

## Questions

Q1.

Humans are surrounded by microorganisms in the air, water and food.  
Some microorganisms are pathogenic.  
The human body has several barriers to prevent infection by pathogens.

Complete the table by putting a tick (✓) in the box if the type of barrier is correct.  
If the type of barrier is not correct, place a cross (✗) in the box.

(2)

Type of barrier	Keratin in the skin	Lysozyme in mucus	Hydrochloric acid in the stomach
Physical			
Chemical			

(Total for question = 2 marks)

Q2.

Tuberculosis (TB) is an infectious disease caused by mycobacteria.

Most cases of TB are caused by infection with *Mycobacterium tuberculosis* (*M. tuberculosis*).

The ribosomes of bacteria are

(1)

- A larger than the ribosomes in eukaryotes
- B smaller than ribosomes in eukaryotes
- C the same size as ribosomes in animal cells
- D the same size as ribosomes in plant cells

(Total for question = 1 mark)

**Q3.**

Hospitals have developed practices in response to the increase in hospital acquired infections.

Describe the infection control practices hospitals have introduced.

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**(Total for question = 3 marks)**

**Q4.**

DNA synthesis in bacterial cell cultures has been investigated.

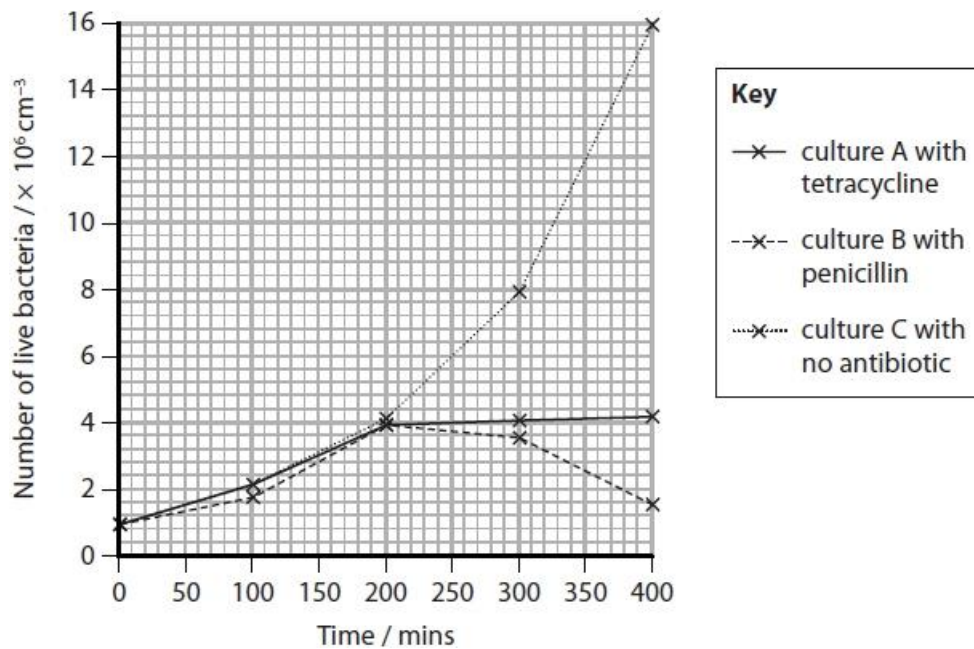
Antibiotics can be used to control bacterial infections.

In an experiment, a culture of bacteria was grown in nutrient broth. The culture was then divided into three separate cultures, A, B and C. The bacterial cultures were grown for 200 minutes.

After 200 minutes the antibiotic tetracycline was added to culture A and the antibiotic penicillin was added to culture B. No antibiotics were added to culture C.

The three cultures were grown for a further 200 minutes.

The results of the experiment are shown in the graph.



Deduce the effects of these antibiotics on the growth of the bacterial cultures.

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**(Total for question = 2 marks)**

**Q5.**

A newborn baby can respond to infections.

