




Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	a weakened / attenuated / dead , form of (polio) <u>virus</u> ✓	1 (AO 2.1)	<p>ALLOW fragments / antigens , of <u>virus</u> IGNORE DNA / RNA IGNORE small amount / dormant / antibodies IGNORE cells</p> <p><u>Examiner's Comments</u></p> <p>Most candidates were aware that the vaccine would contain a dead or weakened version of the polio pathogen but only those that responded to the contextual information in the question by stating that the polio pathogen was a virus were given a mark. Suggestions relating to DNA or RNA were not given because they were not consistent with the context of 1956.</p>
		ii	<p>1 involved in clonal selection ✓ (cell surface) receptors (on 2 T-cell) bind to , antigens / (named) APCs ✓ 3 produce / release , interleukins / cytokines ✓ (T-helper cells / 4 interleukins) stimulate phagocytosis ✓ (T-helper cells / 5 interleukins) , <u>stimulate</u> clonal expansion ✓ 6 T-killer cells destroy infected cells ✓ 7 <u>differentiate</u> into T-memory cells ✓ T-memory cells allow rapid 8 , secondary / AW , response ✓</p>	4 max (AO 1.2)	<p>1 IGNORE activation (of T-helper cells)</p> <p>5 ALLOW cause , mitosis / proliferation / division , of , T/ B , cells 5 ALLOW <u>activate</u> , B / T-killer , cells</p> <p>8 ALLOW description, e.g., T-memory cells rapidly produce T-killer cells if pathogen returns 8 IGNORE produce antibodies more quickly</p> <p>IGNORE regulator cells</p> <p><u>Examiner's Comments</u></p> <p>This question differentiated very well between candidates of differing abilities. Many candidates were aware that T-cells are involved in clonal selection and that they interact with APCs. However, many did not gain the 2nd marking point because they did not refer to receptors on the T-cells. It was relatively common to award marks for the release of interleukins and the stimulation of clonal expansion, or some detail thereof. It was also common for answers to discuss the role of T-memory cells in the secondary response, but use of the key term 'differentiate' was less frequent. Reference to stimulation of phagocytosis was seen less often and, although there were many attempts</p>


				<p>to describe the role of T-killer cells, most of these were not given because they suggested a direct action on the pathogen rather than via infected host cells.</p> <p>Those responses that did not score well tended to be unclear about the distinction between T and B-lymphocytes.</p> <p> Misconception</p> <p>In the context of the humoral immune response, 'activate' and 'differentiate' are important key terms that candidates ought to be able to use correctly in their answers.</p>
b	i	<p>FIRST CHECK ON ANSWER LINE If answer = 85 or 84.9 (%) award 2 marks</p> <p><i>correct reading from graph and subtraction</i> $3440 - 520$ $= 2920 \checkmark$</p> <p><i>correct calculation</i></p> <p>$\frac{2880}{3400} \times 100 = 84.7 \checkmark$</p>	<p>2 (AO 2.2)</p>	<p>ALLOW any answer in the range 82 to 86 ALLOW 1 mark for 80 or if correct answer given to more than 3 significant figures IGNORE sign</p> <p>If answer is incorrect, ALLOW 1 mark for either of the following:</p> <p>correct answer to... $3380 - 3600 - 500 - 600 =$</p> <p>or</p> <p><i>candidate's values substituted into the following equation</i> $\frac{\text{change}}{\text{original}} \times 100 = \text{correctly processed answer}$</p> <p><u>Examiner's Comments</u></p> <p>Most candidates were able to correctly read the graph and calculate a percentage decrease. Answers given to more than 3 significant figures were given only one mark because that level of accuracy is not plausible given the graph they had been presented with. Candidates must understand that the lowest level of accuracy in the inputs of a calculation will determine the level of accuracy in the answer (M1.1).</p> <p><i>Calculation:</i> Percentage change = $((\text{no. of cases in 1960} - \text{no. of cases in 1956}) / \text{no. of cases in 1956}) \times 100$</p> <p>Percentage change = $((3380 - 520) / 3380) \times$</p>

					<p>100</p> <p>Percentage change = 84.6% or 85%</p> <p> OCR support</p> <p>The maths skills handbook offers further support on how to calculate percentage change and on the correct number of significant figures.</p> <p>Additional support on all the maths skills can be found on 'Maths for Biology' resources on Teach Cambridge.</p>
		ii	<p>uptake might not have been , immediate / high in 1956 ✓</p> <p>some cases in 1956 might have occurred before vaccine introduction / 1957 was first full year of vaccine ✓</p>	<p>2 (AO 3.2)</p>	<p><i>Mark as prose</i></p> <p>ALLOW more people would have had the vaccine by then / time needed to get all children vaccinated / slow distribution</p> <p>ALLOW vaccine might have been introduced towards the end of 1956</p> <p>IGNORE vaccine takes time to have affect</p> <p><u>Examiner's Comments</u></p> <p>Perhaps helped by recent lived covid experience, many candidates were able to correctly suggest that more children would have been given the polio vaccine by 1957. However, answers that suggested that this would allow time for the vaccine to have an effect were not given. Fewer candidates suggested that the vaccine may not have been introduced until part-way through 1956. Many answers responded to the shape of the graph and suggested that starting in 1957 would allow a bigger change to be seen. Such responses are contrary to a key scientific principle and were not given.</p>
		iii	<p>use a <u>log</u>(arithmic) scale ✓</p>	<p>1 (AO 3.3)</p>	<p><u>Examiner's Comments</u></p> <p>Fewer than one in four candidates recognised the need for a logarithmic scale.</p>
		iv	<p>(because of virus in sewage) those in London / they are , more at risk / AW ✓ ora</p> <p>vaccination rates , low(er) in</p>	<p>2 max (AO 2.5)</p>	<p>IGNORE answers that discuss differences between children and adults</p> <p>IGNORE ring / herd , vaccination</p>

