to* 3D, shape / structure ; **A** 3D arrangement	**3**
(b)(i)	**X –** site of synthesis of, (light and heavy) polypeptides ; **A** protein(s) **A** transport / modification, of, polypeptides / proteins **A** assembly of polypeptides / translation **R** answers that name the Golgi body **Y –** production of ATP ; **R** 'produce / create / AW, energy' **A** release of energy / provide energy	**2**
(b)(ii)	cell / membrane, fusion / AW ; **I** 'mix' (named) fusogen / hybridogen used ; e.g. polyethylene glycol / electrofusion / electric current **A** PEG for polyethylene glycol (between) plasma cell / (activated) B-lymphocyte / (activated) B-cell / splenocyte, **and**, tumour / cancer / myeloma, cell ; **R** β cells	**3**
(b)(iii)	*any three from:* **1** some mAbs act **directly** on target cells / some mAbs work **indirectly** to kill cells / mAbs do not damage other (non-target) cells ; **2** by binding to, specific / complementary, antigens/cell surface receptors ; **3** (named), drugs / radioactive isotopes, can be attached to mAbs ; **A** 'tagged' **I** labelled **4** enzymes can be attached to mAbs ; **5** so drug can be activated at site of action (linked to mp4) ; **6** bispecific mAbs attach two cells together ; **7** *ref. to* interrupting cell signalling ; **8** use of mAbs for passive immunity ; **A** described *in context of therapeutic antibody for treatment of disease* **9** stimulating / AW, immune system / phagocytes / macrophages / T-lymphocyes, to kill, cancer cells ; **10** name of a cancer or autoimmune disease that is treated with mAbs ;	**3**

219. 9700_w19_ms_21 Q: 2

<table>
<tr><td>(a)(i)</td><td>Mycobacterium tuberculosis
or
Mycobacterium bovis ;</td><td>1</td></tr>
<tr><td>(a)(ii)</td><td><table><tr><td>artificial active immunity</td><td>✓ ;</td></tr><tr><td>artificial passive immunity</td><td></td></tr><tr><td>natural active immunity</td><td></td></tr><tr><td>natural passive immunity</td><td></td></tr></table></td><td>1</td></tr>
<tr><td>(b)(i)</td><td>three from
changes the tertiary structure / shape of active site, of , enzyme / RNA polymerase ;
active site no longer complementary to, RNA nucleotides / substrate ; AW
RNA nucleotides not joined / mRNA not synthesised ; A transcription does not occur
translation prevented ; A described, I polypeptide / protein synthesis prevented
AVP ; ref. to other roles of RNA polymerase not occurring, e.g. does not bind to DNA, double helix does not unwind</td><td>3</td></tr>
<tr><td>b(ii)</td><td>two from
(from 2009 to 2013) overall increase in number of cases (of RR-TB and MDR-TB) ;
use of data to support overall trend ;
ref. to large increase between 2011 and 2012 / 2013
or
very little change between 2010 and 2011 ;</td><td>2</td></tr>
<tr><td>(b)(iii)</td><td>four from
overuse of, antibiotics / rifampicin
or
example of over use ; e.g. taking for viral infection, over prescribing for bacterial infection

people not completing course of antibiotics ;
reservoir of bacteria remains ;
ref. to mutation ;
any detail of the mutation ; e.g. protein produced has a changed binding site

bacteria with resistance, survive / selected for
or
only bacteria sensitive to antibiotic are, killed / selected against ; A antibiotic acts as a selection pressure

bacteria reproduce and pass on, gene / allele, for resistance to offspring
or
vertical (gene) transmission ;

(alleles for resistance to antibiotics transferred by) horizontal (gene) transmission / described ;
frequency of resistance, gene / allele, increases in the bacterial population ;</td><td>4</td></tr>
</table>

220. 9700_w19_ms_21 Q: 4

(a)	**A** neutrophil ; **A** polymorphonuclear, leucocyte / granulocyte **B** lymphocyte ;	**2**
(b)(i)	<table><tr><th>substance</th><th>concentration in lymph compared to the concentration in blood</th></tr><tr><td>oxygen</td><td>lower</td></tr><tr><td>carbon dioxide</td><td>higher</td></tr><tr><td>red blood cells</td><td>lower</td></tr></table> three rows correct = 2 marks one row or two rows correct = 1 mark	**2**
(b)(ii)	*two from* immune response occurs (linked to antibody / cytokine production) ; increased concentration / production of / AW, of antibodies (which are protein) ; AVP ; e.g. cytokine production	**2**
(c)(i)	*two from* emits, impulses / waves of depolarisation / waves of excitation / AW ; at regular intervals / AW ; e.g. acts as a pacemaker spreads across the, atria / atrial muscles / AW **or** stimulates / AW, atrial, contraction / systole ; **A** initiates, heart beat / contraction of the heart	**2**
(c)(ii)	*three from* faster heart rate / increased rate of contraction (of ventricles) ; no, slowing / delay of, impulse / wave of excitation / AW, by AVN ; more impulses reaching the ventricle per unit time ; ventricles may contract before they are full ; irregular heart rate ; AVP ; e.g. may have no effect if only a small proportion of impulses pass through suggestion that ventricles may not contract from apex up	**3**

221. 9700_w19_ms_21 Q: 5

(a)	*two from* *ref.to* non-self / foreign (antigen) ; ***one** from* activation / AW, of lymphocytes ; *ref. to* specificity ; *ref. to* immunological memory ;	**2**
(b)(i)	*three from* (B-) lymphocytes respond / immune response, to self antigens (on muscle cell surface) / antibody produced by, B-lymphocytes / plasma cells ; **A** failure to distinguish between self and non-self antibody binds to receptor ; antibody has complementary shape to receptor ; **A** idea of specificity cell signalling molecule / neurotransmitter / AW, unable to bind to receptor ; reactions / AW, within cells, not triggered / described ;	**3**
(b)(ii)	*three from* active site of enzyme **Y** is, not (fully) complementary / partially complementary ; active site, moulds to fit / becomes fully complementary to, cell signalling molecule ; enzyme-substrate complex forms ; **A** ESC forms *ref. to* interaction between substrate and R groups of enzyme amino acids ; lowers activation energy ; products leave the active site ; enzyme molecule unchanged / able to be re-used ; AVP ; e.g. detail of how activation energy is lowered	**4**
(c)	*three from* **I** *statements about locating or diagnosis of disease* specific / targeted, therapy / treatment ; AW **A** only affects, one cell type in the body / B lymphocytes bind to / recognition of, receptors / antigens / CD20, on cell surface (of diseased cells) ; **A** in context of B lymphocytes or diseased cells monoclonal antibodies, are not recognised as foreign / do not trigger an immune response ; **A** *ref. to* humanisation of antibodies example of presence of monoclonal antibody stimulating the immune system / AW ; *in context of examples given* **A** stimulates phagocytosis / activates B-cells attach, radioactive substance / drug (to treat / kill, B lymphocytes / diseased cells) ; *must be in context*	**3**

222. 9700_w19_ms_22 Q: 5

(a)	**1** prevents formation of, cross links / cross linkages (between, peptidoglycan / murein, chains) **;** **A** peptide cross links **A** links between, murein / polymer, chains **I** peptide bonds **I** formation of peptidoglycan **R** if cellulose chains stated **2** (penicillin) inhibits, transpeptidase action / enzyme involved in forming cross links **;** **A** alternative correct names for transpeptidase **3** weakens cell wall **;** **A** cell wall unable to withstand (turgor) pressure **A** cell wall loses strength **R** idea that penicillin, punches / makes, holes, to weaken **4** (cell), lysis / bursts / ruptures / AW (so bacterium killed) **;** **5** acts, on growing bacteria / when bacteria are increasing in size (when cell wall needs to be synthesised) **;** **I** growing, wall / peptidoglycan chains	**3**
(b)	*(Plasmodium / P.), ovale / falciparum / malariae / vivax ; correct spelling* **I** *if Plasmodium is written after the species name* *if more than one given, all must be correct*	**1**
(c)	*any one valid suggestion:* male does not, need protein for egg production / produce eggs **;** **R** larvae **I** male does not reproduce male does not have mouthparts for piercing skin **;** AW e.g. no 'needle' to pierce skin (to suck blood) adult male does not feed **;** adult male feeds (only) on, plants / nectar **;** blood is toxic to males **;** can't detect presence of, humans / mammals **;** male does not produce anticoagulant (for blood) **;**	**1**

(d)	*accept mosquito or vector for Anopheles* *accept, pathogen / parasite, for Plasmodium* *max 2* **1** *idea that* individuals / people, taking antibiotics for bacterial diseases will pass on antibiotics to *Anopheles* when it feeds **;** e.g. blood taken by *Anopheles* contains antibiotics **2** (so) antibiotics kill bacteria (in *Anopheles* gut) **;** *must be in context of gut bacteria* **3** decreased / no, competition between, *Plasmodium* and (gut) bacteria (so more *Plasmodium* survives) **;** **4** higher survival of *Plasmodium* makes effective (*Anopheles*) immune response more difficult **;** AW *(so Anopheles more likely to pass on Plasmodium)* *max 2* **I** ref. to antibiotic resistance **5** use of antibiotics may increase, incidence / number of cases of, malaria **;** **6** and **7** *two marks for* examples of what doctors need to consider **;** e.g. need to balance antibiotic intake with increased risk of malaria transmission *idea that* do not want to stop people taking antibiotics / antibiotics needed to fight (bacterial) infections treat for malaria before giving antibiotics for (non-serious / non-life threatening) bacterial infections only prescribe antibiotics that have, no / low, impact on bacteria in *Anopheles* (gut) (consider) avoiding use of antibiotics to treat malaria **8** AVP **;** e.g. need to research which antibiotics have this effect look for alternatives to antibiotics to treat bacterial infections	**3**

(e)	*any four from:* **1** (*Plasmodium*) is a, eukaryote / protoctist, so has many antigens ; **R** bacterium / virus, is a eukaryote **or** (*Plasmodium*) has many genes coding for (different) antigens ; **I** antigenic variation **2** *idea that* different *Plasmodium* species have different antigens ; **I** antigenic variation **I** strains *for species* **3** (*Plasmodium*) has different stages of life cycle (within human) with different antigens / shows antigenic variation ; **4** antigenic concealment / *Plasmodium* spends part of life cycle within host cells / AW ; **A** short time in blood plasma **A** spends time inside, red blood cells / liver cells **5** need to find the antigens that give the strongest immune response ; **6** need to, develop / use, more than one type of vaccine ; **A** cannot use only one type of vaccine **7** AVP ; e.g. mutations will give changed antigens need to find antigens present in, all / most, stages of life cycle *difficulties in producing a generic vaccine max 2* **8** costly to produce / need to keep costs low / developing countries need to be able to afford vaccine ; **9** needs to have a long shelf life / be stable / be easily stored (e.g. without cold storage) / AW ; **10** (immunity) needs to be long-lasting / aim to avoid boosters / need to develop a single dose vaccine ; AW	**4**

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223. 9700_w19_ms_23 Q: 5

(a)	*two from* protein coat / capsid / capsomeres ; nucleic acid / DNA or RNA (core) ; **I** single- or double-stranded **A** 'DNA/RNA' **I** genetic material size given in nanometres / smaller than prokaryotes ; **I** small / very small / microscopic **I** acellular	**2**
(b)	*three from* **1** drugs can be inhibitors (of neuraminidase) ; *either* **2** (competitive inhibitor) so binds to active site *or* (non-competitive inhibitor) so binds to allosteric site / AW *or* (drugs may act by) breaking down / hydrolysing / denaturing, all / part of neuraminidase ; **A** changes active site **3** no / less, enzyme-substrate complexes formed ; **A** ESC **A** substrate not able to bind to enzyme **A** neuraminidase cannot bind to (host cell) receptor **4** receptor is (still) complementary to haemagglutinin ; **5** haemagglutinin becomes attached to, cell receptor / host cell (so newly formed virus does not leave the cells) ;	**3**
(c)	*four from* **1** antigen presentation ; *in correct context* **2** clonal selection / activation, of specific, B-lymphocytes / T-lymphocytes ; **A** B cells / T cells **3** (lymphocytes) divide by mitosis / undergo clonal expansion ; **4** B-lymphocytes, differentiate into / mature into / form / AW, plasma cells ; **5** antibodies secreted by plasma cells ; **6** T-helper cells secrete cytokines ; **7** cytokines stimulate / AW, B-lymphocytes / plasma cells / humoral response ;	**4**
(d)(i)	*max 2 (out of total three marks)* *advantages* *allow references to other pathogen types* **1** antibodies are provided to people immediately / no delay for plasma cells to secrete antibodies ; **A** immediate, immunity / protection **R** immediate (immune) response **2** antibodies, immediately neutralise toxins / prevent viruses entering cells ; **3** prevents disease (in the individual) / promotes quicker recovery ; **4** prevents spread of the pathogen through the population / prevents people dying ; **5** antibodies can be manufactured quickly in response to mutations that occur in virus / AW ; *max 2 (out of total three marks)* *disadvantages* **6** short-term / temporary (immunity) ; **7** no memory cells produced ; **8** can have infections of same pathogen again ; **9** allergic reaction / immune response, to the (non-human) antibodies given ; **10** *ref. to* cost qualified ; e.g. needs to be repeated / high cost of production of antibodies **11** AVP – for advantage (A) or disadvantage (D) ; e.g. (A) passive can be used for people who are malnourished / immunosuppressed e.g. (A) *ref. to* using a vaccine with a (live) pathogen that might give person the disease	**3**
(d)(ii)	across the placenta ; **A** via umbilical cord in breast milk / colostrum / breast feeding / during lactation ;	**2**

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224. 9700_s18_ms_22 Q: 6

(a)	*three from:* same / similar, shape as, HMG CoA / substrate ; complementary (shape) to active site (shape) ; binds / attaches / fits into / active site (of, enzyme / HMG CoA reductase) ; HMG CoA / substrate, cannot bind (to active site) ; **A** no / few, enzyme/substrate complexes form mevalonic acid production, decreases / stops ; **I** product not made AVP ; e.g. increase in mevinolin concentration increases inhibition / ora	**3**
(b)	*two from:* *treatment of disease* **I** *statements about locating or diagnosis of disease* specific / targeted, therapy / treatment ; **A** specific to diseased, cells / tissue **A** examples bind to / recognition of, receptors / antigens, on cell surface (of diseased cells) ; kill the cell by stimulating the immune system / AW ; **A** correct immune responses e.g. stimulates phagocytosis / activates B-cells attach, radioactive substance / drug (to treat / kill diseased cells) / AW ; treat infectious diseases / bind to (antigens on) pathogens / recognition of antigens on pathogens ; **A** viruses **I** bacteria *unless stated that they cause disease* *allow examples such as treatment of ebola or rabies or tetanus (by immunising with antibody)*	**2**

225. 9700_s18_ms_23 Q: 3

(a)	*max 2 if only one section attempted* *three from:* *multilayered epidermis* reduces, cuticular transpiration / loss of water vapour through cuticle ; increases distance for diffusion (of water vapour to cuticle) ; ref. to protection from heat from sunlight and reduced evaporation (from spongy mesophyll cells) ; *stomatal crypts* creates area of moist air / AW ; **I** traps water minimises effect of, external air currents / wind ; reduces / less steep, water potential gradient (between intercellular air space and external environment) ; **A** water vapour potential gradient **A** diffusion gradient if referenced to water vapour ref. to only on lower surface / shaded, and reduced evaporation (from spongy mesophyll cells) ; **A** lower temperature reduces rate of diffusion of water vapour (out via stomata)	**3**
(b)	phloem sieve tube element(s) ; **A** phloem sieve tube (cells) **A** sieve elements **I** companion / transfer, cells	**1**
(c)	*allow named assimilates* *source* *in context of assimilates* site of synthesis ; **A** described e.g. photosynthesis in leaf / storage compound breakdown in roots *sink* *in context of, via phloem / from source / from leaf* **I** nutrients / substances, unqualifed *if assimilates / named assimilate, not stated when explaining source* site where assimilates are stored **A** described e.g. roots for storage of starch **or** area where, growth occurs / assimilates are used for growth **A** described e.g. growth in developing buds / growth of immature leaf **or** area that receives, assimilates / AW ; **A** area where sucrose unloaded **I** place that needs assimilates **I** place where assimilates are used, unless qualified	**2**
(d)(i)	change in the, sequence / AW, of, bases / nucleotides (in, the DNA / the gene / *cyFBP*) ;	**1**

(d)(ii)	*one valid suggestion that prevents polypeptide synthesis or prevents synthesis of functional enzyme:* *e.g.* no mRNA produced ; **A** transcription, does not / cannot, occur mRNA produced unable to attach to ribosome ; **A** translation, does not / cannot, occur no start codon on mRNA ; shortened polypeptide chain produced ; **A** ref. to STOP codon premature chain termination mutation / nonsense mutation ; polypeptide produced cannot fold to form, tertiary structure / active site ; **R** changes shape of active site preventing function polypeptide produced cannot form quaternary structure of protein ;	**1**
(e)(i)	*accept cell for lymphocyte throughout* *four from:* 1 (primary) immune response ; 2 cyFBPase / enzyme, is antigen ; 3 formation of, APC / antigen-presenting cell ; **A** antigens presented on surface of macrophages 4 antigen, recognition / binding (in context of B-, or T-lymphocytes) ; 5 detail ; e.g. clonal selection have receptors, complementary / specific, to, antigen / cyFBPase **A** immunoglobulin / antibody, as receptors for B-lymphocytes **A** surface molecules as receptors for T-lymphocytes 6 divide by mitosis / clonal expansion ; 7 (specific) B-lymphocytes form plasma cells ; 8 plasma cells, synthesise / secrete, specific antibody / antibody to cyFBPase ; 9 T-helper / Th, lymphocyte, secretes, cytokine / interleukin ; 10 stimulates, humoral / B-lymphocyte, response ;	**4**
(e)(ii)	no binding of (monoclonal) antibody to, antigen / cyFBPase / enzyme / AW ;	**1**
(f)	*two from:* (less cyFBPase / enzyme, so) less sucrose synthesised ; **A** no enzyme to synthesise sucrose less sucrose transported (source to sink) ; **A** less sucrose unloaded at sink ; ref. to less glucose for synthesis of starch / AW (on context of sucrose hydrolysis) ;	**2**