Inflammation is a non-specific response to an infection.

Explain how changes in the blood vessels result in the redness and swelling seen at the site of inflammation.

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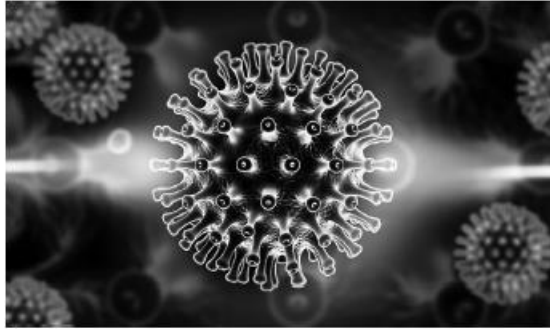
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**(Total for question = 4 marks)**

Q6.

Answer the question with a cross in the box you think is correct . If you change your mind about an answer, put a line through the box  and then mark your new answer with a cross .

The human immunodeficiency virus (HIV), shown in the image, causes acquired immunodeficiency syndrome (AIDS).



© Liya Graphics/Shutterstock

HIV particles contain

- A DNA and DNA polymerase
- B DNA and reverse transcriptase
- C RNA and DNA polymerase
- D RNA and reverse transcriptase

(1)

(Total for question = 1 mark)



(ii) Explain why the destruction of T helper cells causes the symptoms of AIDS.

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**(Total for question = 7 marks)**

Q8.

Answer the question with a cross in the box you think is correct . If you change your mind about an answer, put a line through the box  and then mark your new answer with a cross .

A bacteriostatic antibiotic works by

(1)

- A destroying bacteria
- B destroying viruses
- C preventing the multiplication of bacteria
- D preventing the development of antibiotic resistance

(Total for question = 1 mark)



**Q9.**

A newborn baby can respond to infections.

The mother of a baby will produce an immune response to any infections that she acquires.

Antibodies providing specific immunity to these infections are found in the milk produced by the mother.

(i) Which cell produces antibodies?

(1)

- A** macrophage
- B** plasma cell
- C** red blood cell
- D** T cell

(ii) The type of immunity that the newborn baby obtains from the milk produced by its mother is

(1)

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

**(Total for question = 2 marks)**

**Q10.**

Humans are surrounded by microorganisms in the air, water and food.  
Some microorganisms are pathogenic.  
The human body has several barriers to prevent infection by pathogens.

Explain why the presence of microorganisms on the skin and in the gut helps to prevent pathogenic organisms multiplying in the body.

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**(Total for question = 3 marks)**







**Q13.**

Human papilloma virus (HPV) is a DNA virus.

Cervarix and Gardasil have been used in national vaccination programs.

A person who has been vaccinated becomes infected with HPV-16. Explain the role of the T cells in the body of this person.

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**(Total for question = 3 marks)**

**Q14.**

The human gut contains more than a thousand species of bacteria. Only 30 to 40 of these species are found in the stomach.

Explain why there are relatively few species of bacteria in the stomach.

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**(Total for question = 2 marks)**

**Q15.**

Penicillin is an antibiotic. It was discovered in 1928. Since then many antibiotics have been identified and are widely used in the treatment of bacterial infections.

State what is meant by the term bacteriostatic antibiotic.

(1)

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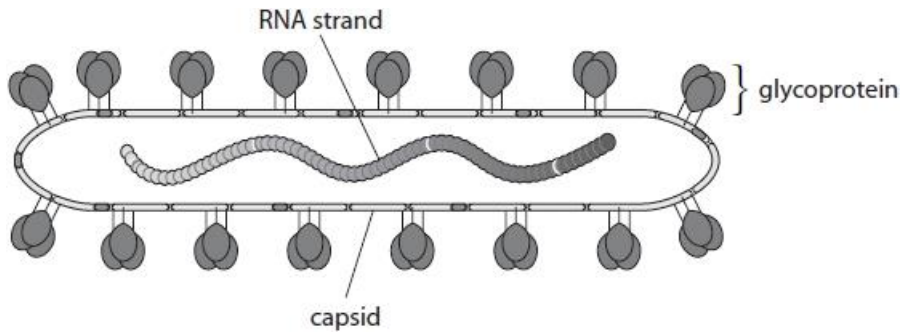
**(Total for question = 1 mark)**



**Q16.**

Ebola virus disease (EVD) is a rare and deadly disease most commonly found in Africa. Following a severe outbreak in 2014, in which 11 000 people died, work has been underway to develop a vaccine.