			<p>London / high(er) outside London ✓</p> <p><i>idea that</i> vaccinating people outside London might be a waste of money ✓</p>		<p>ALLOW vaccination rates already, high / >90%</p> <p>ALLOW e.g. cheaper and more likely to make a difference IGNORE 'cheaper' unqualified</p> <p><u>Examiner's Comments</u></p> <p>The best responses stated that vaccinating children outside London would be a waste of money as their risk of infection was low. However, only around 10% of responses achieved both marks. Many answers focused on ring vaccination preventing spread beyond London or stated that spread within London would be rapid because of a high population density, ignoring the important rationale of protecting those most at risk. Only a few candidates noted the high vaccination rates (of over 90%) in the UK, indicating that children outside of London were unlikely to need a further vaccination against polio.</p>
			Total	12	
2	a	i	<p><i>Ant climbs to high point so</i></p> <p><i>Ants bite into branch/leaf</i></p> <p>1 spores dispersed a, large / wide, distance ✓</p> <p>2 many / other / uninfected, ants can be infected ✓</p> <p>3 increased / rapid, fungal growth / spread of infection, as it is, warmer / humid / windy ✓</p> <p>ants, secure / still, (ready)</p> <p>4 for fungal, growth / ease of feeding / spore dispersal ✓</p>	max 2	<p>IGNORE <i>ref to</i> tree / plants / birds, becoming infected or spreading the fungus</p> <p>e.g. '<i>ant climbs to high point which has more air movement so spores travel further</i>' = mp1 and 3</p> <p>ALLOW ant stays still so, other / uninfected, ants could, become infected / come into contact with spores</p> <p>4 IGNORE provides ant with more material to, digest/feed on</p> <p><u>Examiner's Comments</u></p> <p>Most candidates recognised the main types of behaviour that underpinned the two suggestions and clearly referred to this at the beginning of their answers, e.g. climbing to a high point and biting on a branch. Many answers referred to the infection spreading through the tree as well as the ants. Candidates should make sure they constantly refer to all the information given in the stem of a question as it stated in the opening sentence that the fungus was a disease in ants.</p>


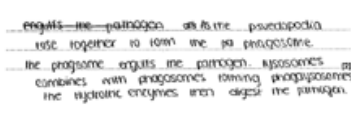
				 Assessment for learning
				<p>Recognition and discussion of disease nomenclature would have helped to emphasise the restriction of the disease to ants and not to other organisms.</p>
	ii	<p>Level 3 (5–6 marks) Detailed use of the data in Fig. 2.2 and Fig. 2.3 to support or not support the student's conclusion, describing the relationship between infection rates and both rainfall and temperature AND detailed analysis of infection data from Fig. 2.2 and temperature and rainfall data from Fig. 2.3. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) Use of the data in Fig. 2.2 and Fig. 2.3 to support or not support the student's conclusion, describing the relationship between infection rates and both rainfall and temperature AND analysis of infection data from Fig. 2.2 and temperature or rainfall data from Fig. 2.3. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p>Level 1 (1–2 marks) Reference to supporting or not supporting the student's conclusion. Reference to the data in Fig. 2.2 and Fig. 2.3, describing a relationship between infection rates and either rainfall or temperature AND simple analysis of the data in Fig. 2.2 or Fig. 2.3.</p>	6	<p>Indicative points can include:</p> <p>Data supports because: <i>Infection rates are affected after rainfall</i></p> <ul style="list-style-type: none"> • Rainfall high in May to July, infections peak in Sept • Highest numbers of infections are in Sept to Oct, 1-3 months after heavy rainfall <p><i>Temperature has no effect because</i></p> <ul style="list-style-type: none"> • Temperatures are highest May to September but infection rates vary / infection rates only start to increase / peak in Sept to Oct • Temp lowest Jan-Feb but infection rate varies • Temp decreasing from Sept but infections, are high in Sept and Oct / vary • Temp constant between July-Sep but infections vary/increase <p>Data does not support because: <i>Infection rates not affected by rainfall</i></p> <ul style="list-style-type: none"> ○ Infections peak in Feb when rainfall is low ○ Low rainfall (below 5) when infection rates high(er) ○ Peak infections in Sep-Oct when rainfall decreased long before. ○ Peak rainfall in (end of) May but June has lowest infection number ○ Infection number increases before (and during) heavy rainfall