226. 9700_w18_ms_21 Q: 1

(a)	**A** trachea ; **A** windpipe **I** *ref.* to cartilage rings **B** bronchiole ; **I** respiratory / terminal , before bronchiole **C** alveoli ; **A** alveolus / air sac / alveolar sac	**3**
(b)	*any one from* lung cancer ; emphysema ; chronic bronchitis ; COPD ; cystic fibrosis ; AVP ; e.g. asthma *must be non-infectious*	**1**
(c)	*Plasmodium, falciparum* / *vivax* / *ovale* / *malariae* ;	**1**
(d)	*any three from* *pathogen* (because) four / several, different, causative species / AW, (with different antigens) ; (pathogen has) many antigens as it is eukaryotic / many genes coding for antigens ; *ref.* to mutation changing antigens ; pathogen has different stages of life cycle (within human) with different antigens ; **I** *ref.* to antigenic shift antigenic concealment / pathogen spends part of life cycle within host cells / AW ; **A** short time in blood plasma *vaccine* *ref.* to more than one type of vaccine needed ; suggestion that antigens used have not given the strongest immune response ; *vaccination programme* *ref.* to only trial programmes ; **A** programmes not global *ref.* to not achieving herd immunity / not enough people (successfully) vaccinated ; detail ; e.g. lack of willingness to be vaccinated lack of trained people to give vaccines poor nutrition and poor immune response	**3**
(e)	*allow* *mosquitoes* / *vectors, for Anopheles* *pathogen* / *parasite, for Plasmodium* *any four from (max 1 for list of factors without explanation)* *assume in context of comparison with area* **Q** *ref.* to a suitable climate for *Anopheles,* e.g. tropical / subtropical / hot and humid ; presence of *Anopheles* species which carry *Plasmodium* ; *ref. Anopheles* breeding sites present / (many) water sources (suitable for breeding) ; difficulty in controlling / lack of control, of *Anopheles* breeding sites ; AW, e.g. stagnant water not drained lack of / cannot afford, spraying with, insecticide / pesticide / repellents ; insecticide-resistant forms of *Anopheles* exist ; lack of / insufficient use of, mosquito nets ; mosquito nets not impregnated with insecticide ; lack of, artemisinin drugs / drugs to treat disease ; drug-resistant forms of *Plasmodium* exist ; idea of *Plasmodium* requiring temperatures of approximately 20 °C (in vector) ; **A** area **P** has temperature / conditions for survival of *Plasmodium* *ref.* to difficulties in diagnosing disease (so delay / no treatment) ; e.g. lack of diagnostic tests lack of trained personnel AVP ;; e.g. some countries in area **Q** have *Anopheles* but control is good, *ref.* to feature of *Anopheles* species present in area **P** feed at all times during the day feed only on humans good host for reproduction of *Plasmodium* poor education so people don't know how to protect themselves from malaria	**4**

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227. 9700_w18_ms_21 Q: 4

(a)	correct formula ; (×) 1200 ; **A** 1171 (41 000 ÷ 35) 1229 **or** 1228.6 (43 000 ÷ 35) *max 1 if units given*	**2**
(b)(i)	*any two from* DNA , replication / AW ; **A** S phase **I** chromosome replication (early interphase) chromosome becomes two chromatids ; **A** described DNA checked for errors / errors in DNA repaired ; synthesis of, (growth) protein / enzymes (for growth) ; cell growth ; organelle synthesis ; centrioles replicate ; AVP ; e.g. *ref.* to checkpoint(s) nucleotide synthesis	**2**
(b)(ii)	*any two from* *ref.* target cells are endothelial cells ; VEGF / cell signalling molecule, binds / AW, to receptor ; **R** receptor cells *ref.* specificity (of receptors) / VEGF / cell signalling molecule, complementary to receptors ; suggestion of detail following binding ; e.g. triggers secondary messenger activates enzymes / enzyme cascade signal transduction phosphorylation events	**2**
(c)	*any four from* VEGF protein / antigen, injected into, mouse / small mammal ; time for immune response to occur ; **A** description of event in immune response plasma cells / B-lymphocytes / splenocytes, extracted from mouse ; plasma cells / AW, fused with, myeloma / cancer, cells ; (to produce) hybridoma cells ; clone hydridoma cells ; separate cells and culture in individual wells ; screen for cells secreting desired antibody ; hybridoma cells grown in large scale culture / AW ; AVP ; e.g. *ref.* to fusogen	**4**
(d)	*any one from* monoclonal antibodies identified, as foreign / non-self / act as an antigen ; (monoclonal antibodies) stimulate an, immune / allergic, response ; AVP ; e.g. (antibodies destroyed so) not enough antibody (to be effective)	**1**

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228. 9700_w18_ms_22 Q: 4

(a)	*any three from* protein coat / capsid ; **I** protein layer nucleic acid ; DNA or RNA ; **R** in nucleus **I** in cytoplasm **I** *ref. to*, double / single, strand acellular / not made of cells ; **I** absence of named cell structures AVP ; e.g. *ref. to* capsomeres size 15 nm to 1000 nm *accept any in range* (some) are enveloped / have phospholipid bilayer **I** with glycoproteins	**3**
(b)(i)	one value in the range 64% – 68% ; *((940 000 – 980 000) ÷ (1 440 000 – 1 480 000)) □ 100*	**1**
(b)(ii)	*allow women for pregnant women and therapy / treatment, for ART* *any three from* **1** (slight) decrease in (total) number of women living with HIV and (overall) increase in number of women living with HIV receiving ART ; **2** slight decrease / plateau / AW, between 2009 to 2010, in number of women living with HIV receiving, ART / therapy ; **3** proportion / percentage cover(age), of women receiving ART increases (in time period) ; **A** calculated values (approx. 13% to 66%) **A** number of women receiving ART increases more steeply than decrease in number of women living with HIV **4** data to support mp1 or 2 ; *mp1 two years and, two values / manipulated data, for either curve* *mp2 two values, 2009 compared to 2010* ***or*** *manipulated data* *allow □ 20 000 for extracted values*	**3**
(b)(iii)	*in context of pregnant and breastfeeding women who are living with HIV* *any three from* **1** *ref. to* mother to child transmission ; *in context of HIV transmission* **A** (because) HIV can be passed from mother to baby **A** decreases HIV transmission during, pregnancy / labour / birth / breastfeeding **A** reduces, number / proportion, of babies born with HIV (so fewer die) **I** stops transmission *(as this is in context of global transmission this implies in all cases)* **I** makes babies immune to HIV / AW or gives passive immunity *allow idea that ART may be passed across, placenta / breastmilk, to baby and so provide(short-term) protection against any HIV transmitted from mother* **2** reduces number of, HIV positive women becoming ill (with HIV/AIDS) /women with HIV/AIDS dying from the disease ; **A** opportunistic infections / named examples e.g. TB **3** example of reduces spread of HIV ; *in any correct context other than HIV mother to child* e.g. child may grow up without HIV and will not pass on mother less likely to pass on to partner **4, 5** examples of, social / economic, effect ;; e.g. (healthy women) can contribute to work force can be main carer if partner has died (*idea that* children not orphaned) overall financial savings e.g. if infants are not born with HIV then no lifelong ART required ART may be less costly than treating HIV/AIDS makes breastfeeding safer when no other options exist to feed babies HIV negative children will become next workforce generation all women throughout world receive same treatment	**3**
(c)(i)	(HIV) antigen / p24 ; **A** capsid protein / capsomere(s) / protein coat **R** HIV	**1**
(c)(ii)	(time needed) so, immune response / clonal expansion / production of B-lymphocytes / production of plasma cells, can occur ; **A** B-cells / splenocytes **R** plasma cells need to multiply **I** *ref. to* antibody production	**1**
(c)(iii)	*any one from* immortal / long-lived ; able to replicate / capable of cell division ; uncontrolled cell division, can grow / survive, in cell culture ; cannot grow on, HAT / hypoxanthine-aminopterin-thymidine / step **4**, (culture) medium ; **A** do not have gene coding for ability to grow on HAT	**1**
(c)(iv)	hybridoma ;	**1**
(c)(v)	*any one from* (check cells for) production / AW, (by hybridoma cells) of, anti-HIVp24 antibody / antibody against p24 ; **A** the antibody / monoclonal antibody **A** check cells, contain / have / AW, desired antibody / AW *idea that* only want cells that produce desired antibody / do not want cells that produce different antibodies / need to remove cells that don't produce the antibody ; waste of, money / resources, to culture other cells / if no antibody produced ;	**1**

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229. 9700_w18_ms_23 Q: 6

<table>
<tr><td>(a)(i)</td><td>[A] C E D B F ;</td><td>1</td></tr>
<tr><td>(a)(ii)</td><td>I early and late except where indicated
<table><tr><th>event in the cell cycle</th><th>name of the stage in the cell cycle</th></tr><tr><td>DNA replication</td><td>interphase / S phase ;</td></tr><tr><td>division of centromeres</td><td>anaphase ;
R late anaphase</td></tr><tr><td>condensation of chromatin</td><td>prophase ;</td></tr><tr><td>contraction of spindle fibres</td><td>anaphase ;</td></tr><tr><td>organisation of chromosomes at the equator</td><td>metaphase</td></tr></table></td><td>4</td></tr>
<tr><td>(b)</td><td>I antibodies have receptors
any three from
1 clones / AW, of B/T cells consist of very few cells ;
AW = types of / specific / groups of
2 (mitosis occurs) during clonal expansion ;
3 many, B cells / plasma cells, to make antibodies ;
4 many, T-helper / T_h, cells to secrete, cytokines / lymphokines / interleukins ;
5 many, T-killer cells / T-cytotoxic cells, to kill, infected cells / cancer cells ;
6 memory cells are produced for, secondary response / faster response (when antigen encountered again) ;
A during a secondary infection (implying of the same pathogen)
7 need to make genetically identical cells ;</td><td>3</td></tr>
</table>

230. 9700_m17_ms_22 Q: 2

(a)(i)	*Vibrio cholerae* ;	**1**
(a)(ii)	**A** 1 *cell structure:* ribosome ; **R** RER 2 *difference:* 70S / smaller / 18 nm v 80S / larger / 25–30 nm ; **B** 3 *cell structure:* DNA / chromosome ; **I** RNA 4 *difference:* circular / (closed) loop v linear OR no histone proteins / naked v histone proteins OR not surrounded by nuclear envelope v surrounded by nuclear envelope ; **A** in a nucleus v not in a nucleus **C** 5 *cell structure:* cell wall ; 6 *difference:* murein / peptidoglycan v cellulose ; **I** lignin	**6**
(b)	*two from* 1 caused by, a pathogen / a bacterium / *V. cholerae* ; 2 transmissible / AW OR reference to faecal-oral route ; 3 reference to reduced effectiveness of functions / AW ;	**2**
(c)	primary, secondary, tertiary ; **A** 1°, 2°, 3° quaternary ; **A** 4°	**2**
(d)	*three from:* 1 choleragen, fits into / complementary to, receptor / GM1 ; **A** complementary shape 2 membrane pinches in / invaginates / AW ; **A** engulfs / envelops 3 membrane fusion ; 4 (endocytotic) vesicle / vacuole, formed ; 5 ATP / energy, required ; ***A*** *points from an annotated diagram*	**3**
(e)(i)	*one from:* 1 portion that binds to cell ; 2 (antibodies produced) prevent binding to cell / prevent entry to cell ; 3 safer as not the toxic portion ; 4 A subunit, causes damage to cell / less safe / AW ; 5 AVP e.g. larger so more likely to provoke immune response / AW ;	**1**
(e)(ii)	*five from:* 1 vaccine contains (subunit B / bacterial) antigen(s) ; 2 primary immune response occurs ; 3 correct ref to B-lymphocytes / formation of plasma cells ; **A** B cells 4 secretion of, antibody / immunoglobulin (against cholera antigens) / antitoxins ; 5 T-helper lymphocytes secrete cytokine ; 6 (cytokine) increases humoral response / stimulates T-killer cells / stimulates macrophages ; 7 memory cell production ; 8 secondary (immune) response / response on further infection, is faster ; 9 higher levels of antibodies produced (during further infection) ; 10 active artificial immunity (against cholera) ; 11 AVP e.g. *idea* of specific antibody against each of the different vaccine antigens ;	**5**

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231. 9700_s17_ms_21 Q: 3

(a)	(antibody has) more than <u>one polypeptide</u> ; **A** <u>four polypeptides</u> **R** two / two or more / two types of / many / AW, polypeptides	**1**
(b)(i)	*allow epitope for antigen* **1** (two) antigen-binding, site(s) / region(s) ; **A** binds to / AW, antigens **R** active site **2** (shape / structure is) <u>complementary</u> to antigen ; *3* *idea of* specificity / AW ; **4** *ref. to*, primary structure / sequence of amino acids ; **5** *ref. to* R-groups / (amino acid) side chains, and interactions with antigen / giving specific shape ;	**max 3**
(b)(ii)	binds to (receptors on), phagocytes / macrophages / neutrophils ; **A** other correct named cell of the immune system AVP ; e.g. gives class of antibody (e.g. IgM, IgG, IgA, IgE)	**max 1**
(c)(i)	**1** <u>antigen</u>, introduced / AW, into, (small) mammal ; **A** named small mammal **2** B-lymphocytes / B cells / plasma cells / splenocytes / antibody-producing lymphocytes, are taken / are isolated (from the spleen / lymph nodes) ; **3** (these) cells are fused / AW, with, myeloma / cancer, cells ; **4** <u>hybridoma</u> cells / <u>hybridomas</u>, formed ; **R** hybridised cells / hybrid cells **5** hybridoma cell, is cloned / AW ; **6** screening / testing, for hybridoma that produces desired antibody ; **7** *ref. to* scaling up / large-scale production / grow in a fermenter ; **8** AVP ; e.g. fusion using, fusogen / polyethylene glycol / PEG / electric current (electrofusion) / (Sendai) virus HAT medium, for, hybridoma growth / inhibiting myeloma growth humanisation of monoclonal antibody	**max 4**
(c)(ii)	**I** *suggestions for treatment* **1** monoclonal antibodies used all have the same specificity ; **R** 'are specific' unqualified **2** detect only one, antigen / epitope ; **3** can distinguish between different, pathogens / strains of, pathogens ; **A** types of cancer cells **4** can be, labelled / tagged / marked / AW ; e.g. with fluorescent label **5** monoclonal antibodies can detect location of, tissues expressing antigen / cancer cells / blood clots ; **A** *idea of* locating areas of infection **6** fast(er) (diagnosis) ; **7** can detect antibody levels (e.g. HIV) ; **8** AVP ; e.g. some pathogens cannot be cultured **I** *ref. to* cost	**max 2**

232. 9700_w17_ms_21 Q: 3

(a)(i)	B-lymphocyte / plasma cell ; **A** B-cell / white blood cell / lymphocyte / leucocyte / **R** beta / β, cells **R** T-lymphocyte / macrophage / neutrophil	**1**
(a)(ii)	*three from* **I** ref. to receptor 1 antibody complementary (shape) to antigen ; **I** matching shape 2 *idea that* variable regions different for each antibody ; 3 (specific) antigen / H / N, binding sites (on antibody) ; *if mp 2 and 3 not gained, allow one mark for antigen binding regions* 4 sequence of amino acids / primary structure, varies between antibodies / gives specificity ; 5 *ref. to* difference in, primary structure / amino acid sequence, leading to different, tertiary structure / 3-D shape ; 6 *ref. to* R group interactions between antibody and antigen ;	**3**
(b)(i)	*Vibrio cholerae* ; **I** bacterium	**1**
(b)(ii)	faecal–oral route ;; *if mode of transmission not named, allow description* *infected person* faeces / sewage, contaminates, (drinking) water / cooking utensils / vegetable plots / crops / food **A** diarrhoea *for faeces* **R** (human) waste unqualified **or** *ref. to* houseflies landing on contaminated faces ; *uninfected person* eating contaminated food / using contaminated utensils / drinking contaminated water ; **A** bacteria enters water in context of drinking **R** infected food or water **I** handling contaminated food *need ref. to contaminated once only*	**2**
(c)(i)	cell wall, breaks / damaged / AW **A** cell wall becomes thinner **or** cell wall weakened ; *plus one from* detail of change to cell wall e.g. cross links break down, quantity of murein / peptidoglycan, decreases **or** cell membrane, breaks / AW **or** increase in water in cell (so increase in turgor pressure) / AW ;	**2**
(c)(ii)	*two from* infect only, *V. cholerae* / cholera bacteria AW **or** do not, infect human cells / infect humans ; **A** do not harm human cells do not give side effects / allergic responses, (to humans) ; able to replicate inside *V. cholerae* (to produce more bacteriophage for treatment) ; *ref. to* remaining, active / infective / AW, with delivery method used / within gut ;	**2**
(c)(iii)	*antibiotics* only effective against bacteria / not effective against viruses **or** do not act on structures possessed by, (measles) virus / *Morbillivirus* **A** named structure e.g. protein coat **or** act on structures that viruses do not have **A** named structure e.g. murein cell wall **or** only act on, living / growing, cells **or** may not be able to reach virus inside (host) cell ; AW	**1**