The diagram shows the structure of an Ebola virus.



Compare and contrast the structure of Ebola virus with that of the human immunodeficiency virus (HIV).

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**(Total for question = 3 marks)**

## Q17.

A newborn baby can respond to infections.

Interferon is involved in the response to viral infections.

(i) The influenza virus can be lethal to mice.

The effects of interferon on influenza infection in mice was investigated.

Mice were infected with influenza virus and then given interferon.

The results of the investigation are shown in the table.

Interferon dose / units per mouse	Median survival time / days
No dose	3.3
$8 \times 10^3$	4.4
$8 \times 10^4$	8.5
$8 \times 10^5$	>42

Explain these results.

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(ii) Interferon can be used to treat people with viral hepatitis.

Interferon can be made by animal cells or by genetically modified bacteria.

The table shows information about interferon made by these animal cells and genetically modified bacteria.

Source of interferon	Type of molecule	Folding	Antiviral activity
Animal cells	Glycoprotein	Correctly folded	High
Genetically modified bacteria	Protein	Incorrectly folded and needs to be refolded before it can be used	Low

Explain why the interferon made by genetically modified bacteria is different from the interferon made by animal cells.

(2)

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(iii) Glycoproteins made in animal cells are released into the extracellular fluid by

(1)

- A endocytosis
- B exocytosis
- C facilitated diffusion
- D phagocytosis

**(Total for question = 6 marks)**

**Q18.**

Ebola virus disease (EVD) is a rare and deadly disease most commonly found in Africa. Following a severe outbreak in 2014, in which 11 000 people died, work has been underway to develop a vaccine.

A vaccine has been developed by genetically modifying a virus that infects cattle. In the genetically modified virus, one of the genes was replaced with a gene for a protein found in the Ebola virus.

In a trial of 52 volunteers, 48 developed antibodies against the Ebola virus within 14 days of injection.

(i) The type of immunity given by this vaccine is

(1)

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

(ii) Explain the role of T cells in the immunity to the Ebola virus that develops following the use of this vaccine.

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**(Total for question = 4 marks)**

**Q19.**

Human papilloma virus (HPV) is a DNA virus.

Some strains of HPV are sexually transmitted and can cause cervical cancer or genital warts.

The table shows some information about the conditions associated with four strains of HPV.

HPV strain	Condition associated with the strain	Percentage of all cases caused by the strain (%)
6	cervical cancer	<1
	genital warts	67
11	cervical cancer	<1
	genital warts	22
16	cervical cancer	55
	genital warts	<1
18	cervical cancer	13
	genital warts	<1

(i) Comment on the relationship between HPV and these two conditions.

(3)

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(ii) The table shows two vaccines developed from different combinations of HPV.

Vaccine	Strains of HPV used in development of the vaccine
Cervarix	16 and 18
Guardasil	6, 11, 16 and 18

Analyse all the data to explain why the Guardasil vaccine is preferred to the Cervarix vaccine.

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(iii) Which of the following describes the type of immunity developed by these vaccines?

(1)

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

**(Total for question = 8 marks)**

**Mark Scheme**

Q1.