		<p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 mark <i>No response or no response worthy of credit.</i></p>		<p><i>Infection rates are affected by temperature</i></p> <ul style="list-style-type: none"> • Infection rates increase as temperature increases / ORA • Infections peak after 3 or 4 months of sustained high temperatures • Infections increase in July-Sep when temperature is high • Infection rates low in Nov/Dec and temperature is low <p><i>General</i></p> <ul style="list-style-type: none"> • Data from only one year (2017) • Data from only one country (Taiwan) <p><i>Examples of when the communication statement would be met include:</i> Correct use of units for data provided Clear reference to the student's conclusion</p> <p><u>Examiner's Comments</u></p> <p>Candidates confidently interpreted data from Figure 2.2 and Figure 2.3 with respect to rainfall, often using well estimated data values to back up their statements. Answers regarding the effect of temperature had less clarity with some candidates not referring to the data or reading the scale incorrectly on Figure 2.3 and providing rainfall data instead of temperature. Good answers discussed the student's conclusion with a clear description of the increase after heavy rainfall, with figures and then the relevance of temperature, with figures.</p> <p>Exemplar 1</p> <p><i>The data doesn't support the student's conclusion, this is because after the heavy rainfall in May the number of infections in June after this heavy rainfall is the second lowest at 5, therefore the student is incorrect by saying infections increase as during the heaviest rainfall the number of infections decreased. (100%)</i></p> <p><i>Again the data doesn't support the student as they stated that temperature doesn't affect the number of infections, however in the hottest month, August (25°C) the infection increased in the following two months both at 38 infections, this suggests that the hotter the environment the higher number of infections.</i></p> <p>This exemplar separates the two components of the question with a paragraph and begin each paragraph with a clear statement of their opinion. The answer is succinct but focuses</p>
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					immediately on a relevant point to back up their opinion. Correct data from both figures is provided with units. The response scored 6 marks.								
	b		<table><tr><th>Communicable Disease</th><th>Type of Pathogen</th></tr><tr><td>Influenza</td><td>virus</td></tr><tr><td>Malaria</td><td>protocist</td></tr><tr><td>Black sigatoka in bananas</td><td>fungus</td></tr></table> <p>✓✓✓</p>	Communicable Disease	Type of Pathogen	Influenza	virus	Malaria	protocist	Black sigatoka in bananas	fungus	3	<p>DO NOT ALLOW more than one answer for each type of pathogen</p> <p>ALLOW protist/protozoa for 'protocist'</p> <p>Examiner's Comments</p> <p>Well answered with most candidates correctly stating the pathogen for influenza and malaria. The most common error was confusing Protocista with Fungi for Black Sigatoka. The spelling for Protocista was variable and phonetically correct spelling was accepted.</p> <p> Assessment for learning</p> <p>Discussing the etymology of these words and treating the Latin names with a phonics approach often helps with correcting poor spelling.</p>
Communicable Disease	Type of Pathogen												
Influenza	virus												
Malaria	protocist												
Black sigatoka in bananas	fungus												
			Total	11									
3			<p><i>disease</i> ring rot ✓</p> <p><i>type of pathogen</i> bacteria ✓</p> <p>OR</p> <p><i>disease</i> (potato / late) blight ✓</p> <p><i>type of pathogen</i> protocista ✓</p>	1	<p>The mark for pathogen can only be awarded when it is correctly matched with the disease</p> <p>ALLOW other correct pairs to those listed</p> <p>ALLOW brown rot / blackleg / pink eye / common scab ✓</p> <p>ALLOW phonetic spelling e.g. (potato) blate</p> <p>ALLOW protista / protocist / phonetic spelling e.g. protocotist etc.</p> <p>ALLOW <i>disease</i> black dot / (common / yellow) rust / early blight / powdery mildew / dry rot ✓</p> <p><i>type of pathogen</i></p>								

					<p>fungus✓ OR <i>disease</i> (potato) leaf roll, (potato) leaf mosaic ✓ <i>type of pathogen</i> virus ✓ IGNORE tomato / tobacco mosaic IGNORE black sigatoka (<i>as it is a disease of bananas not potatoes</i>)</p> <p><u>Examiner's Comments</u></p> <p>There were several correct possible responses which were mentioned commonly, including ring rot being caused by a bacterium and potato blight being caused by a Protocista. However, there were also many candidates who were unable to be credited marks as they thought potato blight was caused by a fungus.</p>
			Total	2	
4	a		<p>FIRST CHECK ON ANSWER LINE If answer = 10, award 2 marks ✓ ✓</p> <p>9.5 / 9.5044919</p> <p>OR</p> <p>(346 x 0.254 =) 87.884 (patients diagnosed with HAP) / (87.884 x 0.146 =) 12.831064 (patients died from <i>P. aeruginosa</i> infection) / 12.831064 ÷ 1.35 ✓</p>	2	<p>ALLOW other decimal places/sig figs</p> <p>ALLOW 1 mark if 88 or 13 is seen</p> <p><u>Examiner's Comments</u></p> <p>Many candidates were given 1 mark here by providing working which showed they were able to correctly calculate that 87.884 patients were diagnosed with HAP and/or 12.83 had died. However, only a few candidates were given 2 marks for then being able to calculate 35% higher.</p> <p>Calculation:</p> <p>People diagnosed with HAP in ICU = 346 x 25.4% = 87.884</p> <p>People died with HAP = 87.884 x 14.6% = 12.83</p> <p>The number of people died in 2012 = 12.831 x 135 % = 9.504....</p> <p>Nearest whole number = 10</p>
	b		<p><i>Suggest Max 2</i></p> <p>1. higher / more, costs ✓</p>	Max 3	<p>Max 2 if answer limited to 'suggest' MPs OR 'explain' MPs</p>

		<p>use of, more antibiotics /</p> <p>2. different antibiotics / 'new' antibiotics ✓</p> <p>longer hospital stays /</p> <p>3. longer to recover / more people hospitalised ✓</p> <p>isolation of infected people / prevention of other</p> <p>4. people getting infected with antibiotic resistant bacteria ✓</p> <p>5. need for extra hygiene practices / AW ✓</p> <p><i>Explain Max 2</i></p> <p>causes, disability / life</p> <p>6. changing illness / organ failure ✓</p> <p>7. more / increased deaths ✓</p> <p>outbreak / increased rate /</p> <p>8. increased spread (of infection) ✓</p>		<p>ALLOW private room for isolation</p> <p>ALLOW examples e.g. increased, hand washing / cleaning the hospital environment, extra use of, antiseptic soaps / gloves / gowns</p> <p>ALLOW pandemic / 'spread more/very, easily'</p> <p>'Due to higher infection rates, there are much higher costs due to people staying in hospital longer' = MP8, MP1 and MP3</p> <p><u>Examiner's Comments</u></p> <p>Successful responses to this question explained the consequences for the hospital of antibiotic resistance (as the question asked). Less successful responses explained how antibiotic resistance happens/comes about, showing that many misunderstood the question or did not recognise the command words in the stem. These candidates discussed natural selection causing, antibiotic resistance to increase, or how the bacteria wouldn't be able to be treated and talked about contributing issues such as staff shortages. More successful responses used comparative words/statements: 'more costly' rather than 'costly', 'more deaths' rather than 'deaths', and 'spread more easily' rather than 'would spread'. 'New antibiotics', 'more deaths' and 'more people hospitalised' were the most common correct responses.</p>
	c	<p>choosing medicines / drugs / treatments, based on a person's, genes / genome / genotype / genetic profile / base sequence ✓</p> <p><i>idea of</i> medicine / treatment created for a specific patient matched to the bacterial infection they have ✓</p>	1 max	<p>ALLOW DNA for, genes / genome</p> <p><u>Examiner's Comments</u></p> <p>Many candidates were able to correctly link personalised treatment to an individual's genome. Those giving the idea of matching the bacterial infection to a specific antibiotic sometimes were not given the mark because they did not link it to a specific person's needs, i.e. the specific infection they had. Most responses were just generalisations about the drug being specific to the individual, which was not given the mark. A common incorrect response was to state 'based on their immune system' rather than a link to a person's individual 'genome'.</p>