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233. 9700_w17_ms_23 Q: 4

(a)(i)	*Plasmodium* , *ovale* / *falciparum* / *malariae* / *vivax* ;	**1**
(a)(ii)	*Anopheles* / anopheline ;	**1**
(b)	*either* 1 numbers of cases have decreased in, all countries / Africa ***or*** number of deaths have decreased in, all countries / Africa ; 2 cases in Africa as a percentage of all countries decreases and, remains constant / reaches a plateau / (small) fluctuations / down + up + down ; 3 deaths in Africa as a percentage of all countries, remains constant / fluctuates (a little) ;	**3**
(c)	*three from* 1 example of control of breeding of, vector / mosquitoes ; e.g. drainage of stagnant water / sterile males / aerial spraying of insecticide / oil on water / fish in water / *ref. to* bacteria 2 example of reduction of contact between vector and humans ; e.g. bed nets (impregnated with insecticide) / insect repellents 3 earlier, identification of cases / treatment of malaria ; 4 use of (new) drugs to, prevent transmission / prevent spread / treat malaria; **A** development of new drugs for malaria 5 better, awareness of / education about, transmission / control methods ; 6 AVP ; e.g. targeting people at risk (e.g. pregnant women / high drug-resistant areas better screening of blood for transfusion **I** *better access to, healthcare / AW, without further qualification*	**3**
(d)	**A** mosquito for *Anopheles* *four from* 1 no vaccine ; **A** no effective vaccine 2 any problem in developing a vaccine ; e.g. *Plasmodium* is eukaryotic / antigens differ in different life stages / intracellular parasite / antigenic concealment / different stages in life cycle 3 drug resistance in *Plasmodium* ; 4 any example, e.g. chloroquine / artemisinins ; 5 insecticide resistance in *Anopheles* ; 6 any example, e.g. DDT / dieldrin / pyrethroids ; 7 *ref. to* conditions for breeding of *Anopheles* ; 8 problems with, funding research / AW ; 9 cost of, drugs / insecticides, to government / health authorities / individuals ; 10 people with HIV / AIDS are at high(er) risk than others ; 11 lack of knowledge / lack of education / 'fatalism' / AW ; 12 inaccessibility of some regions to healthcare ; 13 infected people not, identified / diagnosed ; 14 AVP ; e.g. migration of people with malaria to places without malaria (such as countries where it has been eliminated)	**4**

234. 9700_m16_ms_22 Q: 4

(a) *Morbillivirus*
aerosol / droplet, infection ;
A described, e.g. (from infected person) in, exhaled / airborne, droplets, and inhaled

idea of spread by touching an infected surface and putting fingers into mouth / nose ;
R contact *without qualification*

HIV
sexual intercourse / passed via semen / passed via vaginal fluids / AW ;
blood transmission ; **A** described, e.g. blood transfusion
sharing (contaminated), needles / syringes
accept transmitted in body fluids for one mark *if above two points not gained*

mother to, foetus / baby, transmission ;
A described, e.g. across placenta / during birth / breastfeeding

AVP ; e.g. ref. to measles mode of transmission leading to faster spread of disease / ora

[max 4]

(b) antibiotics (only) used against bacteria (and some fungi) ; **I** used in malaria

idea that antibiotics act at a cell structure not possessed by virus ;
e.g. viruses, do not have, a cell wall / a cell surface membrane / ribosomes

suggestion that viruses are, inside host cells / not within reach ;

antibiotics act only on, living / growing, cells (viruses do not grow) ;

antibiotics do not act on, protein coat / capsid / capsomeres / viral envelope ;

[max 2]

(c) **(i)** phospholipid bilayer ;
proteins / glycoproteins / named ; **I** cholesterol

[2]

(ii) SLAM acts as a receptor ;
haemagglutinin / H / (viral) glycoprotein, binds to / fits into / complementary to, SLAM / receptor ;

fusion protein / F / (viral) glycoprotein, causes fusion (of envelope) to cell surface membrane ;
A (viral) envelope fuses with cell surface membrane
fusion releases nucleoprotein (and viral polymerase) ;

[max 3]

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(iii) *in context of viral RNA*
replication of RNA / to make copies of genes / AW ;

transcription / production of mRNA ;
detail ; e.g. to make viral proteins ;

AVP ; e.g. *credit suggestion of,* RNA-dependent DNA polymerase / reverse transcriptase, to produce viral DNA

[max 2]

(d) (i) protein ; **A** polypeptide **A** glycoprotein [1]

(ii) immunise / inject / AW, mice / small mammals, with p24 / antigen ;
immune response occurs / leave for a number of weeks ; **A** description
harvest / collect / AW, splenocytes / B-lymphocytes / B-cells / plasma cells ;
fuse with, myeloma cells / cancer cells ; **A** tumour
form hybridoma cells ;
select for (hybridoma) cells secreting antibody against, p24 / antigen ;

[max 3]

[Total: 17]

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235. 9700_s16_ms_23 Q: 3

(a) *non-self*
foreign / AW ; **A** not from the person's own body
triggers / AW, an immune response / production of antibodies ;
A other events in immune response described

antigen
protein / glycoprotein ; **A** polysaccharide
ref.to, binding of specific antibody / formation of antigen-antibody complex ; [max 3]

(b) (i) **P** antigen-binding site / site for antigen attachment ; **A** variable region

Q hinge region ;

R constant region / site of attachment to receptors on phagocytes / AW ; [3]

(ii) disulfide (bonds) ; **R** *if more than one type of bond stated* [1]

(c) (i)
1 TNF-α / antigen, introduced into, mice / small mammals / named ;
2 (antibody-producing), B-cells / B-lymphocytes / plasma cells / splenocytes, isolated (from spleen) ; **A** produced
3 fused with myeloma cells ;
4 using fusogen / PEG ;
5 hybridoma cells formed ;
6 *ref. to* screening / testing, for hybridoma producing desired antibody ;
7 *ref. to* scaling up / large-scale production ;
8 AVP ; e.g. HAT medium for, hybridoma growth / inhibiting myeloma growth [max 3]

(ii) antibodies bind to TNF-α ;
inactivate / destroy TNF-α ;
inflammation cannot be triggered / AW ; in context of destroying TNF- α [max 2]

[Total: 12]

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236. 9700_w16_ms_21 Q: 5

(a) (i) antigen binding site / variable region / V_H and V_L ; **A** F_V [1]

(ii) *four from*

1 *ref. to* monoclonal antibody, is recognised as, non-self / foreign ;
or
diseased cell (now) recognised as non-self / foreign ;

2 stimulates an immune response ;

max three suggestions from

3 recognition and binding by / activation of / AW, T-lymphocytes / B-lymphocytes / AW ; **A** clonal selection
A T- / B-, cell

4 *ref. to* specificity so healthy cells not destroyed ;

5 clonal expansion / mitosis ;

6 plasma cells (formed that) secrete antibody ; **A** B-lymphocyte

7 consequence ; e.g. antibody binds monoclonal antibody to lead to cell destruction

8 T-helper lymphocyte secretes cytokine, to activate macrophages / B-lymphocyte response / T-killer response ; AW
e.g. stimulates humoral response

9 T-killer / T-cytotoxic, releases, perforin to, punch holes in (cell) membrane / cause death of cell ; AW

10 detail of involvement of phagocytes / macrophages ;
e.g. receptor recognition of (monoclonal) antibody
engulf the diseased cells with monoclonal antibody attached / AW
A diseased cell (with monoclonal antibody) destroyed by phagocytosis [4]

(b) *one of*
failure to distinguish self and non-self (antigens) ; **A** foreign *for non-self*
immune response / antibodies produced, against self antigens ;

in context of lack of good health **R** does no harm [1]

[Total: 6]

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237. 9700_w16_ms_22 Q: 5

(a) (i) *non-infectious to max 1*
not caused by a pathogen ; **A**
not, communicable / transmissible ; **A** not passed from one living, organism / person, to another AW

disease to max 1
R *if in context of an infectious disease*

abnormal condition (affecting an organism) / condition that reduces the effectiveness of the functions of the organism / lack of good health / AW ; [2]

(ii) *four from*

1 *ref. to* mutation ;

2 further detail ; e.g.
change in sequence of, nucleotides / bases, of, DNA / gene
tumour suppressor gene, switched off / stops functioning / alters / AW
formation of oncogene
proto-oncogene altered

3 uncontrolled, mitosis / cell division / cell replication ; AW

4 *ref. to* changes to checkpoints / coordination of cell cycle lost ;
A cell does not, receive / respond to, signals (to stop dividing)

5 loss of function / lack of differentiation / lack of specialisation / AW ;
allow loss of function idea if referring to the mass of cells

6 other detail of, tumour cell / cellular changes ;
e.g. immortal / no apoptosis / no programmed cell death
no contact inhibition / grows to invade healthy tissue / AW
more protein synthesised (for growth)
(release cell signalling molecules for) vascularisation / blood vessel formation
changed size compared to normal cell size
telomeres do not shorten / AW [4]

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(b) (i) **A** = protoctist ; **A** protoctista, protist(a), protozoa(n), sporozoa(n)
B = bacterium ; **A** bacteria

[2]

(ii) aerosol infection / droplet infection ; **A** described **A** airborne droplets
A direct contact ; **A** *description in this context,* e.g. body contact [1]

(iii) smallpox ; [1]

(iv) *Morbillivirus* ; [1]

(c) *three from*

1 vaccination, gives (active) immunity / stimulates an immune response ;
must be in context of active artificial immunity

2 detail ; e.g. primary immune response
clonal, selection / expansion (specific, B / T, lymphocytes)
formation of antibodies
formation of memory cells
artificial active (immunity)

3 secondary (immune) response, when, pathogen / antigen, present
or
presence of antigen / pathogen, gives, faster response / higher antibody production / AW ; **R** disease (for antigen / pathogen)

4 (effects of vaccination / immunity) long-lived / AW ;
A memory cells remain (in circulation) for a long time

5 herd effect ;

6 explained ; e.g. sufficient, (successfully) vaccinated / immune, so, susceptible / non-vaccinated, people protected

7 stops the transmission cycle ;
A less people with disease so reduces spread

8 AVP ; *ref. to* ring vaccination [3]

[Total: 14]

238. 9700_w16_ms_23 Q: 6

(a) *Morbillivirus* ; **A** *Morbilivirus / Morbili virus / morbillivirus* [1]

(b) *three from*
1 number of cases fluctuates (between 2008 to 2012 / in all years) ;
2 number of cases (much) higher in 2010 ;
3 epidemic lasted longer in 2010 ;
4 highest peak is 42 000 – 43 000 in 2010 ; **R** 45 000 **A** 30 000 – 35 000 in Africa
5 numbers are higher at beginning of each year (than at end) ;
6 five, outbreaks / peaks / epidemics / AW ; **A** four as no data before Jan 2008
7 numbers of cases in rest of world are greater than in Africa in every year except 2010 ; **ora** numbers of cases in Africa were less than in the rest of the world in every year except 2010 [3]

(c) **I** *the term primary immune response*
I *any ref. to, T cytotoxic / T killer cells*

four from
1 antigen presentation ;
2 clonal selection / described ;
3 clonal expansion / described ;
4 B-lymphocytes / B cells, develop / AW, into plasma cells ;
5 plasma cells, secrete / produce / AW, antibody ;
6 any correct ref. to T helper cells ; [4]

(d) **I** virus mutates / different strains *(as one vaccine is effective)*

two from
1 measles introduced by people who caught the disease when abroad ;
A any e.g. tourists / visitors / travellers / returning tourists / migrants / displaced people
2 *idea that* herd immunity, needs to be >90% / is not 100% ;
A herd immunity not achieved
3 some people in these countries have not been vaccinated ;
A too young to receive vaccine / refusal of vaccination / live in remote places / war zones / AW ;
4 some people do not respond to the vaccine ; **A** people have weak immune system / malnutrition
5 some people do not receive booster(s) ;
6 (reconstituted) vaccine is not thermostable / difficult to maintain the cold chain ; [2]

[Total: 10]

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239. 9700_s15_ms_22 Q: 5

(a)

A *reverse wording for both*
mark vertically / one mark each correct column

description of event	outcome for the individual	production of memory cells / yes or no	precise type of immunity acquired by individual
individual **P** is injected with a live, weakened disease-causing organism	individual **P** does not become ill from the disease and has long-lasting protection from the disease	yes	artificial active
individual **Q** is exposed to a disease-causing organism and is immediately injected with a specific antibody	individual **Q** does not become ill from the disease but suffers from the disease a year later	no	artificial passive

[2]

(b) bone marrow **;** **A** stem cells / myelocytes **I** white blood cell **[1]**

(c) **(i)** **1** healthy body cells, (recognised as) self / have self-antigens **;** **A** non-foreign
2 cancer(ous) / tumour, cells, (recognised as) non-self / have non-self antigens **;** **A** foreign
3 idea that changes occur to structure of cell surface membrane of, cancer(ous) / tumour, cells **;**
4 phagocytes have receptors for, non-self / foreign, antigens **or** phagocytes have receptors for antibody complexed to non-self / foreign antigens **;**
[max 2]

(ii) **1** uncontrolled / AW, mitosis / (mitotic) cell division / cell replication / cell cycle **;**
either
2 one example of a change occurring in a healthy cell
e.g. proto-oncogene to oncogene
mutation of / switching of, tumour suppressor gene
uncontrolled growth
increase in growth proteins
shorter interphase (of cell cycle)
(rapid) DNA replication
cells do not respond to signals (from other cells)
or
further detail of tumour formation **;**
e.g. cells immortal / no apoptosis / no programmed cell death
no contact inhibition / cells continue to grow when they contact other cells
cell cycle checkpoints not controlled
abnormal / AW, mass of cells formed
undifferentiated / unspecialised, cells / tissue / mass
cells do not function (as tissue of origin) **[2]**

[Total: 7]

240. 9700_s15_ms_23 Q: 3

(a) (endoplasmic reticulum / RER) has ribosomes ;
(ribosomes / RER) site of protein synthesis ;
antibodies are proteins ;
RER for, modification / transport / transport vesicle formation ; [max 2]

(b) 3000 ;; **A** 2933 / 3067 *if units given allow one mark only*
if incorrect allow one mark for correct length measured 44 / 45 / 46 mm and
knowledge of formula is correct (magnification = image length / actual length –
this can also be seen by workings e.g. 45 mm / 15 μm) but incorrect conversion
factor used for final calculation [2]

(c) Variola (virus) ; [1]

(d) memory cells produced (along with plasma cells) ;
to max 2
idea of greater number of (specific immune system) cells ;
(memory cells are) long(er) lived / remain in circulation ;
memory T and B cells ;
ref. to / detail of, faster secondary response (to give immunity) ; [max 3]

(e) *two relevant e.g.*
1 vaccine, thermostable / freeze-dried ; **A** *idea of* longer shelf-life / no wastage
2 virus did not mutate ; **A** pathogen / strain
3 same vaccine could be used everywhere ;
4 cheap to produce (in large quantities) ;
5 ease of production ;
6 used a live virus / vaccine gave a strong immune response ;
7 no need for boosters ;
8 ease of administration ; e.g. ref. to enthusiastic volunteers
needles could be, sterilised / re-used
9 high percentage cover / AW ;
10 ref. to ring vaccination / described ;
11 global effort / AW ; [2]

(f) artificial active / active artificial ; [1]

[Total: 11]

241. 9700_w15_ms_23 Q: 1

(a) (i) **A** – nuclear envelope **;**
B – rough endoplasmic reticulum **; R** RER / ER / smooth ER
C – (large sub-unit of) ribosome **; A** ribosomal RNA, **R** rRNA [3]

(ii) **D** – transfer / t, RNA **;** [1]

(iii) *at* **1** – transcription **;**
A post-transcription modification / removal of introns
A DNA / gene, copied (to synthesise mRNA)
A genetic information copied
R DNA copied onto mRNA
R DNA code copied onto mRNA

at **2** – amino acid activation **;**
A attachment / AW, of (specific) amino acid (to specific tRNA)

at **3** – translation / condensation of amino acids / formation of peptide bond(s) (between amino acids) **;**
A codon-anticodon binding
I (poly)peptide synthesis [3]

(b) a protein combined with, a carbohydrate / sugars / AW **;**
A protein with sugar
R protein with, glycogen / polysaccharide [1]

(c) *antibody molecule*
has (2) heavy and (2) light chains / two types of polypeptide / different types of polypeptide **;**
idea that each different, polypeptide / chain, is coded for by a gene **;**
ref. to gene coding for enzyme for carbohydrate attachment (to make the glycoprotein) **;**
[max 2]

(d) *points can be taken from an annotated diagram*
1 variable region / Fab region, has antigen binding sites **;**
2 *ref. to* specificity for binding antigen / complementary (shape) to the antigen **;**
A *idea of* sequence of amino acids (on light and heavy chain) giving specific shapes
3 (IgG has) two (antigen) binding sites (per antibody molecule) **;**
4 heavy chains / Fc / constant, region binds to (receptors on), phagocytes / named phagocyte **;**
5 hinge region gives flexibility when binding to, antigen / pathogen / AW **;**
6 disulfide bridges, give stability / hold chains together / AW **;**
award on a diagram if bond and chains are labelled
7 AVP **;** e.g. R groups bind to antigen
bind to antigen by, hydrogen bonding / ionic bonding
constant region gives antibody class / AW [max 4]

[Total: 14]

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Q1.

3 During an immune response, some B lymphocytes change into plasma cells.

Fig. 3.1 is a drawing made from an electron micrograph of a plasma cell.