Question Number	Answer	Additional guidance	Mark												
	<table border="1"> <thead> <tr> <th></th> <th>Keratin in the skin</th> <th>Lysozyme in mucus</th> <th>Hydrochloric acid in the stomach</th> </tr> </thead> <tbody> <tr> <td>Physical barrier</td> <td>✓</td> <td>x</td> <td>x</td> </tr> <tr> <td>Chemical barrier</td> <td>x</td> <td>✓</td> <td>✓</td> </tr> </tbody> </table>		Keratin in the skin	Lysozyme in mucus	Hydrochloric acid in the stomach	Physical barrier	✓	x	x	Chemical barrier	x	✓	✓	3 correct answers 1 mark All correct 2 marks	(2)
	Keratin in the skin	Lysozyme in mucus	Hydrochloric acid in the stomach												
Physical barrier	✓	x	x												
Chemical barrier	x	✓	✓												

Q2.

Question Number	Answer	Mark
	<p><b>B</b> - smaller than ribosomes in eukaryotes</p> <p><i>The only correct answer is B</i></p> <p><b>A</b> is not correct because bacterial ribosomes are smaller than eukaryotic ribosomes</p> <p><b>C</b> is not correct because bacterial ribosomes are smaller than animal ribosomes</p> <p><b>D</b> is not correct because bacterial ribosomes are smaller than plant ribosomes</p>	(1)

Q3.

Question Number	Answer	Additional guidance	Mark
	<p>A description that makes reference to three of the following:</p> <ul style="list-style-type: none"> <li>• hand wash (stations) (1)</li> <li>• (doctors / nurses) not to wear { ties / watches / long sleeves } (1)</li> <li>• testing patients for the presence of antibiotic resistant bacteria before admission / {isolation / quarantine} of infected patients (1)</li> <li>• increased washing of bedding / disinfection of { beds / surfaces } (1)</li> </ul>	<p>ALLOW antibacterial / antiseptic / alcohol gel / hand sanitisers</p> <p>ALLOW use of disposable bedding</p>	<b>(3)</b>

Q4.

Question Number	Answer	Additional Guidance	Mark
	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• tetracycline { is bacteriostatic / stops bacteria dividing } (because the number of bacteria stays the same) (1)</li> <li>• penicillin {is bactericidal / kills bacteria } (because the number of bacteria decreases) (1)</li> </ul>		<b>2</b>



Q5.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> <li>histamine is released</li> <li>(histamine) causes {arterioles to dilate/ vasodilation}</li> <li>which increases the blood flow (to the site causing redness)</li> <li>(histamine) also causes the permeability of capillaries to increase</li> <li>allowing blood plasma to {leave the capillary / enter the tissues} (causing oedema / swelling)</li> </ul>	ALLOW reference to 'leaky' capillaries	(4)

Q6.

Question Number	Answer	Mark
	<p><b>The only correct answer is D - RNA and reverse transcriptase</b></p> <p><i>A is incorrect because it is does not contain DNA</i></p> <p><i>B is incorrect because it is does not contain DNA</i></p> <p><i>C is incorrect because it does not contain DNA polymerase</i></p>	(1)

Q7.

Question Number	Answer	Additional guidance	Mark
(i)	<p>A description that makes reference to three of the following:</p> <ul style="list-style-type: none"> <li>• (glycoproteins / GP120) on the (surface of the) virus(1)</li> <li>• bind to (CD4) receptors on the (surface of the) T (helper) cells(1)</li> <li>• viral envelope fuses with cell membrane of T helper cell (1)</li> <li>• viral RNA enters the cell (1)</li> </ul>	<p>ALLOW GP130</p> <p>IGNORE capsid</p>	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation that makes reference to the following</p> <ul style="list-style-type: none"> <li>• ( lack of T helper cells ) reduces cytokine production (1)</li> <li>• therefore reducing { cloning / activation } of B cells (1)</li> <li>• reducing antibody production (1)</li> <li>• there is an increased risk of opportunistic infections (1)</li> </ul>	<p>ALLOW reduced production of {B effector cells/plasma cells}</p> <p>ALLOW example eg TB</p>	(4)

Q8.