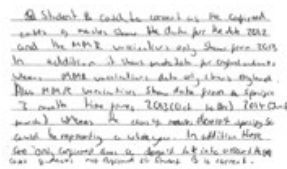
			Total	6	
5			<p>(engulfed) pathogen inside, vesicle / phagosome ✓</p> <p>lysosomes fuse/combine with phagosome / (phagocytic) vesicle formed</p> <p>OR</p> <p>phagolysosome is formed / created ✓</p> <p>enzymes are released / secreted / move in (to the , vesicle / phagolysosome)</p> <p>OR</p> <p>enzymes can now act upon pathogen ✓</p>	2 max	<p>IGNORE vacuole</p> <p>IGNORE attach / bind</p> <p>ACCEPT lysozymes for enzymes</p> <p><u>Examiner's Comments</u></p> <p>This question was a good discriminator, with more successful responses given 2 marks. The most common errors was that the pathogen is engulfed inside the phagocyte cytoplasm and that the lysosome fuses directly with the pathogen. Many candidates correctly used the term phagolysosome and were given the marks.</p> <p> Misconception</p> <p>Although candidates were using key terminology, they did not fully understand the sequence of events and often confused this response with the action of antibodies on pathogens.</p> <p>Exemplar 3</p> <p></p> <p>Exemplar 3 shows a clear and concise response with the key terminology used in the correct order. The candidate was given 2 marks although there are 3 mark points within the response.</p>
			Total	2	
6			B ✓	1	<p><u>Examiner's Comments</u></p> <p>Only a few candidates were able to identify the correct organism as a prokaryote and select B as the right response. The additional guidance provided in the specification should be used to make sure that all key examples of specific organisms are covered in teaching. Specification point 4.1.1 (a) lists ring rot as an example of bacterial pathogen. The most common incorrect response was A.</p>


			Total	1			
7			D ✓	1	<u>Examiner's Comments</u> Most candidates got this question right with only a few not selecting D.		
			Total	1			
8			B ✓	1	<u>Examiner's Comments</u> This question was well answered with most candidates making the link between callose and a physical defence and selecting B as the correct answer.		
			Total	1			
9			B ✓	1	<u>Examiner's Comments</u> The majority of candidates selected the correct response B. The most common incorrect response was C. Some candidates may have been confused by the reference to bacteria and fungi in option C. Fungi are usually treated with antifungal drugs.		
			Total	1			
10			A ✓	1	ALLOW if labelled correctly on image		
			Total	1			
11	a		<u>mucus</u> traps , pathogen / virus ✓ cilia , move / AW , mucus / pathogens (away from lungs) ✓	2 (AO1.2)	ALLOW pathogen / virus / microorganism , sticks to mucus IGNORE germs / bacteria / microbes ALLOW ciliated , cells / epithelium , waft mucus out of the body <u>Examiner's Comments</u> Most candidates scored at least 1 mark here and around half achieved both marks. Each of the marking points was seen equally often. The first marking point was attempted more often but many candidates merely stated that the mucous membranes trapped the pathogen, without explicitly stating that it was the mucus, and so were not given the mark. A few referred to cilia as microvilli or pili.		
	b		<table border="1"><tr><td>Event</td><td>Letter or letters</td></tr></table>	Event	Letter or letters	5 (AO2.2)	DO NOT CREDIT if any incorrect or ambiguous letters appear in a box IGNORE D
Event	Letter or letters						

			<table><tr><td>Antigen presentation</td><td>A</td></tr><tr><td>Clonal expansion</td><td>B and D</td></tr><tr><td>Clonal selection</td><td>A</td></tr><tr><td>High T-helper cell activity</td><td>B and D</td></tr><tr><td>Highest number of memory cells</td><td>E</td></tr></table> 	Antigen presentation	A	Clonal expansion	B and D	Clonal selection	A	High T-helper cell activity	B and D	Highest number of memory cells	E
Antigen presentation	A												
Clonal expansion	B and D												
Clonal selection	A												
High T-helper cell activity	B and D												
Highest number of memory cells	E												


					<p>The difference mark was rarely scored. Most candidates who had the right idea stated that the F_{ab} fragment had <i>no</i> constant region (or <i>no</i> heavy chain). Very few candidates seemed to be aware that the constant region includes part of the upper 'arms' and those that did appeared to be centre-specific. Candidates that gained the difference mark rarely gained both of the other marks so all 3 marks were given to fewer than 1 in 20 responses.</p>
	d		<p>widespread / AW , use ✓</p> <p>at low dose / unfinished course ✓</p> <p>natural selection / antibiotic is selective agent ✓</p> <p>AVP ✓</p>	<p>3 (AO1.1)</p>	<p>ALLOW have been used a lot / overprescribing / use in agriculture / used to treat viral infections</p> <p>CREDIT description that includes genetic variation and differential survival and passing on traits IGNORE immune</p> <p>CREDIT sharing of , DNA / plasmids (containing resistance gene) , between bacteria ALLOW horizontal (gene) transmission</p> <p><u>Examiner's Comments</u></p> <p>Most candidates scored at least 1 mark for this question, with around 1 in 10 scoring all 3 marks. Many candidates devoted their entire answer to a description of natural selection, gaining 1 mark only. The question asked candidates to explain why some bacteria are <i>now</i> resistant, not how this resistance evolved. So, without reference to overprescription, often at a low dose, the question was not fully answered. As natural selection was not the focus of the question, references to bacterial immunity to antibiotics was ignored. A few candidates described natural selection by suggesting that the antibiotic was causing mutations and were not credited.</p>
	e		<p>genetic modification of (named) organisms ✓</p> <p>to produce , (named) drug / (therapeutic) proteins / vaccine ✓</p>	<p>2 (AO1.2)</p>	<p>IGNORE humans</p> <p>Must be linked to (attempt at) first marking point CREDIT e.g. insulin / artemisinin IGNORE 'medicine'</p>