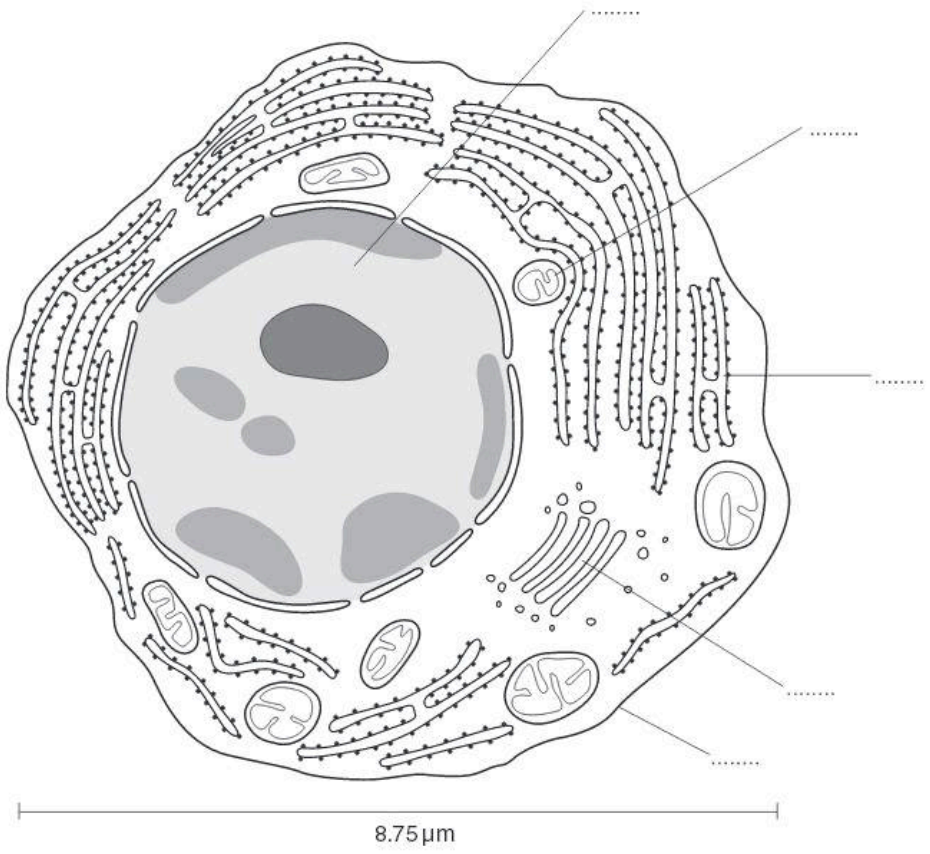


Fig. 3.1

(a) Use the label lines and the letters **A** to **E** to identify where the following processes occur.

A transcription
B polypeptide synthesis
C aerobic respiration
D formation of secretory vesicles
E active uptake of amino acids [4]

(b) State the function of plasma cells during an immune response.

.....

.....[1]

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(c) State **two** ways, visible in Fig. 3.1, in which the plasma cell differs from a typical prokaryotic cell.

1. .....

.....

2. .....

.....[2]

[Total : 7]

Q2.

6 Fig. 6.1 is a diagram that shows three different T lymphocytes and the events that occur during an immune response to an antigen.

Use

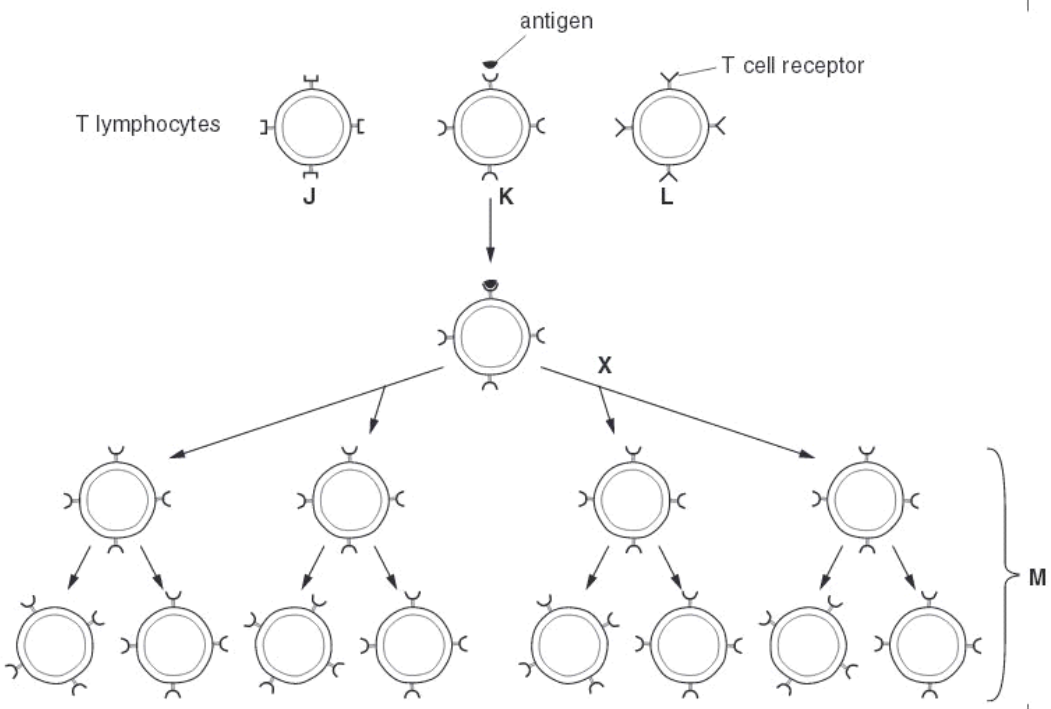


Fig. 6.1

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(a) Name the type of nuclear division that occurs at **X** on Fig. 6.1.

.....[1]

(b) State the term used to describe a group of identical cells, such as those shown at **M** on Fig. 6.1.

.....[1]

(c) Explain why T lymphocyte **K** has responded to the antigen during the immune response, but not T lymphocytes **J** and **L**.

.....

.....

.....

.....[2]

(d) Describe **one** role of T lymphocytes in fighting an infectious disease.

.....

.....

.....

.....[2]

In certain types of cancer, T cells do not mature properly, fail to develop antigen receptors on their cell membranes and do not function normally.

(e) **(i)** State the name given to agents that increase the chances of cancerous growth.

.....[1]

(ii) Suggest the likely effects on the body of T cells that do not function normally.

.....

.....

.....

.....

.....

.....[2]

Q3.

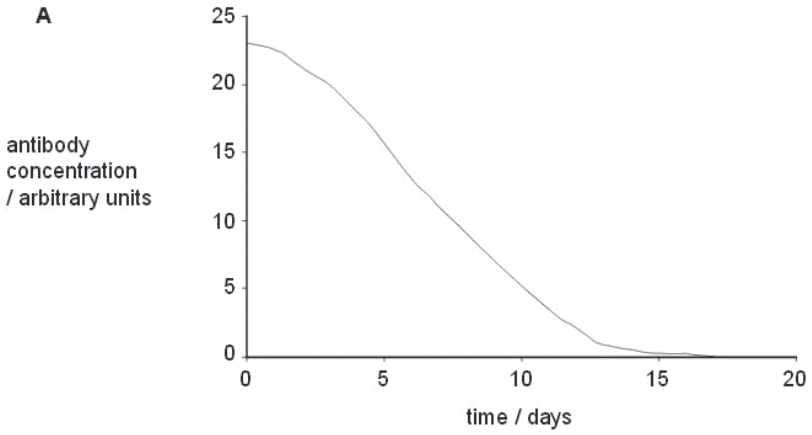
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Use

5 Two people took part in a study to find out the effectiveness of two types of immunisation. Person **A** received an injection of antibodies against tetanus and person **B** received a tetanus vaccination.

Over the new few weeks, the blood from these two people was analysed for the presence of antibodies to tetanus. The results are shown in Fig. 5.1**A** and Fig. 5.1**B**.

A



B

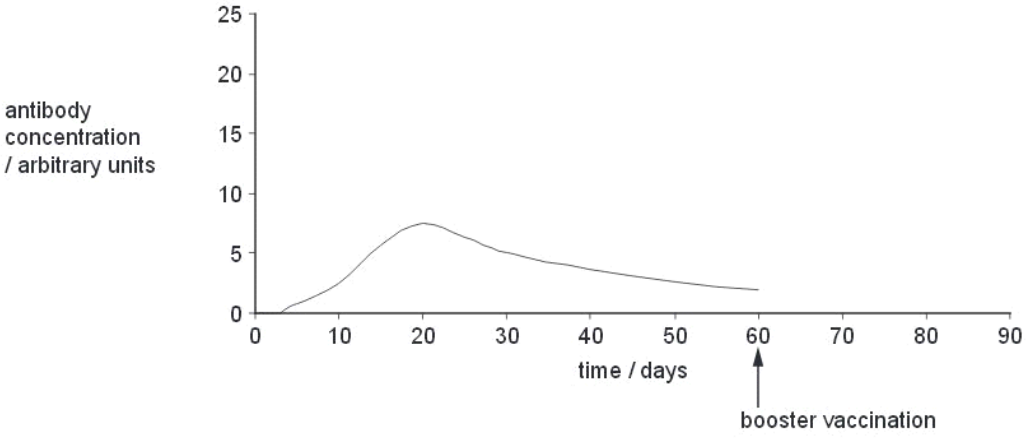


Fig. 5.1

(a) Name the types of immunity shown by Fig. 5.1 **A** and **B**.

A .....

B .....[2]

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Examiner Use

(b) Explain why the antibody concentration in person **A**,

(i) decreased during the study period

.....

.....

.....

(ii) did not increase.

.....

.....

.....

.....

.....

.....[3]

(c) **Sketch on** Fig. 5.1 **B**, on page **10**, what you would expect to happen to the antibody concentration if person **B** received a booster vaccination at **day 60**.

Put your answer to this question on Fig. 5.1 **B** on page **10**.

[2]

(d) Explain why, in this investigation, the experimenters had to measure the concentration of antibodies to tetanus rather than the concentration of all antibodies in the blood of **A** and **B**.

.....

.....

.....

.....[2]

[Total: 9]

Q4.

2 Fig. 2.1 is a transmission electron micrograph of a plasma cell. Plasma cells are antibody-secreting cells that are formed from B-lymphocytes.

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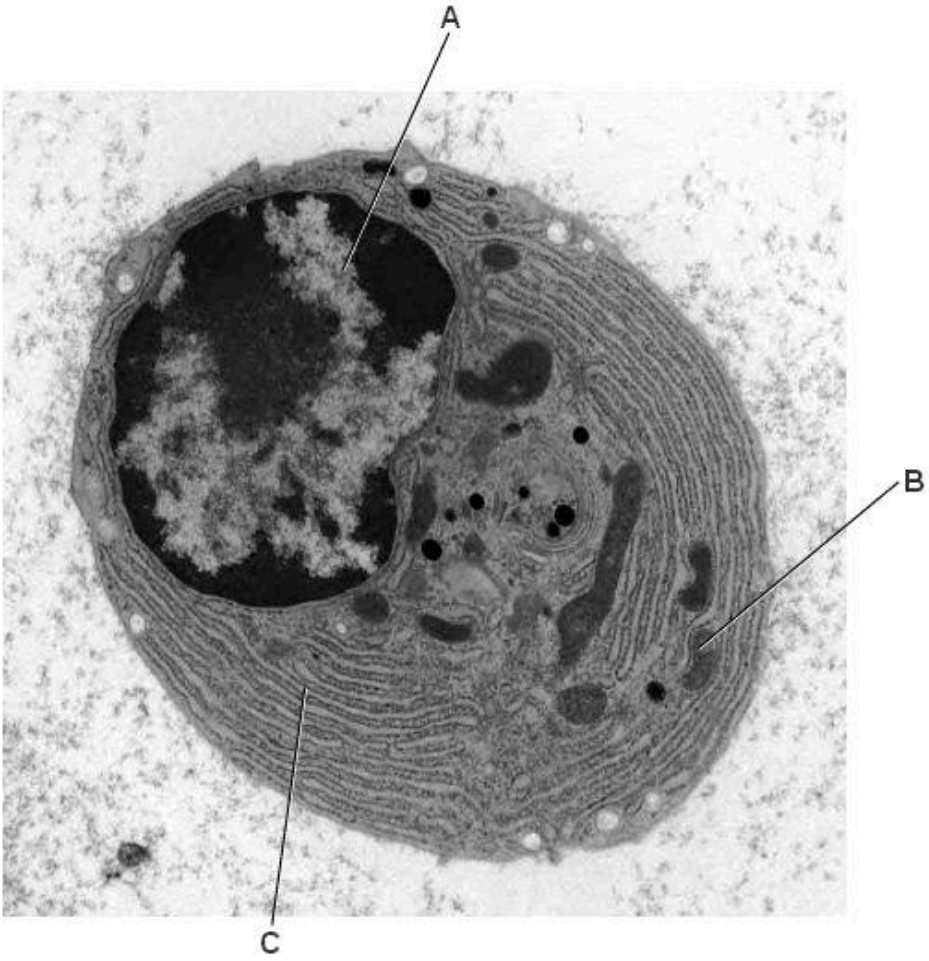


Fig. 2.1

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(a) Complete Table 2.1 to:

- name in full, structures **A**, **B** and **C**
- outline how each structure functions to contribute to the **specific role of the plasma cell**.

Table 2.1

structure	name of structure	function of structure within plasma cell
A		
B		
C		

[6]

(b) An activated B-lymphocyte divides repeatedly by mitosis to produce many identical plasma cells.

(i) Explain why it is important that many identical plasma cells are produced.

.....

.....

.....

.....

.....

..... [3]

(ii) B-lymphocytes have centrioles and a spindle that can be observed during mitosis.

Describe and explain how the behaviour of the centrioles and spindle of a cell dividing by mitosis is associated with the behaviour of the chromosomes.

You may use the space below for labelled diagrams.

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.....

.....

.....

.....

.....

..... [4]

[Total: 13]

Q5.

2 (a) Explain how the virus that causes measles is transmitted.

.....

.....

.....

..... **[2]**

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(b) Antibodies against measles are produced by plasma cells during an immune response.

Fig. 2.1 shows a diagram of an antibody molecule.

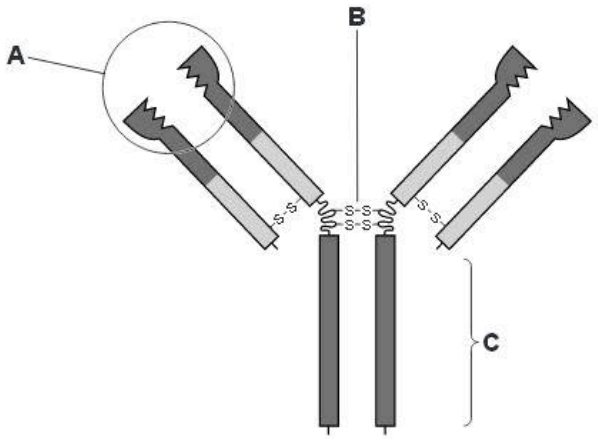


Fig. 2.1

Explain the functions of the parts labelled **A**, **B** and **C**.

(i) **A** .....

.....

.....

.....

..... [2]

(ii) **B** .....

.....

..... [1]

(iii) **C** .....

.....

..... [1]

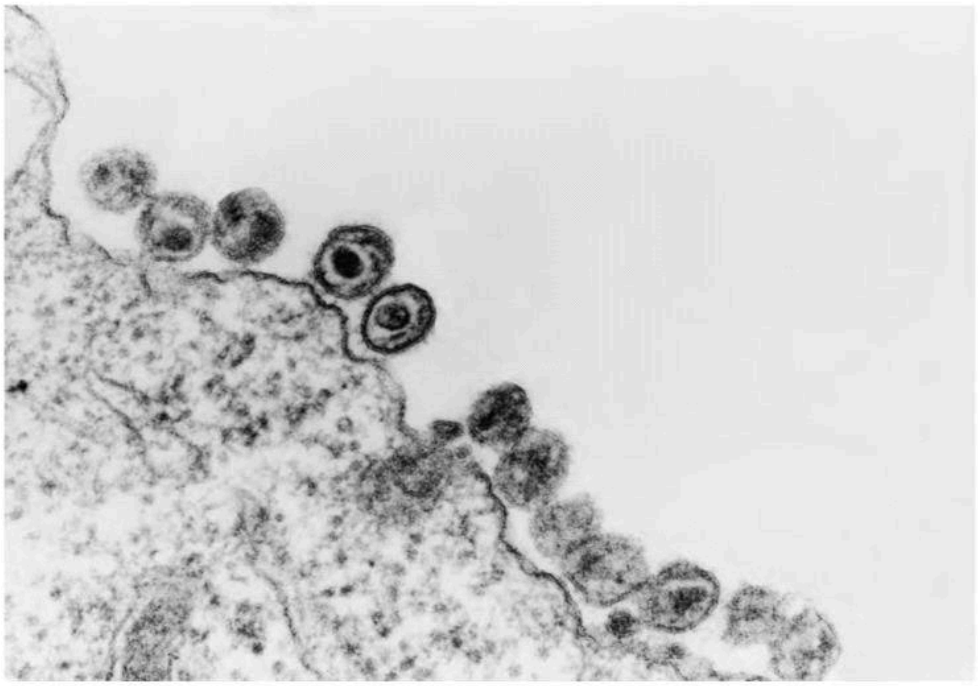
[Total: 6]

Q6.

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Use

3 Fig. 3.1 is an electron micrograph of HIV particles leaving a T lymphocyte.



Magnification × 100 000

Fig. 3.1

HIV instructs the cell to reproduce more viruses. During this process the cell makes viral DNA and viral proteins that assemble to make new viral particles. These particles bud away from the cell membrane to infect other T lymphocytes. This process of viral budding kills T lymphocytes. A decrease in the number of T lymphocytes in the blood results in the destruction of a person's immune system and leads to the onset of AIDS.

(a) (i) Calculate the actual size of a viral particle shown in Fig. 3.1. Show your working and express your answer to the nearest nanometer.

Answer ..... nm [2]

(ii) State the property of the electron microscope that makes it possible to view clearly very small objects, such as viral particles.

.....[1]

(b) Suggest why an infected T lymphocyte that is producing HIV particles has a higher demand for amino acids than an uninfected cell.

.....

.....[1]

Q7.

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(c) Fig. 4.1 shows the origin and development of a B lymphocyte and its subsequent role in an immune response following an infection with the measles virus.