Question Number	Answer	Mark
	<p><b>The only correct answer is C - preventing the multiplication of bacteria</b></p> <p><i>A is not correct because bacteriostatic antibiotics do not destroy bacteria</i></p> <p><i>B is not correct because antibiotics are not effective against viruses</i></p> <p><i>D is not correct because antibiotics do not prevent the development of antibiotic resistance</i></p>	(1)

Q9.

Question Number	Answer	Mark
(i)	<p><b>B</b> - plasma cell</p> <p><i>The only correct answer is B</i></p> <p><b>A</b> is not correct because macrophage does not produce antibodies</p> <p><b>C</b> is not correct because red blood cells do not produce antibodies</p> <p><b>D</b> is not correct because T cells do not produce antibodies.</p>	(1)

Question Number	Answer	Mark
(ii)	<p><b>D</b> – natural passive immunity - the immunity is provided by components of the mother’s milk produced as part of a natural immune response. The baby has not produced these components so the immunity is passive.</p> <p><i>The only correct answer is D</i></p> <p><b>A</b> is not correct because the baby has not produced the immunity gained from the mother’s milk so it is not active immunity</p> <p><b>B</b> is not correct because the immunity from the mother was not generated by artificial exposure to antigens (e.g. immunisation) so it is not artificial immunity</p> <p><b>C</b> is not correct because the baby has not produced the immunity gained from the mother’s milk so it is not active immunity</p>	(1)

Q10.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation that makes reference to the following</p> <ul style="list-style-type: none"> <li>• flora in the gut and skin are better adapted to the conditions (1)</li> <li>• therefore they can outcompete pathogenic organisms (1)</li> <li>• bacteria in the gut secrete {chemicals /lactic acid} which help to destroy pathogens (1)</li> </ul>	<p>ALLOW details of competition for space or nutrients</p> <p>ALLOW enzymes</p>	(3)

Q11.

Question Number	Answer	Additional guidance	Mark
(i)	<p>An answer that makes reference to two of the following:</p> <ul style="list-style-type: none"> <li>the protein is a receptor in the cell surface membrane of T helper cells (1)</li> <li>{ glycoprotein / GP120 } is unable to bind with the (CD4)receptor (on the host cell) (1)</li> <li>viral RNA cannot enter the cell (1)</li> </ul>	<p>ALLOW the receptor that HIV binds to</p> <p>ALLOW HIV cannot enter the cell</p>	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> <li>stem cells (from the bone marrow) can differentiate into specialised cells (1)</li> <li>the stem cells will differentiate into T helper cells that { are resistant to HIV / have the mutated protein } (1)</li> <li>T helper cells are destroyed by HIV so the patient cannot produce an immune response (1)</li> <li>mutated (CD4) receptor prevents HIV entering the ( replacement ) T helper cells (1)</li> <li>T helper cells are not destroyed therefore { HIV is not present in the blood / AIDS does not develop } (1)</li> </ul>		(4)

## Q12.

Question Number	Answer	Additional guidance	Mark
(i)	<p>An explanation that makes reference to three of the following</p> <ul style="list-style-type: none"> <li>• ribosome shape is altered (1)</li> <li>• mRNA is prevented from binding (to the ribosome) / causing change in tRNA binding (1)</li> <li>• therefore translation cannot occur (1)</li> <li>• { protein / polypeptide } is not synthesised (1)</li> </ul>	<p>ALLOW translation is affected / reduced / altered</p> <p>ALLOW faulty protein produced</p>	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An answer that makes reference to two of the following</p> <ul style="list-style-type: none"> <li>• bacteria have not been exposed to new antibiotics before / bacteria do not have mechanisms to make them resistant to the new antibiotics (1)</li> <li>• bacteria have developed resistance (to other antibiotics) by { evolving / natural selection } (1)</li> <li>• therefore there has been {no advantage to possessing a mutation to bypass the new antibiotic / no mutation present to give resistance } (1)</li> </ul>		(2)