					<u>Examiner's Comments</u> Very few candidates gave a concise description of synthetic biology. Most answered in terms of personalised medicine or using computer modelling to synthesise and test drugs.
			Total	16	
12	a	i	FIRST CHECK ON ANSWER LINE If answer = (-)5.6 award 2 marks $171855 - 162193 = 9662 \checkmark$ $(9662 / 171855 \times 100) = (-) 5.6 \checkmark$	2 (AO2.6)	ALLOW for one mark correct answer (if no workings shown) that is not to 2 significant figures e.g. 6%/ 5.62%/ 5.622%
		ii	Any four from: Student B is correct because 1 vaccination is for, MMR / three diseases , but data only shows confirmed cases of measles✓ 2 cannot tell how effective the vaccination was for the other two diseases / could be effective for other 2 diseases ✓ 3 vaccination data is only given for part of 2013 and 2014 whereas measles data is given for the whole year ✓ 4 more vaccinations could have been given (in the other 9 months of 2013 and 2014) ✓ 5 no data on, number of children who were not vaccinated / % vaccinations relative to total population✓ 6 no data on whether children who had measles were, vaccinated/not vaccinated ✓ 7 no vaccination data for 2012 ✓	Max 4 (AO3.2)	IGNORE any ref to, student A's statement/ data that should not be included e.g. <i>Measles data for 2012 shouldn't be included</i> 1 ALLOW vaccinations are for measles, mumps and rubella. 5 ALLOW 'the number of children born in 2014 might be less than in 2013' 8 ALLOW no data for vaccinations in Wales <u>Examiner's Comments</u> This was a highly discriminating question that challenged all candidates. Most candidates did not focus their whole answer on the data provided in the table and student B's statement about this data. Candidates did not interpret this question as student B criticising the validity of the data but instead focused on whether student A was correct. Therefore, most answers referred to the role of vaccines and herd immunity in preventing measles. Very few candidates appreciated that the vaccine data referred to a combined vaccine but the disease discussed was only measles.

		<p>8 measles data for 2012 is for England and Wales, measles data for 2013 and 2014 is for England only ✓</p> <p>9 only confirmed cases included / unreported cases not included ✓</p>		<p>Some candidates did realise that not all cases of measles would be reported and also appreciate the discrepancies with the inclusion of Wales in some years but not others.</p> <p>Exemplar 3</p>  <p>This candidate focused only on student B only, as asked in the question, and clearly went through each part of the data to see if there were issues with its validity. The answer begins with the obvious differences between the 2 parts of the data: vaccines and cases of measles, commenting on the lack of parity between the data provided for vaccines versus the data provided for cases of measles. They finish by recognising that the data states confirmed cases of measles and this may not be indicative of all cases of measles. The candidate scored 4 marks.</p>
	iii	<p><i>Any three from:</i></p> <p>Incorrect because</p> <p>1 different, vaccines are given to different age groups ✓</p> <p>2 this vaccine is, changed/ different, from year to year ✓</p> <p>3 because the, virus/pathogen, mutates (regularly) ✓</p> <p>4 so antigens (on the surface of the virus) change ✓</p> <p>5 immune system may not, recognise it/ respond to it ✓</p> <p>Correct because</p> <p>6 vaccine is recommended to,</p>	<p>Max 3 (AO3.3)</p>	<p>1 ALLOW same flu vaccine not given to different ages</p> <p>1 IGNORE ref to dose of vaccine for 'different vaccines'</p> <p>2 ALLOW vaccine has to be up to date (with changing virus) / vaccine is newly produced/ vaccine is changed frequently</p> <p>3 ALLOW new strains of virus emerge</p> <p>4 ALLOW vaccine (must) contain new antigen</p> <p>5 ALLOW new antibodies need to be made/old antibodies no longer effective</p> <p><u>Examiner's Comments</u></p> <p>Most candidates attempted to critique the statement and appreciated that there were incorrect and correct statements, often referring to the medically vulnerable as the correct part of the statement. A large majority of candidates did state that the vaccines</p>


			<p>pregnant/ >50 years old/ diabetic / asthma / AW (medically vulnerable) ✓</p>		<p>changed every year. Many answers referred to the disease/influenza mutating without reference to the virus itself.</p> <p>A lot of answers discussed a different vaccine for the medically vulnerable as they would need a weakened version due to a weak immune system. This suggests a lack of understanding of how vaccines work and the vulnerability referring to their vulnerability of the disease/virus not to the vaccine that would provide protection.</p> <p> Assessment for learning</p> <p>Different vaccines and how they work is a great discussion point for AS Level Biology, especially with the advent of the new RNA vaccines. Candidates could each have a vaccine to research and then present it to the class.</p> <p>The NHS website lists all the vaccines and who receives them and when. This will help to make it clear to candidates that everyone should have the opportunity to get a vaccine and the vulnerability of a person is not related to the vaccine but to the susceptibility they have, in getting the actual disease.</p>
		iv	<p>Any two from:</p> <p>1 mass vaccination (at start of epidemic) can prevent spread of, pathogen/disease (into the wider population) ✓</p> <p>2 herd immunity ✓</p> <p>3 minimises possibility of, another outbreak of the disease/ a variant spreading✓</p>	<p>Max 2 (AO1.2)</p>	<p>ALLOW immunised for 'vaccinated' throughout</p> <p>1 ALLOW if everyone vaccinated the disease cannot spread e.g 'if population immunised pathogen is killed before it can spread' = mp1</p> <p>IGNORE 'if more people are immune' for 'mass vaccination'</p> <p><u>Examiner's Comments</u></p> <p>Many candidates did refer to herd immunity, but they didn't discuss how mass vaccination prevents the spread of a disease. A lot of answers discussed vaccinations in terms of the individual and did not realise the question was about a vaccination programme rather than a single vaccine.</p>
	b	i	<p>(named part of) Immune system attacks, cells/tissues,</p>	<p>1 (AO1.2)</p>	<p>IGNORE body attacks itself for 'immune system attacks'</p>