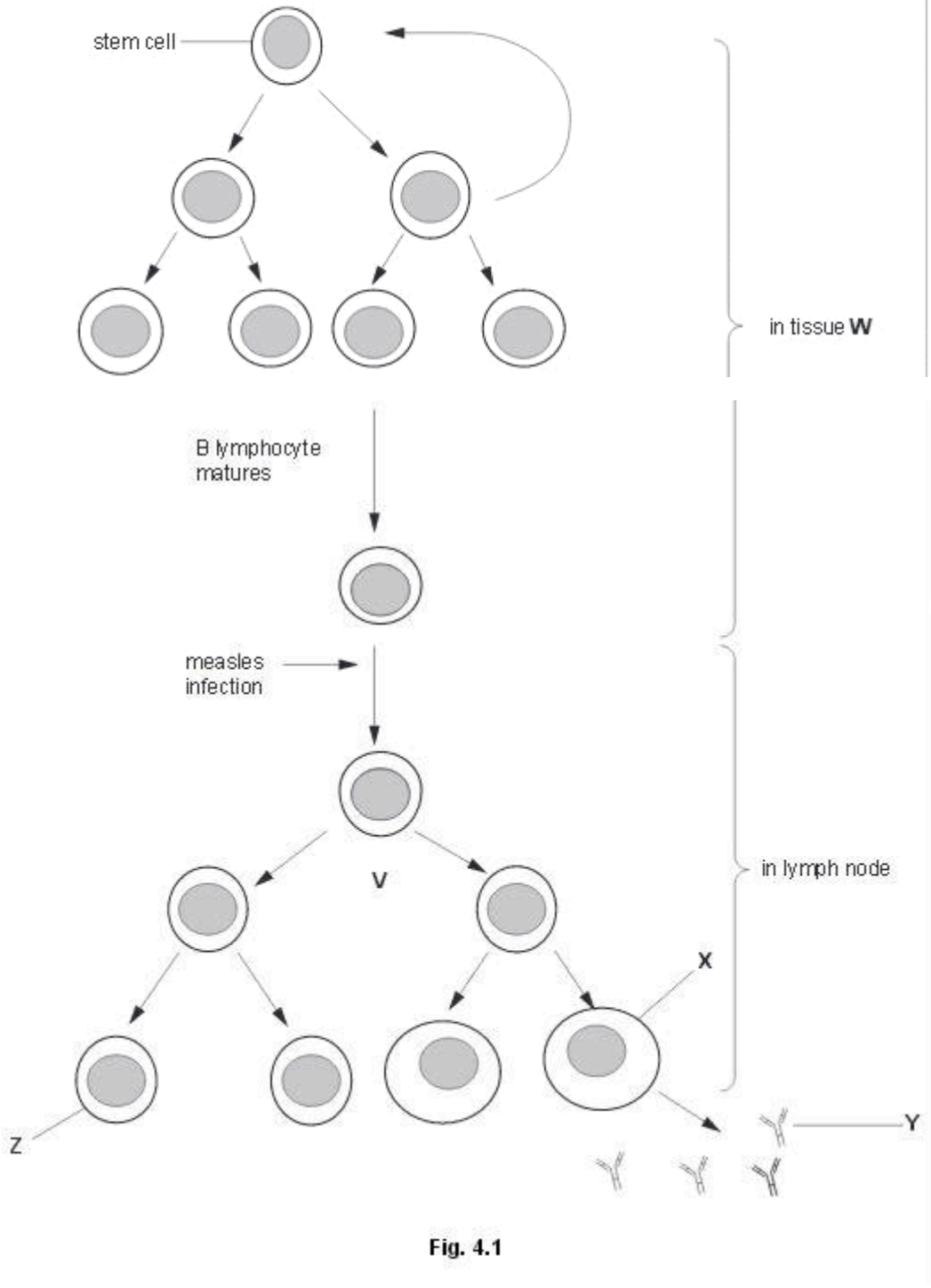


Fig. 4.1

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(i) Name the type of nuclear division that occurs at **V**.

.....[1]

(ii) Name the tissue **W**.

.....[1]

(iii) State the term given to foreign molecules, such as those on the surface of the measles virus, that stimulate an immune response.

.....[1]

(iv) Name cell **X** and molecule **Y**.

X .....

Y .....[2]

(v) Cell **Z** is responsible for long-term immunity to measles.

Name cell **Z** and outline its role.

name .....

role .....

.....

.....

.....[3]

Q8.

(b) **State the roles of phagocytes and T helper lymphocytes during an immune response to a bacterial infection.**

phagocytes

.....

.....

T helper lymphocytes

.....

.....**[2]**

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(c) Antibiotics are used to treat people with bacterial infections.

Explain the danger of the widespread use of antibiotics to treat disease.

.....

.....

.....

.....[2]

Q9.

1 **(a)** Phagocytes and lymphocytes are both involved in defence against infectious diseases. Active B lymphocytes are known as plasma cells.

Fig. 1.1 shows drawings made from electron micrographs of a phagocyte, **A**, and a plasma cell, **B**.

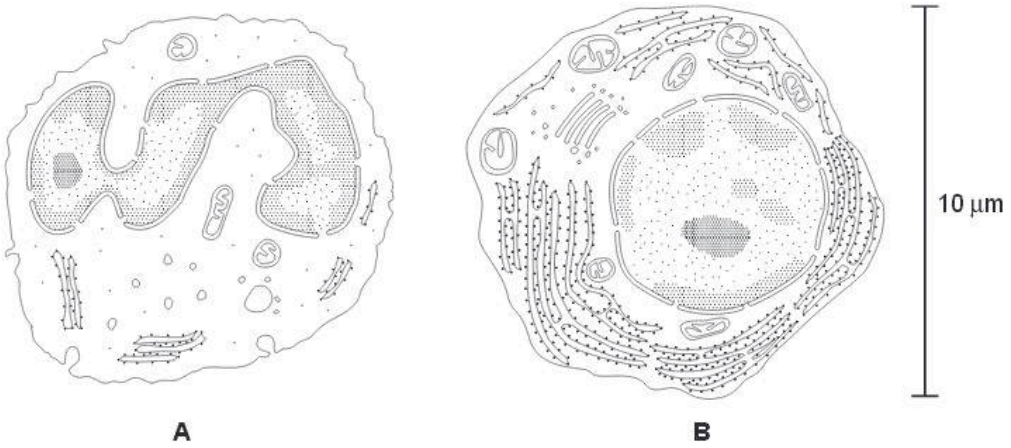


Fig. 1.1

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Complete the table to show three **visible structural** differences between the cells **A** and **B**.

feature	cell **A**	cell **B**

[3]

(b) Calculate the magnification of the cells in Fig. 1.1.

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

..... [2]

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(c) With reference to Fig. 1.1, describe the modes of action of the two cells in defence against infectious diseases.

For Examiner Use

phagocyte .....

.....

.....

.....

.....

..... [3]

plasma cell .....

.....

.....

.....

.....

..... [3]

(d) The bacteria that cause tuberculosis (TB) infect cells in the lungs, including some phagocytic cells. TB is treated with a combination of several antibiotics that are taken over a period of about nine months.

Explain why the antibiotics used to treat TB are taken in combination over a long period of time.

.....

.....

.....

.....

.....

.....

.....

..... [4]

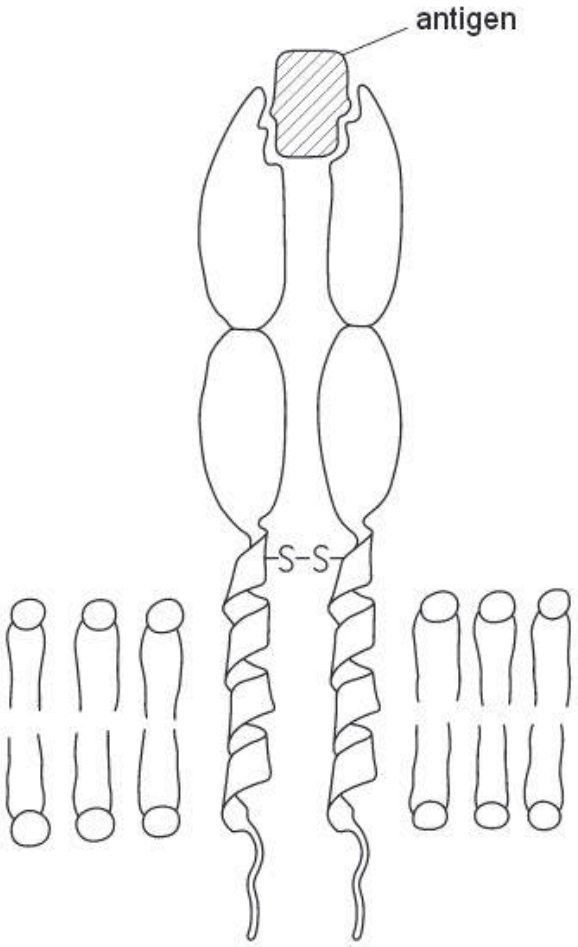
[Total: 15]

Q10.

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1 Receptor proteins are part of the fluid mosaic structure of cell surface (plasma) membranes of T-lymphocytes. Each type of receptor protein is specific to a particular antigen.

Fig. 1.1 shows a receptor protein and the surrounding phospholipids of a cell surface membrane of a T-lymphocyte.



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(iii) Describe how the **structure** of the receptor shown in Fig. 1.1 is similar to the structure of an antibody molecule.

.....

.....

.....

.....

..... [2]

(b) Describe the roles of T-lymphocytes in a primary immune response.

.....

.....

.....

.....

.....

.....

.....

..... [4]

Q11.

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1 During an immune response, plasma cells secrete antibody molecules. Fig.1.1 is a diagram of an antibody molecule. The diagram is **not** complete.



Fig. 1.1

(a) (i) Draw a circle around a variable region. [1]

(ii) Draw in and label the position of the disulfide bonds in the molecule. [1]

(iii) Explain the importance of disulfide bonds in protein molecules, such as antibodies.

.....

.....

.....

.....

.....

.....[3]

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(b) Describe how antibodies provide protection against pathogens.

.....

.....

.....

.....

.....

.....

.....

.....[4]

(c) Other proteins are found in cell surface membranes.

Describe three roles of the proteins in cell surface membranes.

1 .....

.....

2 .....

.....

3 .....

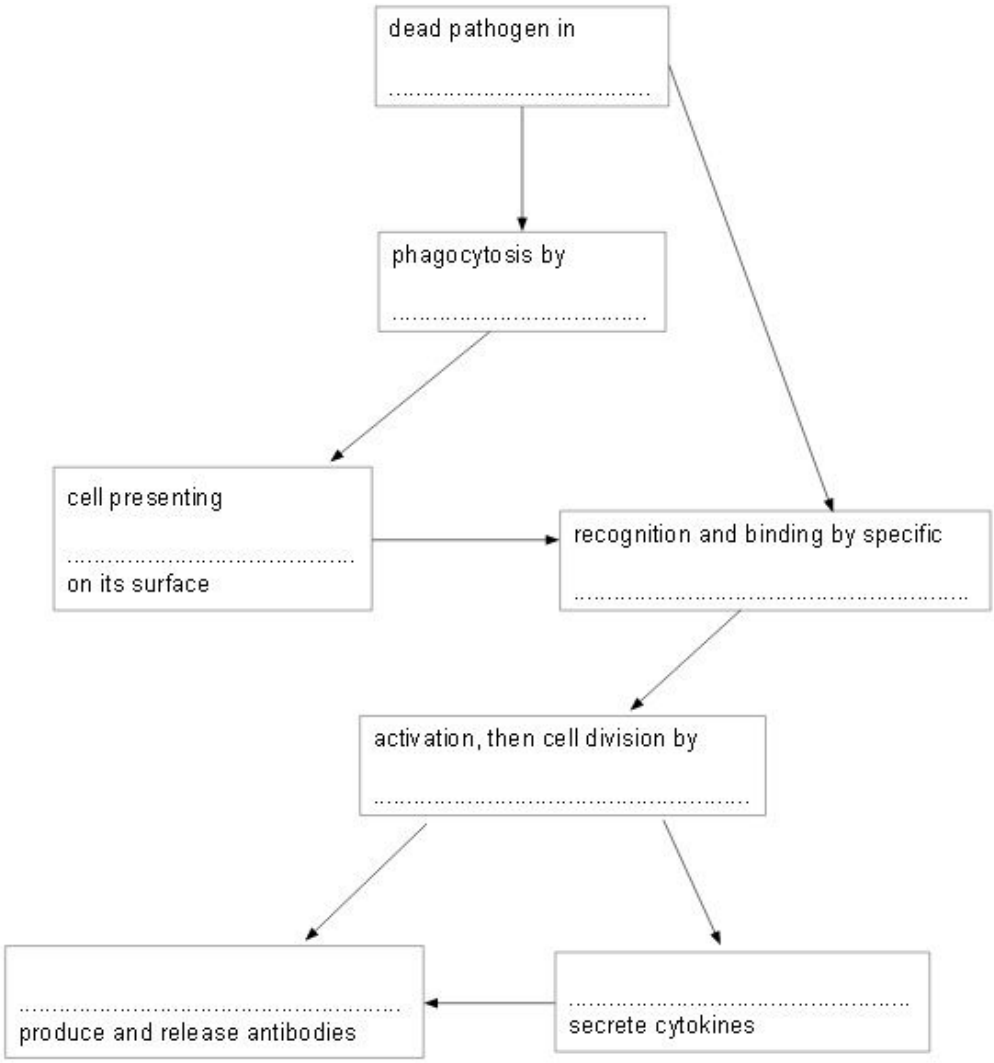
.....[3]

[Total: 12]

Q12.

4 Fig. 4.1 is an incomplete flow chart showing some of the events of the primary immune response that occur after a person has been given a vaccine.

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(a) Choose the correct term from the list below to complete Fig. 4.1.

lymphocytes	**antigens**	**mitosis**	**vaccine**
T_h-lymphocytes	**plasma cells**	**macrophages**	

[3]

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(b) Explain why the person is unlikely to become ill if they are infected by the same pathogen some months later.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

(c) Some parents decide that their children should not take part in a vaccination schedule.

Suggest how a country-wide vaccination schedule can give protection against infection to **unvaccinated** children.

.....

.....

.....

..... [2]

[Total: 8]

Q13.

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4 (a) Outline the roles of the T-lymphocytes and B-lymphocytes in a primary immune response.

6

T-lymphocytes .....

.....

.....

.....

B-lymphocytes .....

.....

.....

.....[4]

Fig. 4.1 shows how the concentration of antibody in blood plasma changes during the response to an antigen which is injected at day 0.

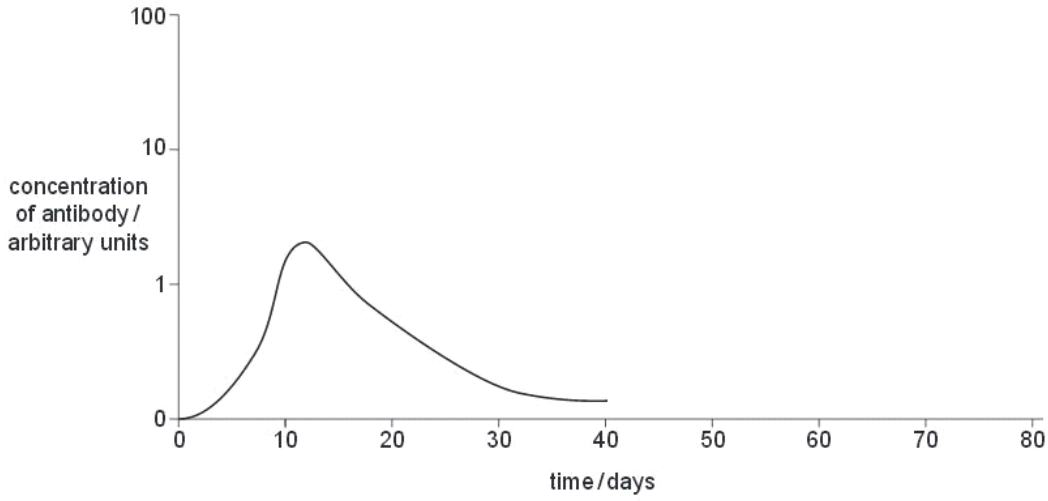


Fig. 4.1

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(b) Explain why the concentration of antibody falls as shown in Fig. 4.1.

.....

.....

.....

.....

.....[3]

(c) Draw on Fig. 4.1 how the antibody concentration would change if the **same** antigen entered the blood plasma on day 40. [3]

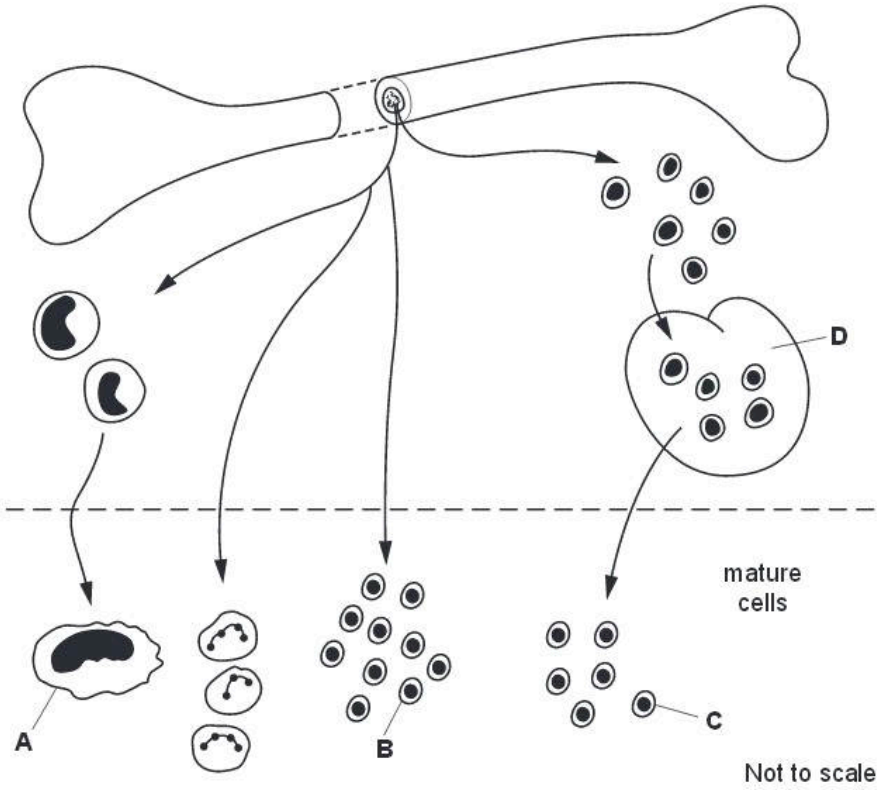
[Total: 10]

Q14.