Question Number	Answer	Mark
(iii)	<p>Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.</p> <p>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.</p> <p>Indicative content</p> <ul style="list-style-type: none"><li>• prepare agar plates with bacterial cultures / bacterial lawn / seeded with bacteria –use bacteria that are resistant to other antibiotics</li><li>• prepare solutions of new antibiotic and penicillin</li><li>• place onto paper discs / into wells in the agar / prepare mast rings</li><li>• control time and temperature of incubation</li><li>• same concentration and volume of both antibiotics</li><li>• measure the area of inhibition</li><li>• repeat for effective antibiotics</li><li>• description of serial dilution of each antibiotic</li><li>• range of dilutions on each plate-one antibiotic per plate</li><li>• statistical test to determine which is the most effective</li><li>• repeat with different strains of resistant bacteria</li></ul>	(6)

Level	Marks		Additional Guidance
0	0	No awardable content	
1	1-2	<p>An explanation of how the investigation should be modified may be attempted but with limited analysis, interpretation and/or evaluation of the scientific information. Generalised comments made.</p> <p>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.</p>	<p>Preparation of agar plates Method of adding antibiotic</p> <p>Use of new antibiotic and penicillin Measure zone of inhibition</p>
2	3-4	<p>An explanation of how the investigation should be modified will be given with occasional evidence of analysis, interpretation and/or evaluation of the scientific information.</p> <p>The explanation shows some linkages and lines of scientific reasoning with some structure.</p>	<p>Incubated for stated time 24-72 hours Incubated at stated temperature 25-37°C Method of culturing bacteria on agar plates/preparing a lawn</p> <p>Repeats to calculate the mean Larger zone of inhibition-more effective antibiotic</p>
3	5-6	<p>An explanation of how the investigation should be modified is given which is supported throughout by evidence from the analysis, interpretation and/or evaluation of the scientific information.</p> <p>The explanation shows a well-developed and sustained line of scientific reasoning which is clear, coherent and logically structured.</p>	<p>Strain of bacteria known to be resistant to penicillin/other antibiotics Same volume/concentration of both antibiotics</p> <p>Several strains of resistant bacteria tested with new antibiotic Preparation of serial dilutions for both antibiotics Range of concentrations give minimum effective dose Named statistical test eg T-test</p>

Q13.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> <li>a vaccinated person will have memory T cells (1)</li> <li>(memory T cells) recognise (antigens specific to) the HPV-16 virus (1)</li> <li>T helper cells that activate {B cells / T killer cells} (1)</li> <li>(formation of) T killer cells destroy cells infected with virus (1)</li> </ul>	<p>ALLOW a response that begins with 'T memory cells ...' / or statement that T memory cells are already present</p> <p>ALLOW cytotoxic T cells for T killer cells</p>	<b>3</b>

Q14.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation that makes reference to two of the following</p> <ul style="list-style-type: none"> <li>because the pH inside the stomach is too low for the enzymes of most bacteria to function (1)</li> <li>bacteria that live in the stomach have adaptations that enable them to survive (1)</li> </ul>	<p>ALLOW reference to bacterial enzymes being denatured</p> <p>ALLOW (some) bacteria have evolved specifically to withstand the conditions</p>	<b>(2)</b>

Q15.

Question Number	Answer	Additional guidance	Mark
	<ul style="list-style-type: none"> <li>A substance which can {inhibit the growth / prevent multiplication} of bacteria</li> </ul>		<b>(1)</b>



## Q16.

Question Number	Answer	Additional guidance	Mark
	<p>An answer that makes reference to three of the following</p> <p>Similarities</p> <ul style="list-style-type: none"> <li>• both contain RNA (1)</li> <li>• both have {a (protein) capsid / glycoproteins} (1)</li> </ul> <p>Differences</p> <ul style="list-style-type: none"> <li>• Ebola contains one strand of RNA but HIV contains two strands of RNA (1)</li> <li>• HIV is spherical, Ebola virus is elongated (1)</li> </ul>	<p>IGNORE retrovirus</p> <p>ALLOW protein coat</p> <p>ALLOW HIV is icosahedral / Ebola is filamentous</p> <p>ALLOW HIV is round</p> <p>ALLOW HIV has a lipid layer/envelope and Ebola does not (acceptable on basis of diagram provided)</p>	<b>(3)</b>