			as it recognises them as, foreign/non self. ✓		<p>ALLOW have an abnormal immune response as body cells treated as foreign</p> <p>Examiner's Comments</p> <p>Few candidates gave the correct meaning as they did not refer to why the immune system was attacking body cells. Some answers referred to the body attacking its own cells without specifying the immune system. Some candidates confused this with a disease that attacks the immune system itself.</p>
		ii	Any two from fibrous ✓ insoluble ✓ (high) tensile strength ✓ resistant to stretching ✓	Max 2 (Ao2.1)	<p>ALLOW (high) mechanical strength</p> <p>Examiner's Comments</p> <p>Most candidates recognised that collagen was a fibrous protein and some answers referred to it being insoluble. Many candidates gave statements about it needing to be strong for its role but not being precise with the type of strength it exhibits. Some answers referred to collagen as having elastic properties, confusing collagen with elastin.</p>
		iii	bone marrow ✓	1 (AO1.1)	IGNORE embryos
		iv	Error 1: perforins Correction: interleukins / cytokines ✓ Error 2: antigen-toxin Correction: antigen-antibodies (complex) ✓	2 (Ao2.5)	<p>Examiner's Comments</p> <p>Most candidates identified the errors in the statement, but some struggled to correct those errors. Perforins to interleukins was recalled the most but very few candidates were able to correct antigen-toxin to antigen-antibody. Some candidates did not state the error and only stated the correction.</p>
			Total	17	
13	a		(R) opsonin ✓ (S) <u>agglutinin</u> ✓ (T) anti-toxin ✓	3(AO2.5)	<p>ALLOW R = opsonisation / opsonising ALLOW S = IgM / agglutin / agglutinin / agglutination / agglutinating / agglutinator ALLOW T = neutralisation / neutralising IGNORE detoxifying</p> <p>Examiner's Comments</p> <p>Most candidates could identify at least two types of antibodies. The most poorly answered option was for R where they didn't write opsonin for their answer. Option S was the best answered, with the majority of</p>

					<p>candidates knowing the answer or using 'agglutination or agglutin' as alternatives. The candidates who were not given any marks either fell into the category of 'no response' or named different types of white blood cell. Phonetic spellings were accepted for the names of the antibodies.</p>  <p>Assessment for learning</p> <p>Some candidates may have struggled to identify opsonins, agglutinins, and anti-toxins as antibodies because in some cases, 4.1.1(h) (the structure and function of antibodies) and 4.1.1(i) (the action of opsonins, agglutinins, and anti-toxins) might not be taught together. It is important that teaching should emphasise that all three are examples of antibodies, and that their structure is related to their function.</p>
	b		autoimmune ✓	1(AO2.1)	<p>ALLOW autoimmunity</p> <p><u>Examiner's Comments</u></p> <p>A very well answered question, upwards of 90% of candidates knew the correct answer. Incorrect answers included names examples of autoimmune diseases (e.g. rheumatoid arthritis) or other general disease names, e.g. communicable disease, coronary heart disease, immunodeficiency.</p>
			Total	4	
14	a	i	<p>(X) (T or B) lymphocyte ✓</p> <p>(Y) neutrophil ✓</p>	2(AO2.3)	<p>ALLOW T cell / B cell / T helper cell / T killer cell / T regulator cell</p> <p>ALLOW phagocyte</p> <p><u>Examiner's Comments</u></p> <p>Most candidates only got 1 mark for correctly naming Y as a neutrophil. The most common errors were incorrectly naming X as a macrophage or monocyte, with few candidates correctly identifying it as a lymphocyte.</p>
		ii	flattened / biconcave (shape), to increase surface area (to volume ratio) ✓	2 max(AO1.1)(AO2.1)	<p>IGNORE concave</p> <p>ALLOW few organelles so more haemoglobin can be in the cell</p>