6 Phagocytes and lymphocytes are part of the body's cellular response to infection by pathogens.

Fig. 6.1 shows the origin and maturation of phagocytes and lymphocytes.

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(a) Name the site of origin of phagocytes and lymphocytes.

.....[1]

(b) Name:

(i) cells **A**, **B** and **C**

A .....

B .....

C .....[3]

(ii) organ **D**.

.....[1]

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(c) Explain the roles of the cells, **A**, **B** and **C** in an immune response.

In your answer use the terms *antigen* and *non-self*.

.....

.....

.....

.....

.....

.....

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.....

.....

.....

.....

.....[5]

Q15.

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2 **(a)** White blood cells play an important role in defence.

For Examiner Use

State precisely the type of white blood cell that fits each of the descriptions given in **(i)** to **(iv)**.

(i) It is formed in the bone marrow and matures from a monocyte. It contains many lysosomes with hydrolytic enzymes.

.....[1]

(ii) It is formed, and matures in, the bone marrow. It contains a lobed nucleus and has the ability to ingest microorganisms by endocytosis.

.....[1]

(iii) When activated, it differentiates into a cell that secretes a chemical, which causes other cells to lyse (burst). It contains a large, spherical nucleus.

.....[1]

(iv) It is formed as a result of a primary immune response and remains in the body. On activation, it has the potential to produce antibodies during a secondary immune response.

.....[1]

Q16.

Stem cells in bone marrow give rise to phagocytes, B-lymphocytes and T-lymphocytes.

Exa

(b) Describe how a red blood cell develops from a stem cell.

.....

.....

.....

.....

.....

.....[3]

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(c) During an immune response, cells divide by mitosis.

Describe how mitosis is involved in an immune response.

.....

.....

.....

.....

.....

.....[3]

(d) Describe the modes of action of T-lymphocytes during an immune response.

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.....

.....[3]

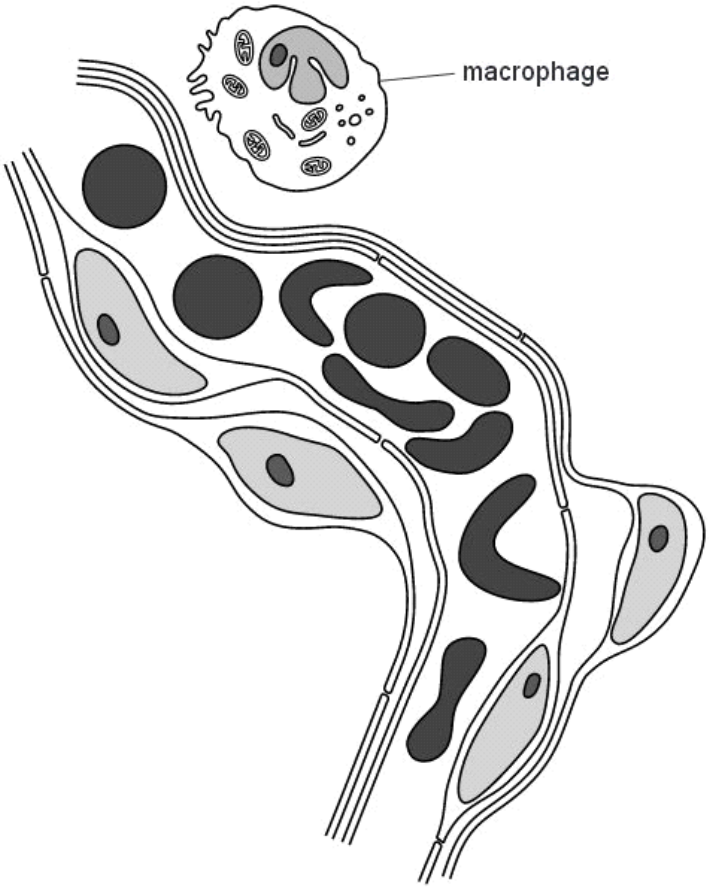
[Total: 13]

Q17.

Macrophages are large phagocytic cells that are found in many tissues including alveolar tissue in the lungs. They provide the main means of defence against pathogens in this tissue.

Fig. 3.1 is a drawing made from an electron micrograph showing part of a capillary and two alveoli, with a macrophage.

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(ii) how macrophages function to protect the lungs from becoming infected.

.....

.....

.....

.....

.....

.....

.....

.....[4]

Q18.

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6 **(a)** Nicotine, in cigarette smoke, is highly addictive. A nicotine vaccine has been developed to try and reduce the effects of addiction. The vaccine stimulates an immune response to produce antibodies that bind to the nicotine molecule. Fig. 6.1 is a diagram of an antibody molecule.

On Fig. 6.1:

- label **three** structural features that enable an antibody molecule to carry out its function.
- next to each label, state the function of the feature.

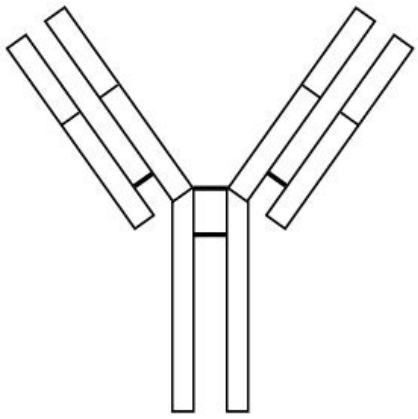


Fig. 6.1

[3]

Q19.

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1 Fig. 1.1 is a diagram of an antibody molecule.

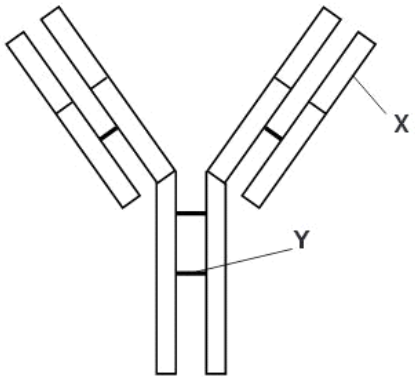


Fig. 1.1

(a) (i) Name the part labelled **X**.

..... [1]

(ii) Name the bond labelled **Y**.

..... [1]

(iii) The antibody molecule in Fig. 1.1 has quaternary structure.

Explain the meaning of the term *quaternary structure* as applied to proteins.

.....

.....

..... [1]

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(b) When a pathogen enters the body, a primary immune response occurs. This response includes the production of antibodies.

Describe the stages in the immune response that lead to antibody being produced against a specific antigen.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(c) Vaccination was used in the eradication of smallpox.

Explain, in terms of antigens, why it has not been possible to do the same for malaria.

.....

.....

.....

.....

.....

..... [2]

[Total: 9]

Q20.

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A potential vaccine for choleragen was trialled on volunteers. Fig. 4.1 shows the concentration of antibodies against choleragen in the blood of a volunteer who received a first injection at week 0, followed by a booster injection at week 15.

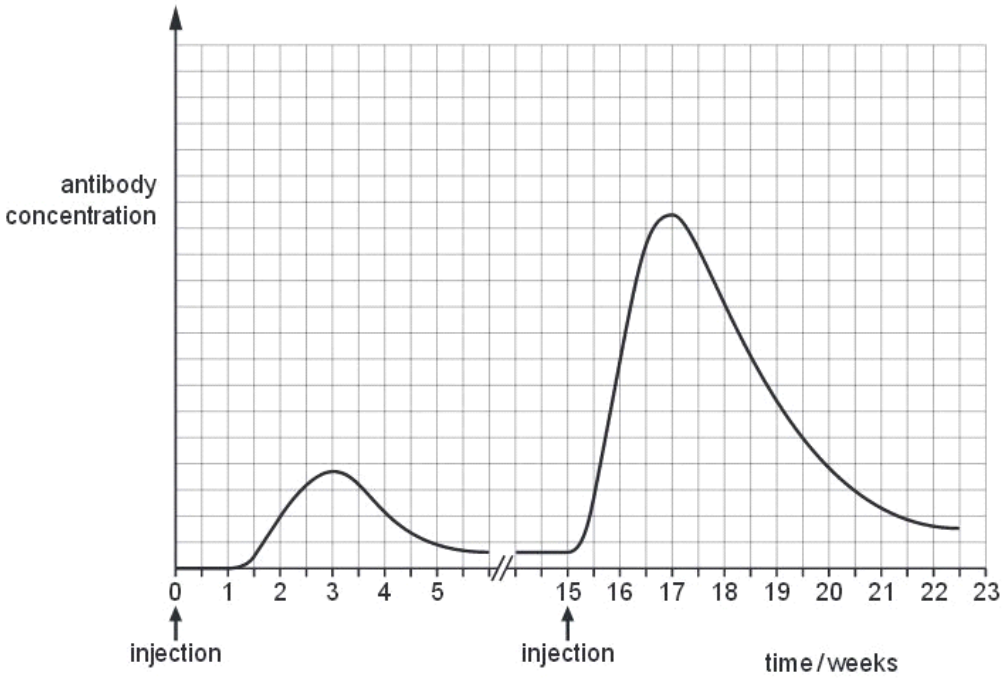


Fig. 4.1

(b) Using the information in Fig. 4.1, explain the differences between the responses to the first injection and the booster injection.

Fo
Exam
Us

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.....[4]

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Q1.

3 (a)	Correct letter order **on** Question Paper: A - nucleus; C - mitochondria; B - RER; D - Golgi apparatus; E - cell surface membrane; *R. process statements instead of letters*	**max 4**
(b)	secrete/release/produce/make antibodies; A. immunoglobulins R. memory cells unless linked to antibody production	**1**
(c)	nucleus/nuclear envelope/nuclear membranes/nucleolus; no cell wall; have organelles/named visible organelles; (golgi/mitochondrion/ RER) R. more organelles larger (cell); fixed ribosomes/ribosomes attached to E.R./no free ribosomes;	**max 2**
		[Total 7]

Q2.

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6 (a) mitosis / mitotic division; **R** cell division / cytokinesis **1**

(b) clone; **1**

(c) T cell receptor is correct / exact / perfect match / fit / complementary to antigen; **R** corresponds / identical / same
ref to different / wrong shapes of receptors on J and / or L;
ref to specificity; **2 max**

(d) *N.B. Mark first role given*
either

helper cells
secrete / release / produce, cytokines / lymphokines / hormones;
to stimulate B cells to, divide / develop into plasma cells;
(which) produce antibodies;
(and) stimulate macrophages to carry out phagocytosis / (idea of);

or

cytotoxic / killer T cells
seek out / find / bind to (foreign) antigens on host cells / pathogens;
destroy, host cells / intracellular parasites / virally infected cells / viruses;
attach to surface of cells / 'punch holes' into cells;
release toxic substances / interferons / hydrogen peroxide (into cells); **R** enzymes **2 max**

(e) (i) carcinogen / mutagen; **R** all other responses **1**

(ii) T cells do not recognise antigens;
no immune response / weak immune response / no secondary immune response;
no / few antibodies produced;
no / few T killer cells produced;
susceptible / vulnerable to / increased likelihood of, infection / disease / opportunistic infections;
R refs to cancer / autoimmune disease **2 max**

[Total: 9]

Q3.

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5 **(a)** **A** passive artificial ;
B active artificial ;

if artificial omitted score one mark if passive and active are correct [2]

(b) mark **(i)** and **(ii)** together

(i) antibody, destroyed/broken down ;
antibody excreted ;

(ii) no antigen entered body ;
no immune response ;
no, (active) B cells/plasma cells/memory cells ;
no antibody made ;

AVP ; e.g. further detail of lack of immune response /
no stimulation of B cells by T helper cells/no cloning [max. 3]

(c) *line drawn on graph to show*

increase occurs faster than in primary response ;

higher peak of concentration than in primary response ; [2]

(d) antibody is specific (for tetanus) ;
further detail ; e.g. variable region
always some (circulating) antibody molecules, linked with qual ;; [max. 2]

[Total: 9]

Q4.

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2 **(a)** *allow immunoglobulin for antibody*

structure	name of structure	function of structure within plasma cell
A	nucleus ; **A** (eu)chromatin **R** heterochromatin **R** chromosome	ref. gene(s) / genetic information / genetic material / DNA, (coding) for, antibody / protein / polypeptide ; transcription (occurring) / mRNA synthesis ; AW (ref. antibodies) *allow ecf for nucleolus*
B	mitochondrion ; **A** mitochondria	provides / synthesises / produces / makes, ATP (for antibody synthesis / exocytosis) ; *treat as neutral other uses of ATP* *allow ecf for lysosomes*
C	rough endoplasmic reticulum ; ignore RER	synthesis / modification / processing / transport, of, antibody / protein / polypeptide ; **A** translation *allow ecf for Golgi or SER or ER*

[max 6]

(b) **(i)** **1** part of the immune response ; **A** primary / secondary, response

many plasma cells

2 to produce high, concentration / level / AW, of, antibody / immunoglobulin ;

3 (high concentration antibody so) more effective against pathogens / AW ;

identical plasma cells

4 specific / particular / AW, to an, antigen / epitope ;
in context of antibodies or plasma cells

5 antibody (molecules) produced are all the same ; **A** ora, qualified

6 only the gene coding for particular antibody, switched on / transcribed / expressed ;

[max 3]

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(ii) *accept from annotated diagrams*

cell cycle stages are not required for mark points 1, 3, 4 and 7
reject if incorrect mitotic stage given for these mark points

1 ref. to, duplication / replication, of centrioles (in late interphase / before prophase);
A dividing
R splitting
2 (centriole pairs) move to opposite poles in prophase ;
accept asters or centrosomes for centrioles
3 (movement allows) spindle formation / organisation of spindle fibres / microtubule assembly / microtubule organisation / AW, (in prophase) ;
4 (late prophase / early metaphase / metaphase), chromosomes / centromeres, attach to, spindle fibres / microtubules ;
5 chromosomes, line up / aligned / AW, at, equator / metaphase plate ;
6 ref. separation of, sister / identical, chromatids, at anaphase (to poles) ;
A sister chromatids move to opposite poles at anaphase
A daughter chromosomes *for sister chromatids*
7 ref., pulling / shortening, by, microtubules / spindle fibres ; AW [max 4]

[Total: 13]

Q5.

2 **(a)** (infected) person, sneezes / coughs / talks / breathes out, (airborne) droplets / aerosol / moist air ;
ignore contact
inhaled / inspire / breathed in, by uninfected, person ;
ignore transplacental transmission [2]

(b) **(i)** *variable region*
binds / attaches / combines, to antigen ;
R receptor site **R** 'fit'
ref. to specificity ;
ignore complementary shape (to antigen)
R same / similar shape [max 2]

(ii) *disulphide bond*
ignore ref. to hinge

holds, polypeptides / heavy chains / long chains, together ;
ignore constant as description of chains
maintains, tertiary / quaternary / 3D, structure / shape ;
R shape unqualified [max 1]

(iii) *constant region*
binds to, receptors / cell (surface) membrane, on, phagocytes / macrophages ;
antigen, marking / tagging, for, phagocytosis / macrophage action ; AW
A ref. to opsonisation
R agglutination [max 1]

[Total: 6]

Q6.

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3 (a) (i) *2 marks for the correct answer – leeway on measurement to be decided.*

$\frac{10\text{ mm}}{100\,000}$;

100 nm. **[2]**

(ii) Good/high, resolution. **A** short wavelength **[1]**

(b) (T lymphocyte) makes viral, protein/enzyme;
Cell needs more enzymes for replicating, DNA/protein synthesis/AW;
AVP. **max [1]**

Q7.

(c) (i) Mitosis. **[1]**

(ii) Bone (marrow). **[1]**

(iii) Antigen. **[1]**

(iv) **X** plasma cell;
Y antibody ; **A** immunoglobulin **[2]**

(v) Memory cell. **[1]**

Remains in, lymph node/blood/lymph/lymphatic system/body;
Recognises next infection by same, antigen/(measles) virus;
Secondary response;
(More) rapid (than primary);
Immunological memory;
AVP. **max [2]**

Q8.

(b) *phagocytes*
ingest/engulf/digest, bacteria; **R** destroy/kill/phagocytosis unqualified act as APC
(Antigen Presenting Cell) to stimulate B/T cell response; [max 1]

T helper cells
secrete/release, cytokines/lymphokines;
to activate/stimulate B lymphocytes to produce plasma cells/antibodies/memory
cells, or stimulate/activate phagocytosis; [max 1]

[2]

(c) resistance; **R** bacteria become immune
ref to selection of resistant bacteria;
antibiotic, can then not be used/are ineffective/no longer kill bacteria;
ref to multiple resistance;

R answers that suggest people become resistant **[max 2]**

Q9.