## Q17.

Question Number	Answer	Additional Guidance	Mark
<b>(i)</b>	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> <li>• increasing dose of interferon increases the survival time of the mice</li> <li>• because interferon inhibits viral replication (inside cells)</li> <li>• the greater the dose of interferon the fewer virus particles {produced / released} (to infect other cells)</li> </ul>	<p>ALLOW positive correlation between interferon dose and survival time</p> <p>ALLOW interferon prevents virus infecting other cells</p>	<b>(3)</b>

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to two of the following:</p> <ul style="list-style-type: none"> <li>• bacteria do not possess {rER / Golgi apparatus}</li> <li>• polypeptide chain is not {processed / modified} properly</li> <li>• therefore the protein is {incorrectly folded / carbohydrate is not added}</li> </ul>	<p>ALLOW converse statements for each marking point</p> <p>ALLOW Golgi body</p> <p>ALLOW protein</p> <p>ALLOW is not glycosylated</p>	(2)

Question Number	Answer	Mark
(iii)	<p><b>B</b> - exocytosis</p> <p><i>The only correct answer is B</i></p> <p><b>A</b> is not correct because endocytosis is the process used to take particles into cells</p> <p><b>C</b> is not correct because facilitated diffusion is not used to transport proteins</p> <p><b>D</b> is not correct because phagocytosis is a process used to engulf large particles such as bacteria</p>	(1)

## Q18.

Question Number	Answer	Mark
(i)	<p>The only correct answer is A artificial active immunity</p> <p><i>B is incorrect because the immunity is not passive</i></p> <p><i>C is incorrect because the immunity is not natural</i></p> <p><i>D is incorrect because the immunity is not natural or passive</i></p>	(1)

Question Number	Answer	Additional guidance	Mark
(ii)	<p>An explanation that makes reference to three of the following</p> <ul style="list-style-type: none"> <li>• T helper cells bind to { protein / antigen } the APC (1)</li> <li>• (therefore) leading to the production of {active T helper cells / T memory cells} (1)</li> <li>• the T helper cells activate the B cells to { divide / become } cells capable of producing antibodies (1)</li> <li>• The memory cells remain in the body so antibodies can be produced quickly (on re-infection)(1)</li> </ul>	ALLOW B cells develop into B effector cells or plasma cells	(3)

## Q19.

Question Number	Answer	Additional Guidance	Mark
	<p>An answer that makes reference to three of the following:</p> <ul style="list-style-type: none"> <li>• HPV strains 16 and 18 are { more associated with cervical cancer / not associated with genital warts } (1)</li> <li>• HPV strains 6 and 11 are { more associated with genital warts / not associated with cervical cancer } (1)</li> <li>• (for the strains shown) greater percentage of cases of genital warts associated with HPV than cervical cancer (1)</li> <li>• quantitative comparison made to demonstrate the difference (1)</li> </ul>	e.g. 89% for genital warts and 68% for cervical cancer	3

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> <li>• Gardasil is developed from four strains of HPV, whereas Cervarix only developed from two (1)</li> <li>• Gardasil provides protection against all four strains of HPV whereas Cervarix provides protection against two strains of HPV (1)</li> <li>• both vaccines will provide immunity against (HPV 16 and 18) viruses that cause cervical cancer (1)</li> <li>• Gardasil will also provide immunity against (HPV 6 and 11) viruses that cause genital warts (1)</li> </ul>		4

Question Number	Answer	Mark
(iii)	<p><b>The only correct answer is A - artificial active immunity</b></p> <p>B is not correct because vaccination produces artificial active immunity</p> <p>C is not correct because vaccination produces artificial active immunity</p> <p>D is not correct because vaccination produces artificial active immunity</p>	1