		<p>no, nucleus / organelles, to give (more) space for haemoglobin ✓</p> <p>flexible, to increase surface area in contact with <u>capillary</u> wall / to squeeze through <u>capillaries</u> ✓</p> <p>small, for short diffusion pathway / to fit through <u>capillaries</u> ✓</p> <p>transport proteins in plasma membrane, to allow chloride shift ✓</p> <p>high concentrations of carbonic anhydrase (inside cells), to allow transport of carbon dioxide / described ✓</p>		<p>IGNORE to give (more) space for oxygen</p> <p>'cells are small and flexible to fit through capillaries' = 2 marks</p> <p><u>Examiner's Comments</u></p> <p>This question was generally answered well by a wide range of candidates. Common errors included omitting 'bi' from 'biconcave' and describing the lack of a nucleus as giving more space for oxygen (rather than haemoglobin). Some candidates lost marks for linking an adaptation to the wrong benefit, especially biconcave with being able to fit through capillaries, rather than increasing surface area.</p>
	iii	<p>FIRST CHECK ON ANSWER LINE If answer = 13 award 2 marks</p> <p>10 mm / 800 (= 0.0125mm) ✓</p> <p>0.0125mm × 1 000 (= 12.5µm) ✓</p>	2(AO2.8)	<p>ALLOW 12.5 for 2 marks ALLOW answer to more than 3 s.f. for 1 mark</p> <p>ALLOW ECF if incorrect measurement of cell W with units used but divided by 800 for 1 mark or measurement of cell W with units correctly converted to µm for 1 mark</p> <p>ALLOW 0.01m / 800 (= 0.0000125m) and 0.0000125m × 1 000 000 (= 12.5µm)</p> <p>ALLOW 1cm / 800 (= 0.00125cm) and 0.00125 × 10 000 = (12.5µm)</p> <p>If candidate measures cell W as 9.5 mm ALLOW 12 / 11.9 for 2 marks and 11.88/11.875 for 1 mark If candidate measures cell W as 10.5 mm ALLOW 13 / 13.1 for 2 marks and 13.13 / 13.125 for 1 mark</p> <p><u>Examiner's Comments</u></p> <p>About half of candidates gained the full 2 marks for this question. Marks were most often lost for measuring in cm then an incorrect conversion to micrometres – most multiplying by 1000 rather than 10,000. Candidates who showed working, including the measurement of the diameter with units</p>

					divided by 800, could access 1 mark even if their final answer was incorrect.
	b	i	digests / hydrolyses / destroys / kills / breaks down, pathogens ✓	1(AO1.1)	<p>IGNORE 'get rid of pathogens'</p> <p>IGNORE ref to antigens</p> <p>ALLOW ref to parasites / damaged cells / tumour cells / old cells / old organelles for 'pathogens'</p> <p>DO NOT ALLOW 'engulf pathogens'</p> <p><u>Examiner's Comments</u></p> <p>Most candidates gained this mark. The most common reason for losing the mark was suggesting that the lysosome engulfed the pathogen, rather than the phagocyte engulfing it, or for suggesting that lysosomes are enzymes. Very few candidates gave acceptable alternatives to pathogens, such as damaged or old cells, rather giving vague answers such as breaking down molecules.</p>
		ii	<p>FIRST CHECK ON ANSWER LINE</p> <p>If answer = 2×10^{-5} award 2 marks</p> <p>$1.3 \times 10^{-21} / 6.5 \times 10^{-14} = 2 \times 10^{-8} \text{ (mol cm}^{-3}\text{)} \checkmark$</p> <p>$2 \times 10^{-8} \text{ (mol cm}^{-3}\text{)} \times 1000 = 2 \times 10^{-5} \text{ (mol dm}^{-3}\text{)} \checkmark$</p>	2(AO2.2)	<p>ALLOW 0.00002 for 2 marks</p> <p>ALLOW '× 1000' seen anywhere in the answer</p> <p><u>Examiner's Comments</u></p> <p>Few candidates scored both marks for this question. Many candidates did not convert cm^3 into dm^3 or divided the numbers the wrong way round. Often incorrect answers were from not multiplying 2×10^{-8} by 1000 giving the final answer as 2×10^{-8}. Subsequently many candidates achieved ECF for 2biii and 2biv.</p>
		iii	$(-\log 0.00002 =) 4.7 \checkmark$	1(AO2.2)	<p>This mark is for a correct calculation, therefore</p> <p>ALLOW ECF from part (ii) if the pH value calculated is given to 2 sig figs, even if outside the normal pH range, including correctly calculated negative values</p> <p><u>Examiner's Comments</u></p> <p>This mark was for a correct calculation, therefore ECF from Question 2 (b) (ii) was allowed, even if outside the normal pH range, including correctly calculated negative values. Many candidates did not have an awareness of physiological pH values or that a $\text{pH} > 14$ or < 0 was not plausible which may have helped them revisit 2bii. A small number of</p>

					<p>candidates recorded to 2 decimal places rather than 2 significant figures.</p> <p> OCR support</p> <p>Advice on using calculators to find logarithm functions for maths skill M0.5 can be found on page 16 of the Biology mathematical skills handbook on this page: https://www.ocr.org.uk/qualifications/as-and-a-level/biology-a-h020-h420-from-2015/planning-and-teaching/ A tutorial, quiz sheet and teacher answers are available here under M0.5. https://www.ocr.org.uk/subjects/science/maths-for-biology/arithmetic-and-numerical-computation/</p>
		iv	B ✓	1(AO3.1)	<p>Apply ECF from part (iii) ALLOW B if calculated pH is less than 7 ALLOW A if calculated pH is greater than 7 ALLOW C if calculated pH is 7. ALLOW B if no pH calculation given in (iii) ALLOW answer if shown on table if no answer given on answer line</p> <p><u>Examiner's Comments</u></p> <p>Again, an ECF was allowed from Question 2 (b) (iii). A common error by candidates was the selection of C for pH values just above or below a neutral pH, recorded between 6.7 and 7.7.</p>
			Total	11	
15	a		<p>1 phagocyte engulfs pathogen in a, vesicle / phagosome / endosome ✓ 2 lysosomes combine with, phagosome / vesicle / endosome ✓ 3 (lysosyme) enzymes, break down / digest / destroy, pathogen ✓</p>	3 (AO1.1)	<p>1 ALLOW encloses / traps / captures / AW for 'engulfs' 1 ALLOW vacuole for 'vesicle' 2 ALLOW fuse with / join to / attach to / bind to, for 'combine' 3 IGNORE combat / fight / attack, for 'destroy' 3 DO NOT ALLOW lysozymes for 'enzymes'</p> <p><u>Examiner's Comments</u></p> <p>Some candidates had a good understanding of phagocytosis and used the terms phagocyte, phagosome, lysosome and phagolysosome correctly. A common error in less successful responses was confusing the cell (phagocyte) with the vesicle it forms after</p>