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1 **(a)** *check column **A** and **B** for correct ref. to feature if not clear in first column e.g. gives description*

feature	phagocyte (**A**)	plasma cell (**B**)
rough endoplasmic reticulum / RER *allow ER if rough / RER stated in next column(s)* **R** SER	small quantity / AW **A** few, less	large quantity / AW ; **A** many, more
ribosomes	few *or* ref. to free	many ; *or* not free / fixed
lysosomes	some / present / ✓	none / absent / x ;
vacuoles / vesicles / phagosomes	some / present / ✓	none / absent / x ;
nucleus	lobed / AW **A** irregular, not round **R** curved, elongated, no definite shape	round / not lobed / not irregular / AW ; **A** spherical, circular
Golgi (body)	absent / x	present / ✓ ;
plasma / cell (surface), membrane	with, endocytotic / pinocytotic / phagocytic / exocytotic, vesicles / vacuoles **A** invaginations, infoldings **R** indentations	without, endocytotic / pinocytotic / phagocytic / exocytotic, vesicles / vacuoles **A** no invaginations, no infoldings **R** no indentations
mitochondria	less / few / 3	more / many / 7 ;

[3 max]

(b) (to nearest whole number) (x) 6000 :: **A** 5900 – 6100
allow 1 mark for correct working if answer incorrect / not to whole number
e.g. length of scale bar in mm × 1000, divide by actual size
60 mm × 1000 / 10 **A** 59 – 61 mm [2]

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(c) *phagocyte*
move to sites of infection ;
ingest / engulf / pseudopodia enveloping / phagocytosis of / endocytosis of, bacteria / microbes / pathogens / AW ;
R antigens, virus
(form) phagocytic / endocytotic, vacuoles ;
A vesicles, phagosomes
ref to lysosomes ;
enzymes / named (hydrolytic) enzymes ;
digest / hydrolyse, (bacteria / AW) ;
antigen presentation / description ; [3 max]

plasma cell
produce / secrete / release / synthesise , antibodies ; **A** make
into, plasma / tissue fluid / lymph ; **A** blood
antibodies are proteins ;
ref to, RER / ribosomes ;
specificity qualified e.g. of, antibodies / lymphocyte / plasma cell
or description e.g. each type of plasma cell produces one type of antibody ;
Golgi (body) packages antibodies / ref to formation of (Golgi) vesicles ; [3 max]

(d) (bacteria likely to be) resistant to (at least) one antibiotic (so useless) ;
less likely to be resistant to all / chance that bacteria will develop resistance to all antibiotics used is very small ;
ref to mutation / change to DNA ;

(bacteria are) inside cells where protected from antibiotics ;
(mycobacteria) divide / grow, slowly ;
ensures all bacteria killed / reduces below critical level ;
otherwise, bacteria remain / reservoir of infection ;
(so) prevents development of antibiotic resistance ; [4 max]

[Total: 15]

Q10.

(iii) both made of, protein / polypeptide(s) / amino acids ;
both have
disulphide bond ;
antigen binding site ;
variable region ;
constant region ; **A** non-variable [2 max]

(b) *helper cells*
secrete / release / produce, cytokines / lymphokines / hormones ;
to stimulate B cells to, divide / develop into plasma cells ;
(which) produce antibodies ;
stimulate macrophages to carry out phagocytosis ;

cytotoxic / killer T cells
seek out / find / bind to, (foreign) antigens, on host cells / pathogens ;
destroy, virally infected host cells / intracellular parasites / viruses ;
attach to surface of cells / 'punch holes' into cells / disrupt cell surface (plasma) membrane;
(release) toxic substances / hydrogen peroxide (into cells) / interferons ;
R enzymes [4 max]

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Q11.

1 **(a)** **(i)** circle around one *or* two variable regions ; [1]

(ii) line(s) between **one** light polypeptide and **one** heavy polypeptide,
line(s) between the two heavy polypeptides ;
maximum of six lines in each site [1]

(iii) **1** (disulfide) bonds are between, cysteine(s) / cysteine residues ;
A between R groups S-H S-H
2 covalent bond ;
3 strong bond / not easily broken ;
4 hold, polypeptides / chains / protein , together ; **R** proteins / strands
5 (in protein with) tertiary / quaternary (structure) ;
6 maintain shape / stop loss of shape / prevent deforming ;
A 3D structure **R** structure unqualified [3 max]

(b) **1** secreted / synthesised / produced / released, by, plasma cells / B lymphocytes / B cells ;
2 combines / AW, with, antigens / pathogens / toxins / viruses / bacteria / microbes ;
A 'bonds with' / 'sticks to' / 'attaches to' **R** 'disease'
3 ref to, specificity / described ; *in context of antibody / B cells / antigen*
4 variable region is antigen binding region ; **R** 'receptors on antibodies'
5 neutralises toxins / antitoxin(s) ;
6 lysis of pathogens / described / lysin(s) ; **R** breaks down
7 prevents viruses entering cells ;
8 clumps / agglutinates / aggregates / AW, bacteria ; **R** 'coagulation'
9 opsonisation / opsonins ; **A** enable recognition
10 coats / AW, bacteria to facilitate phagocytosis ; *only in context 8 or 9*
11 receptors on phagocytes for constant regions (of antibodies) ; [4 max]

(c) **1** (carrier / channel protein for) facilitated diffusion / described ;
A action of (co-) transport protein described
2 (carrier protein for) active transport / described ;
3 cell recognition / distinguishing self from non-self / act as antigens / AW ;
4 receptor ; **A** binding site qualified in terms of, hormones / neurotransmitters / cytokines / cell signalling molecules ;
5 T-cell receptor / described ;
6 cell (to cell) adhesion / described ;
7 enzyme ;
8 form (hydrogen) bonds with, water / fluid surroundings, to stabilise membrane ; **[3]**

[Total: 12]

Q12.

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4 (a)

vaccine
macrophages } ;

antigens lymphocytes } ;
mitosis

plasma cells *and* T_h-lymphocytes ;

[3]

no ecf from **(a)** to **(b)**

(b) **1** active (artificial) immunity ;

2 memory cells / immunological memory ;
3 *idea that* many specific, B-cells / T-cells / lymphocytes, in the body ;
A large(r) clones of specific, B- / T-cells *or* lymphocytes

actual invasion by the pathogen
4 fast secondary (immune) response ;
5 fast increase in antibodies / immediate production of antibodies ;
ignore incorrect type of cell secreting antibodies

6 high(er) concentration of antibodies are produced ; **A** more antibodies produced
7 pathogen destroyed before person becomes ill / AW ; **R** antigen
A pathogen do not, increase in number / infect cells / AW [max 3]

(c) *two points to look for*

(if) most / sufficient / many / AW, people / children, immunised / vaccinated ;
A herd immunity

reduces the pool of infected, people / children, in the, community / population ;
A fewer people can catch disease and be source of infection
A protects those unvaccinated as, disease / illness, does not spread
A less chance of transmission
A pathogen cannot develop in immunised people
A reduced exposure to pathogen [max 2]

[Total: 8]

Q13.

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4 **(a)** **R** if mark points are in context of secondary response

sensitised / activated / AW, by (foreign) antigen / epitope ; *accept once only*
correct ref. specificity ; *accept once only*
production of memory cells ; *accept once only*

T lymphocytes
(T-helper / Th) secrete, cytokines / lymphokines ;
(T-helper / Th) stimulate, B cells to divide ; **A** stimulate humoral response
(T-killer / Tk / T-cytotoxic / Tc) secrete, perforin / hydrogen peroxide / AW ;
A toxins
R hormones
(T-killer / Tk / T-cytotoxic / Tc) kill / destroy / AW, non-self cells / pathogens / infected cells ;
(T-surpressor / Ts) ref., surpresses / reduces, response (on recovery) ;

B lymphocytes
formation of plasma cells ;
antibody production ; [max 4]

(b) no more antigen / AW ;
(remaining) antibodies, removed from the blood / broken down (in the liver) ;
R excreted
plasma cells, are short-lived / begin to die / are not replaced ;
no more antibody produced ;
AVP ; e.g. detail of removal / macrophage engulfs, digested, peptide bonds broken [max 3]

(b) no more antigen / AW ;
(remaining) antibodies, removed from the blood / broken down (in the liver) ;
R excreted
plasma cells, are short-lived / begin to die / are not replaced ;
no more antibody produced ;
AVP ; e.g. detail of removal / macrophage engulfs, digested, peptide bonds broken [max 3]

(c) line drawn continuous with that provided ;
and rising more steeply before day 55 ; *should start to rise from day 40 / should rise more steeply initially /should not remain as a plateau from day 40*

reaches higher than primary response between day 45-55 and, peaks / plateaus ;
must not go below the day 40 antibody concentration [3]

[Total: 10]

Q14.

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6 **(a)** bone marrow ; [1]

(b) **(i)** **A** = macrophage / APC ; **A** monocyte
B = B, lymphocyte / cell ;
C = T, lymphocyte / cell ;

allow one mark if lymphocyte given for both B and C but not qualified or incorrectly qualified [3]

(ii) thymus ; [1]

(c) *max 4 if no reference to, antigen / non-self*

foreign / AW, antigens are non-self ;
non-self / foreign antigens, induce immune response ; AW ora

*macrophage / APC (**A**)*
phagocytosis / described ;
cuts up / AW, bacterium / pathogen ;
presents antigens / becomes antigen presenting cell / antigens on cell surface ;

*B/T, cells (**B** and **C**)*
antigen recognition by lymphocytes ;
(with) complementary / specific, receptors / immunoglobulins (B) / antibodies (B) ;
divide by mitosis ; **A** clonal expansion
ref. formation of memory cells (for secondary response);

*T_h cells (**C**)*
secrete cytokines to stimulate B cells ;
cytokines stimulate macrophages ;

*Tc/k cells (**C**)*
ref. destroy pathogen / AW ;
produce perforin / AW ;

*B cells (**B**)*
B cells become plasma cells ;
(plasma cells) secrete antibodies ;

AVP ; e.g.
macrophages, non-specific / faster response
ref. specificity of, lymphocytes / B and T cells
antibody variable region is the antigen binding site ; [5 max]

[Total: 10]

Q15.

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2 **(a)** *'cell' is not required as it is in the stem of the question*

(i) macrophage ; **A** antigen-presenting cell **R** mycrophage [1]

(ii) neutrophil ; **A** PMN / polymorphonuclear leucocyte [1]

(iii) T-killer / T_K / T-cytotoxic / T_C, lymphocyte ; **A** cell for lymphocyte [1]

(iv) memory B- lymphocyte ; A cell for lymphocyte [1]

Q16.

(b) transcription (of specific genes) ; **A** reference to gene switching
protein / polypeptide, synthesis ; **A** translation
production of haemoglobin ;
further detail ; e.g. assembly of quaternary structure
(production of) carbonic anhydrase ;
loss of, mitochondria / named organelles ;
loss of nucleus ;
adopts biconcave disc shape ; [max 3]

(c) occurs in both primary and secondary (immune) responses ;
selected / specific / AW ;
lymphocytes / B -cells / T-cells / divide (by mitosis) ;
clonal expansion / described in terms of producing, clone / many cells ;
A *idea that* different types of immune cell can result
reference mitosis in memory cells (for rapid) secondary response ; [max 3]

(d) *T helper / Th,*
secrete, cytokines / interleukins ;
activate B-lymphocytes to, divide / form plasma cells ; **A** idea that leads to enhanced antibody levels
enhances / AW, phagocyte / macrophage, response ; **A** angry macrophages ;

T cytotoxic / Tc / T killer / Tk
attach to / kill / AW, infected cells / damaged cells / tumour cells / cells with non-self antigens / AW;
mechanism of killing ; e.g. perforin

T memory / Tm
already exposed to antigen ;
reference to role in secondary response ;

AVP ; ; e.g. T suppressor cells
function of suppressor cells [max 3]

Q17.

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(ii) *allow microorganisms or named type of microorganism or infectious agent for pathogens*

1 recognise, non-self / foreign, antigens, (on pathogen) ;

2 receptors (on macrophage) bind antigens (on pathogen) ;

3 (or), pathogen / AW, adheres / 'sticks', to (cell surface) membrane ;

4 infolding of (macrophage cell surface) membrane around / engulf / phagocytosis of, pathogen ; **R** engulf antigen

5 vacuole / vesicle / phagosome, forms ;

6 ref. to lysosomes ;

7 hydrolytic / digestive / named, enzymes ;
e.g. lysozyme / protease / nuclease
A pathogen broken down by enzymes

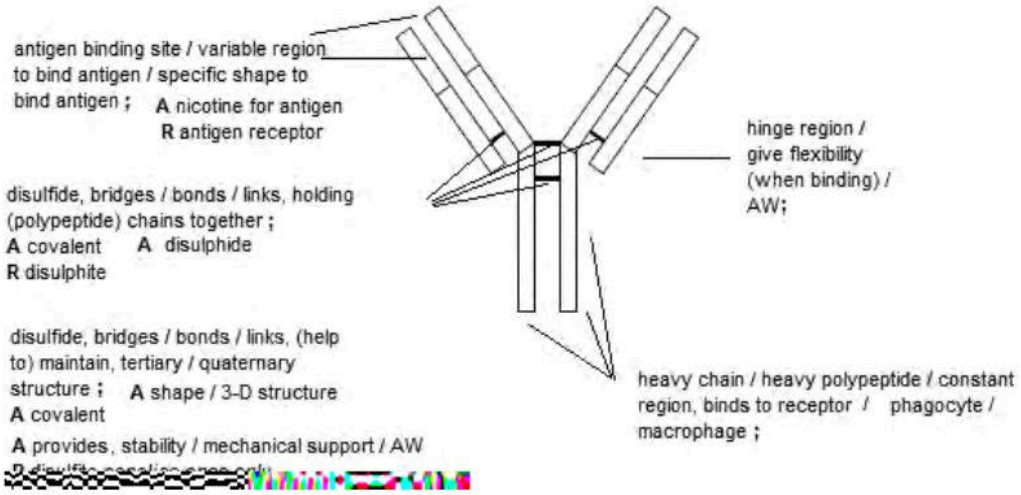
8 hydrolysis of named compound(s) ;

9 ref. to destroying / killing, pathogen ;

10 ref. to antigen presentation ;
accept idea even though does not occur in alveoli [max 4]

Q18.

6 **(a)** *labels to correct areas, mark to max 3*



AVP ; e.g.
light and heavy polypeptide chain, ref. forming variable region / different primary structure(s) giving different shapes ;
heavy / polypeptide, chain constant region gives antibody class ; AW [max 3]

Q19.

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1 **(a)** **(i)** variable region / antigen binding site ; **A** antigen binding region
A light, polypeptide / chain **R** antigen receptor [1]

(ii) disulfide ; **I** bridge
A disulphide **R** disulfite / covalent [1]

(iii) two or more / more than one , polypeptide(s) / tertiary structure(s) ;
R any specific number of polypeptide on its own
R more than one type of polypeptide / many polypeptides
R more than two / several, polypeptides
I ref to prosthetic group [1]

(b) 1 antigen recognised as / AW, non-self / foreign ;
accept once for macrophage, B-lymphocyte or T-lymphocyte
A non-self / foreign, antigen leads to immune response
2 *idea of* phagocytosis leading to antigen presentation ;
3 antigen (on pathogen or APC) binding to, receptor / membrane, of B-cell(s) / B-lymphocyte(s) ; **A** clonal selection of B-lymphocytes occurs
4 (helper) T-cell / T-lymphocyte, activate B-cells ; **I** killer T-cells
A release cytokines to stimulate B-cells
5 B-cells / B-lymphocytes, divide by mitosis ; **A** replicates / proliferates by mitosis
A clonal expansion of B-cells
6 plasma cells, formed / AW ;
7 plasma cells / B-cells / B-lymphocytes, produce / secrete / AW, antibody / immunoglobulin / Ig ; [max 4]

(c) *parasite / Plasmodium / pathogen / protoctist / protist / protozoan must be mentioned at least once somewhere in the answer to gain any marks*
e.g. 'malaria / disease has many antigens' = 0

if malaria is caused by a virus / bacterium penalise once only

1 (malarial) parasite / pathogen / *Plasmodium*, (is eukaryotic) has many genes ;
A has greater genetic complexity cf smallpox / AW
2 different (malarial) parasite, species / strains / AW, have different antigens ;
R 'strands'
3 (malarial) parasite has different antigens in different stages of its life cycle ;
4 (malarial) parasite / *Plasmodium*, switches antigens / idea of antigens changing during infection / different genes coding for antigens switching on / AW ;
R 'active sites' of antigens changing
R 'antigens mutate'
5 parasite / antigen / stages of the life cycle, inside (host / liver / red blood) cells ; [max 2]

[Total: 9]

Q20.

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(b) *must be in context of B-lymphocytes / B-cells / plasma cells*
max 3 if T-cells

secondary response ***A*** *ora*
presence of memory cells / AW (giving larger numbers) ;
ref. increased chance of, encountering antigen / antigen presentation / clonal selection ;
ref. larger numbers cells following, clonal expansion / AW (cf primary response) ;
(so) shorter duration for onset of antibody production ;
(so) higher antibody concentration ;

secondary response antibody production (by plasma cells) lasts longer ;
AVP ; e.g. faster rate, plasma cell / antibody, production, ref. longer-life of cells involved in secondary response [max 4]

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Immunity – AS 9700 Biology June 2022

1. June/2022/Paper_11/No.38

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

2. June/2022/Paper_11/No.39

A person's blood group is determined by antigens present on the red blood cells.

The table shows the antigens and antibodies in the blood of people with different blood groups.

blood group	presence of A or B antigens on red blood cells	presence of antibodies to A or B in plasma
A	A only	anti-B only
B	B only	anti-A only
AB	A and B	neither
O	neither	anti-A and anti-B

During a blood transfusion, it is essential that the person receiving the blood does not have antibodies to the donor's blood.

Which blood groups can be given to a person with blood group AB?

A AB only

B O only

C A and B only

D A, B, AB and O

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3. June/2022/Paper_11/No.40

Which types of cell are stimulated to divide by the cytokines produced by T-helper cells?

A macrophages

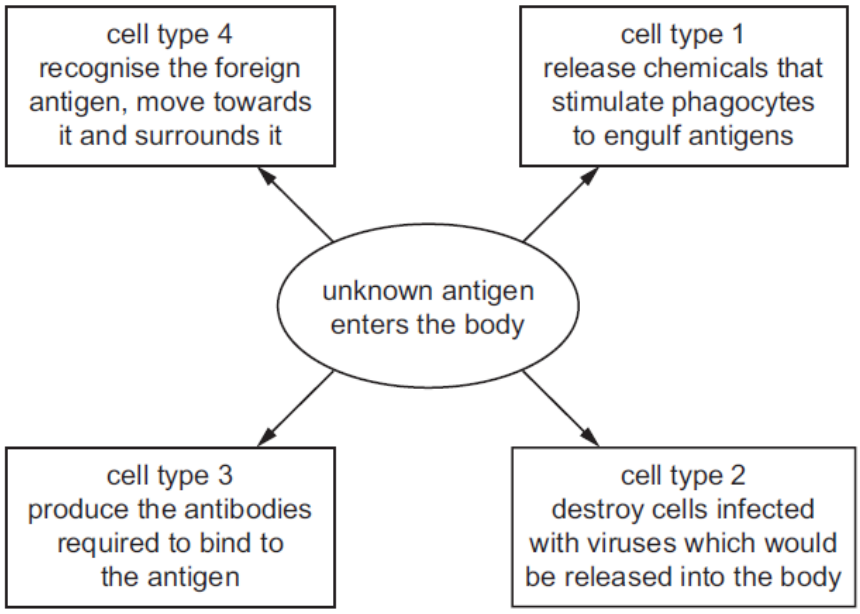
B B-lymphocytes only

C T-killer cells only

D B-lymphocytes and T-killer cells

4. June/2022/Paper_12/No.40

A student used a diagram to show four types of cells involved in the primary immune response.