					engulfing a pathogen (phagosome), so the incorrect phrase 'The phagosome engulfs the pathogen' appeared in some responses. Another common error was to refer to the enzymes in the lysosomes as 'lysozymes'.
	b	i	phagocyte / neutrophil ✓	1 (AO1.1)	<p>ALLOW (non-human) macrophage IGNORE leucocyte / white blood cell</p> <p><u>Examiner's Comments</u></p> <p>Many candidates named the cell correctly as phagocyte or neutrophil. Macrophage was accepted although in humans, macrophages are larger than this cell (the diameter of which was calculated in part (ii)). The most frequently written incorrect response was the general term 'white blood cell'.</p>
		ii	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 14 or 15 (µm) award 2 marks</p> <p>14mm ÷ 950 = 0.0147mm ✓</p> <p>0.0147 × 1000 = 15µm ✓</p>	2 (AO2.8)	<p>ALLOW answer given to 3 significant figures for 2 marks e.g. 13.7 / 14.2 / 14.7µm If answer given to more than 3 sig. fig. max 1 mark ALLOW (13 000 ÷ 950) = 13.7µm for 2 marks ALLOW (13 500 ÷ 950) = 14.2µm for 2 marks</p> <p>If final answer incorrect award 1 mark for two clearly shown correct steps in working (other than 1 plus 4). IGNORE crossed-out working.</p> <p>steps in working: 1 (diameter with units =) 13 / 13.5 / 14mm OR 1.3 / 1.35 / 1.4cm 2 divide by 950 3 convert EITHER original diameter OR answer to µm (mm → µm × 1000, cm → µm × 10 000) 4 round to 2 significant figures</p> <p><u>Examiner's Comments</u></p> <p>Candidates seemed well-prepared in terms of knowing the equation:</p> $\text{magnification} = \frac{\text{image size}}{\text{object size}}$ <p>(although, not all could rearrange it). Many were given 1 mark for measuring the cell correctly and stating the length with units in their working and for dividing by the</p>

					<p>magnification, 950. Where many ran into problems was in converting their answer to micrometres and giving the answer to an appropriate number of significant figures (the same number as the original measurement or one more than that). Many answers were out by a factor of 10 because the candidate measured in centimetres and then multiplied by 1000 instead of 10 000 to convert to micrometres. A simple protocol for performing this calculation is shown below.</p> <p>Checklist for calculating the diameter of a cell in a photomicrograph</p> <ul style="list-style-type: none"> • Measure in millimetres • Multiply by 1000 to convert this measurement to micrometres • Divide by the magnification • Round answer to same number of significant figures as the original measurement (or one more).
		iii	made up of different cells / not made up of different tissues ✓	1 (AO1.1)	<p>IGNORE differentiated cells ALLOW two or more named blood cells for 'different'</p> <p><u>Examiner's Comments</u></p> <p>Only a minority of candidates explained that blood is made up of different cells but not different tissues. Although the different cell types were visible in the photomicrograph many candidates wrote that blood consisted of similar cells carrying out a similar function.</p>
	c	i	<u>artificial active</u> (immunity) ✓	1 (AO1.1)	<p><u>Examiner's Comments</u></p> <p>The type of immunity given by an influenza vaccine needed to be fully described as both artificial and active. The most frequently written incorrect response (apart from those who omitted one of the two descriptors) was 'herd immunity'.</p>
		ii	<p>1 low shallow hump labelled 'primary' first and higher steeper hump labelled 'secondary' later ✓</p> <p>2 primary starts at 5-10 days</p>	2 (AO2.1)	<p>1 IGNORE timing 1 ALLOW curve that plateaus and does not come back down 2 ECF missing label</p> <p><u>Examiner's Comments</u></p>

			and secondary at 25-28 days ✓		Candidates needed to read the question carefully and to proceed with care before drawing their curve. Successful responses were able to label the parts of the curve corresponding to the primary and secondary immune responses, make the secondary response steeper and higher than the primary (more rapid response and increased number of antibodies) and in particular they started to plot the primary response after the vaccine was given on day 5 and the secondary response after the second exposure on day 25. Less successful responses were not able to demonstrate this accuracy in their graphicacy skills.
		iii	1 (memory cells) divide to form plasma cells ✓ 2 plasma cells, produce / release, antibodies (rapidly) ✓ 3 antibodies, bind to / disable / destroy, antigen / virus ✓	2 Max (AO1.2) (AO2.1)	3 ALLOW pathogen for 'virus' <u>Examiner's Comments</u> Few candidates outlined the role of memory B cells correctly. Responses were often vague.  Misconception "Memory cells remember the pathogen and produce antibodies." Memory cells do not directly produce the antibodies that kill the pathogen. The selected memory cells divide and differentiate to form a clone of plasma B cells which then produce and release the antibodies.
			Total	12	
16			C ✓	1(AO1.1)	
			Total	1	
17			C ✓	1(AO1.2)	<u>Examiner's Comments</u> This had not been well learnt by candidates and the proportion of correct answers was similar to that which would be expected by chance.
			Total	1	
18			C ✓	1(AO1.2)	

					<u>Examiner's Comments</u> About half were correct responses. Many candidates chose A, perhaps not realising that droplets of moisture are carried through the air.
			Total	1	
19			B ✓	1(AO2.5)	<u>Examiner's Comments</u> Just under half of answers were correct. Many candidates chose A or C.
			Total	1	
20			A ✓	1	<u>Examiner's Comments</u> Most candidates gave the correct response (A). The most common incorrect response appeared to be C.
			Total	1	
21			C ✓	1	<u>Examiner's Comments</u> Most candidates gave the correct response (C). The most common incorrect response appeared to be A. Candidates need to read all the answer options before committing to a response.
			Total	1	
22			B ✓	1	<u>Examiner's Comments</u> Only a minority of candidates gave the correct response (B). The most common incorrect responses were A and C.
			Total	1	