Which row is correct?

	cell 1	cell 2	cell 3	cell 4
A	B-lymphocyte	macrophage	T-killer cell	T-helper cell
B	macrophage	B-lymphocyte	T-helper cell	T-killer cell
C	T-helper cell	T-killer cell	B-lymphocyte	macrophage
D	T-killer cell	T-helper cell	B-lymphocyte	macrophage

5. June/2022/Paper_13/No.38

Rheumatoid arthritis is a disease which causes the body's immune system to attack its own cells. The disease can be treated using monoclonal antibodies.

The table shows how five different monoclonal antibodies can work.

monoclonal antibody	mode of action
1	binding to proteins on cell surfaces and triggering the immune system
2	blocking molecules on cell surfaces that inhibit T-lymphocytes
3	blocking cell signalling receptors that trigger cell division
4	binding to antigens on cell surfaces and releasing a drug
5	blocking cell signalling receptors that trigger the immune response

Inflammation and swelling of joints are symptoms of rheumatoid arthritis. The cytokine, TNFalpha, activates cells in the immune system leading to death of cells in the joint.

Which types of monoclonal antibody could be used to treat rheumatoid arthritis?

A 1, 2, 3, 4 and 5

B 1, 2, 3 and 4 only

C 2, 3 and 5 only

D 4 and 5 only

6. June/2022/Paper_13/No.40

Some of the events during the primary immune response are listed.

1 phagocytosis of a foreign microbe by a macrophage and antigen presentation

2 some T-lymphocytes will become T-killer cells which kill infected body cells

3 the T-helper cell divides by mitosis to produce T-lymphocyte clones

4 a T-helper cell with the complementary receptor binds to the antigens being presented

What is the correct sequence of events during the primary immune response?

A $4 \rightarrow 1 \rightarrow 3 \rightarrow 2$

B $1 \rightarrow 4 \rightarrow 3 \rightarrow 2$

C $3 \rightarrow 1 \rightarrow 4 \rightarrow 2$

D $3 \rightarrow 4 \rightarrow 1 \rightarrow 2$

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7. June/2022/Paper_21/No.2

B-lymphocytes are activated to form plasma cells during immune responses.

Fig. 2.1 is a drawing of a plasma cell made from a transmission electron micrograph.

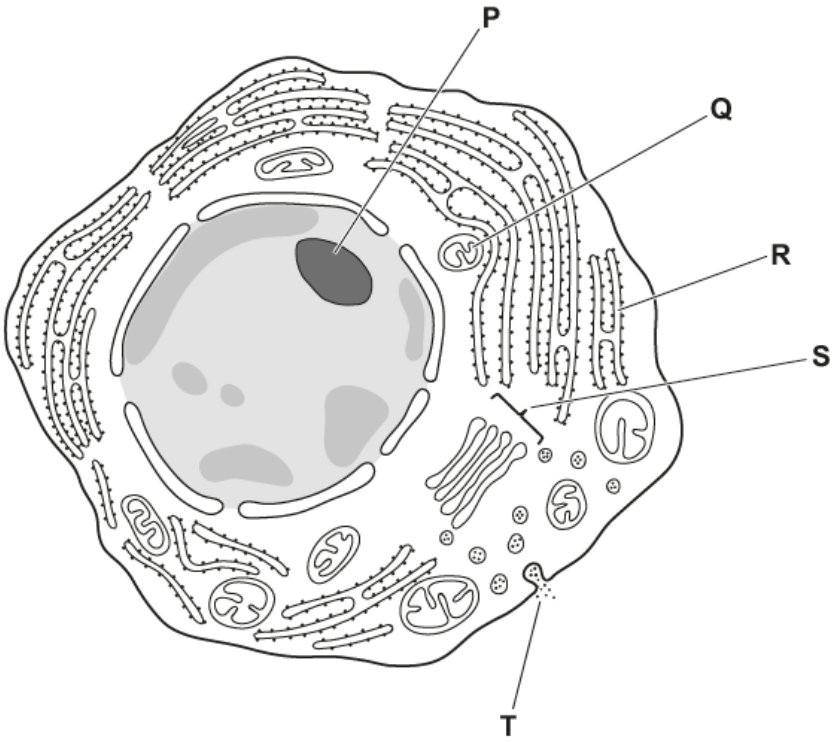


Fig. 2.1

(a) (i) State the name of the process that is occurring at **T**.

..... [1]

(ii) Complete Table 2.1 to show the names and functions of the cell structures labelled **P**, **Q**, **R** and **S** in the plasma cell shown in Fig. 2.1.

Table 2.1

cell structure in Fig. 2.1	name of cell structure	function of cell structure in plasma cell
P		
Q		
R		
S		

[4]

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(b) Plasma cells can be used in the commercial production of some monoclonal antibodies.

The method of production is known as the hybridoma method.

Outline the steps in the production of monoclonal antibodies by the hybridoma method.

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..... [3]

(c) Antibodies can be collected from human blood donors and used to treat people that may have been infected with a pathogen. This prevents them becoming ill with the disease.

Explain why this treatment does not prevent people becoming ill if they are infected again with the same pathogen.

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..... [4]

[Total: 12]

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Immunity – AS 9700 Biology Nov 2022

1. Nov/2022/Paper_11/No.40

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.

2. Nov/2022/Paper_12/No.35

Which statement about the structure of the heart is correct?

A The semilunar valves close when the pressure in the ventricles falls lower than the pressure in the arteries.

B A muscle called the septum separates the atria from the ventricles.

C There is a small patch of tissue in the right atrium that acts to delay the electrical impulse.

D Closure of valves in the veins prevents backflow of blood into the ventricles.

3. Nov/2022/Paper_12/No.39

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

4. Nov/2022/Paper_12/No.40

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

5. Nov/2022/Paper_22/No.2(a)

Human cytomegalovirus (HCMV) is a common virus affecting humans. In people with a fully functioning immune system, infection by HCMV usually causes no, or only mild, symptoms.

Fig. 2.1**A** is a diagram of a section through HCMV. In Fig. 2.1**B**, only the outer part of HCMV is sectioned.

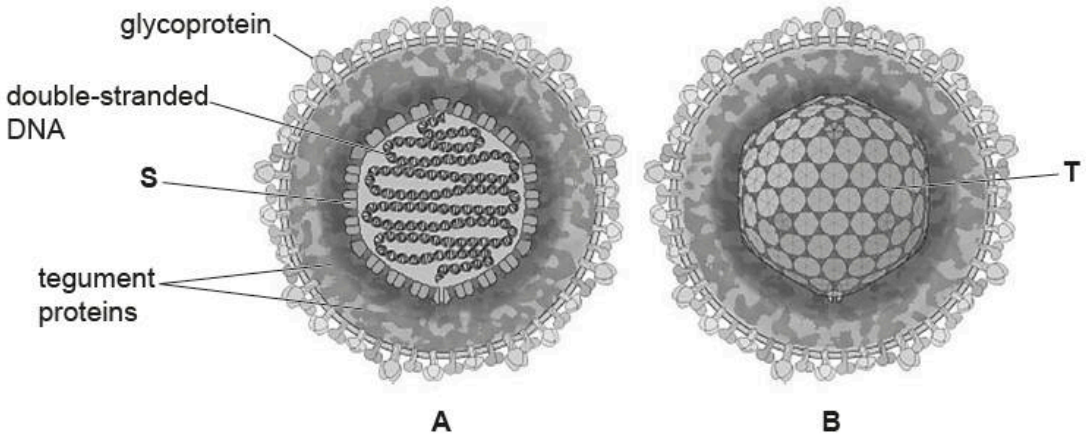


Fig. 2.1

The viral DNA shown in Fig. 2.1 contains genes that code for proteins important in viral replication and viral structure, including viral DNA polymerase and proteins known as tegument proteins.

Viruses can only replicate in host cells as they need to use processes and contents of the host cell. Complete viral particles that are released from the host cell are known as virions.

(a) Structure **S** in Fig. 2.1**A** is a subunit of structure **T** in Fig. 2.1**B**.

Name the chemical compound used to make structure **S and** name structure **T**.

S .....

T .....

[2]

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6. Nov/2022/Paper_22/No.3(a_ b)

Plasmodium falciparum is one species of *Plasmodium* that causes the life-threatening disease malaria. With early diagnosis and the correct drug treatment, the pathogen can be eliminated from the body, particularly if the disease is not severe.

(a) Name the type of pathogen that causes malaria.

..... [1]

(b) To help prevent the development and spread of drug resistance in *Plasmodium*, the World Health Organization (WHO) recommends using a treatment known as artemisinin-based combination therapy (ACT).

ACT involves two different types of drug:

- a fast-acting drug derived from a compound known as artemisinin, which causes a rapid decrease in the number of *P. falciparum*
- one or more longer-acting, non-artemisinin, drugs that eliminate any remaining pathogens.

(i) Suggest why using ACT with the two different types of drug is more effective in preventing the development of drug resistance in *Plasmodium* than a treatment using only one type of drug.

.....

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..... [2]

(ii) In some areas, partial artemisinin resistance has developed. This means ACT takes a longer time for the pathogen to be eliminated from the body.

Explain why there is an increased risk of transmission of the pathogen to other people if a person is receiving ACT and the pathogen has partial artemisinin resistance.

.....

.....

.....

.....

..... [2]

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7. Nov/2022/Paper_23/No.2(a)

Fig. 2.1 is a scanning electron micrograph showing a macrophage engulfing some bacteria.



Fig. 2.1

(a) (i) Describe how macrophages engulf bacteria.

.....

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.....

.....

..... [3]

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(ii) Explain the functions of lysosomes in cells such as macrophages.

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.....

..... [3]

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8. Nov/2022/Paper_23/No.5(a_ b)

Cathelicidin LL-37 is a cell signalling compound that stimulates many different cells in humans. One role of cathelicidin LL-37 is stimulating the production of endothelial cells in the formation of capillaries during wound healing.

(a) (i) Explain how it is possible for many different cell types to respond to the same cell signalling compound.

.....

.....

.....

.....

..... [2]

(ii) Describe the appearance of the endothelial cells of a capillary.

.....

.....

.....

.....

..... [2]

Cathelicidin LL-37 is a protein composed of 37 amino acids.

Table 5.1 shows:

- the sequence of the first 10 amino acids in the primary structure of cathelicidin LL-37
- DNA triplets in the non-transcribed strand in the gene that codes for the first 10 amino acids in the primary structure of cathelicidin LL-37.

Table 5.1

amino acid position	1	2	3	4	5	6	7	8	9	10
amino acid	leu	leu	gly	asp	phe	phe	arg	lys	ser	lys
DNA triplet	CTG	CTG	GGT	GAT	TTC	TTC	CGG	AAA	TCT	AAA

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Table 5.2 shows the triplets of bases in **DNA** and the amino acids for which they code.

Table 5.2

first base	second base: T		C		A		G		third base
T	TTT	phe	TCT	ser	TAT	tyr	TGT	cys	T
	TTC		TCC		TAC		TGC		C
	TTA	leu	TCA		TAA	stop	TGA	stop	A
	TTG		TCG		TAG		TGG	try	G
C	CTT	leu	CCT	pro	CAT	his	CGT	arg	T
	CTC		CCC		CAC		CGC		C
	CTA		CCA		CAA	gln	CGA		A
	CTG		CCG		CAG		CGG		G
A	ATT	ile	ACT	thr	AAT	asp	AGT	ser	T
	ATC		ACC		AAC		AGC		C
	ATA	ile	ACA		AAA	lys	AGA	arg	A
	ATG	met	ACG		AAG		AGG		G
G	GTT	val	GCT	ala	GAT	asp	GGT	gly	T
	GTC		GCC		GAC		GGC		C
	GTA		GCA		GAA	glu	GGA		A
	GTG		GCG		GAG		GGG		G

(b) Mutations of DNA base sequences in a gene can affect the primary structure of proteins.

Use the information in Table 5.1 and Table 5.2 to suggest the effect on the primary structure of cathelicidin LL-37 of:

(i) the substitution of the base T with the base A in the middle of the triplet at position 5

..... [1]

(ii) the deletion of base T in the triplet at position 2

.....

.....

..... [2]

(iii) the insertion of base G between bases G and T in the triplet at position 3.

.....

.....

..... [2]

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Immunity – AS 9700 June 2022

1. June/2023/Paper_9700/11/No.39

Which blood cell type does **not** recognise, engulf and digest non-self particles?

A macrophages

B neutrophils

C phagocytes

D T-killer cells

2. June/2023/Paper_9700/11/No.40

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

3. June/2023/Paper_9700/12/No.40

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

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4. June/2023/Paper_9700/13/No.40

Monoclonal antibodies are produced using the hybridoma method.

What are removed from the spleen of a mouse to produce monoclonal antibodies?

A antigens

B clones

C lymphocytes

D myeloma cells

5. June/2023/Paper_9700/22/No.3

Cells of the immune system respond to the presence of non-self antigens.

(a) Outline the features of non-self antigens.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(b) Four different types of cells of the immune system are shown in Table 3.1.

Complete Table 3.1:

- use a tick (✓) if the description applies to the named cell of the immune system
- use a cross (✗) if the description does **not** apply.

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Table 3.1

description of cell	cell of the immune system			
	B-lymphocyte	plasma cell	T-helper cell	T-killer cell
able to go through a number of cell cycles (clonal expansion)				
main role is to secrete cytokine during an immune response				
present during a **primary** immune response to a virus				

[4]

(c) The cell cycle can be divided into different parts.

Complete sentences **A**, **B** and **C** to provide more information about the mitotic cell cycle.

A The part of the cell cycle that occurs immediately after mitosis is

.....

B The part of the cell cycle in which the S phase occurs is

.....

C The main event that occurs during the S phase is

.....

[3]

[Total: 10]

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6. June/2023/Paper_9700/23/No.4

Food crops such as barley and wheat contain gluten. Gluten contains two proteins, glutenin and gliadin.

(a) (i) Table 4.1 contains descriptions of the structures of glutenin and gliadin.

Complete Table 4.1 by writing the level of protein structure that applies to each description.

Table 4.1

description	level of protein structure
a gliadin protein is a single polypeptide that forms a compact structure	
20% of the amino acids in a glutenin molecule are glycine	
gliadin and glutenin molecules contain regions of β-pleated sheets	

[3]

(ii) Many genes in eukaryotic cells contain introns. The genes that code for gliadin do **not** contain introns.

Explain how a lack of introns in a gliadin gene affects the production of mRNA from the primary transcript.

.....

.....

..... [1]

(b) Coeliac disease is a condition in which the immune system of a person responds to gluten in their diet.

In coeliac disease, there is a response to the presence of peptides (short chains of amino acids) that are produced as a result of gliadin digestion.

(i) The gliadin peptides produced as result of digestion are often as large as 33 amino acids in length. Intestinal cells take up large numbers of these peptides at the same time.

Suggest **and** explain how gliadin peptides are transported into intestinal cells.

.....

.....

.....

..... [2]

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(ii) The presence of gliadin causes the immune system of a person with coeliac disease to respond by producing anti-gliadin antibodies.

Describe the sequence of events that results in the immune system producing anti-gliadin antibodies.

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..... [4]

[Total: 10]

7. March/2023/Paper_9700/12/No.39

Which statement correctly explains why viruses are unaffected by penicillin?

A Penicillin only affects host cell metabolism.

B Penicillin only binds with 70S ribosomes.

C Penicillin only blocks mRNA synthesis in prokaryotes.

D Penicillin only blocks peptidoglycan synthesis.

8. March/2023/Paper_9700/12/No.40

Which processes characterise the mode of action of phagocytes?

1 antibody production

2 receptor binding

3 endocytosis

4 exocytosis

5 hydrolysis

A 1, 2 and 4 **B** 1 and 4 only **C** 2, 3, 4 and 5 **D** 3 and 5 only

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Immunity – AS 9700 November 2023

1. Nov/2023/Paper_ 9700/11/No.38

Some responses made by cells of the immune system to a pathogen are listed.

1 mitosis

2 bind to specific antigens

3 produce memory cells

4 secrete antibodies

Which responses are correct for B-lymphocytes?

A 1, 2, 3 and 4

B 1, 2 and 4 only

C 1 and 3 only

D 2, 3 and 4 only

2. Nov/2023/Paper_ 9700/11/No.39

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

3. Nov/2023/Paper_ 9700/11/No.40

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.

4. Nov/2023/Paper_ 9700/12/No.39

Some responses made by cells of the immune system to a pathogen are listed.

1 mitosis

2 recognises a pathogen

3 produces memory cells

4 secretes enzymes

Which responses are correct for phagocytes?

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1 and 3 only

D 2 and 4 only

5. Nov/2023/Paper_ 9700/12/No.40

Some vaccines do not contain antigens. The vaccines contain a molecule of mRNA. Cells in the immune system use the mRNA molecule to make a protein antigen.

The statements describe the stages of how mRNA vaccines work when they enter a cell of the immune system.

1 B-lymphocytes and T-lymphocytes with complementary receptors bind to the protein.

2 Lymphocytes differentiate into memory cells that give long lasting immunity.

3 Ribosomes translate the mRNA molecule to make a protein.

4 The cell displays the protein on its cell surface membrane.

What is the correct order of the stages of how mRNA vaccines work?

A $1 \rightarrow 2 \rightarrow 4 \rightarrow 3$

B $3 \rightarrow 1 \rightarrow 2 \rightarrow 4$

C $3 \rightarrow 4 \rightarrow 1 \rightarrow 2$

D $4 \rightarrow 1 \rightarrow 2 \rightarrow 3$