Pearson Edexcel

Mark Scheme (Results)

Summer 2022

Pearson Edexcel GCSE
In Biology (1BI0) Paper 1H

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Mark schemes have been developed so that the rubrics of each mark scheme reflects the characteristics of the skills within the AO being targeted and the requirements of the command word. So for example the command word 'Explain' requires an identification of a point and then reasoning/justification of the point.
Explain questions can be asked across all AOs. The distinction comes whether the identification is via a judgment made to reach a conclusion, or, making a point through application of knowledge to reason/justify the point made through application of understanding. It is the combination and linkage of the marking points that is needed to gain full marks.
When marking questions with a 'describe' or 'explain' command word, the detailed marking guidance below should be consulted to ensure consistency of marking.

Assessment Objective		**Command Word**	
Strand	**Element**	**Describe**	**Explain**
AO1		An answer that combines the marking points to provide a logical description	An explanation that links identification of a point with reasoning/justification(s) as required
AO2		An answer that combines the marking points to provide a logical description, showing application of knowledge and understanding	An explanation that links identification of a point (by applying knowledge) with reasoning/justification (application of understanding)
AO3	1a and 1b	An answer that combines points of interpretation/evaluation to provide a logical description	
AO3	2a and 2b		An explanation that combines identification via a judgment to reach a conclusion via justification/reasoning
AO3	3a	An answer that combines the marking points to provide a logical description of the plan/method/experiment	
AO3	3b		An explanation that combines identifying an improvement of the experimental procedure with a linked justification/reasoning

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Question number	Answer	Mark
1(a)	C Aa The only correct answer is C *A is incorrect because there has to be a dominant and a recessive allele* *B is incorrect because there has to be a dominant and a recessive allele* *D is incorrect because the alleles are not co-dominant*	(1) AO2 1

Question number	Answer	Additional guidance	Mark
1(b)(i)	3:1 / 3	accept three : one accept three	(1) AO1 1

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>1(b)(ii)</td><td>correctly completed Punnett square:

correct gametes (1)
correct offspring (1)

correct percentage 25(%) (1)

<table>
<tr><td></td><td>A</td><td>a</td></tr>
<tr><td>A</td><td>AA</td><td>Aa</td></tr>
<tr><td>a</td><td>Aa</td><td>aa</td></tr>
</table>
</td><td>accept correct offspring from incorrect gametes for 1 mark

ecf from incorrect Punnett square

accept aA

accept the use of other letters</td><td>(3)

AO3 1ab</td></tr>
</table>

Question number	Answer	Additional guidance	Mark
1(c)(i)	(genetic) variation in the offspring / offspring have different alleles / genetically diverse (1)	accept allows evolution / natural selection / species to adapt /survive a selection pressure	(1) AO1 1

Question number	Answer	Additional guidance	Mark
1(c)(ii)	meiosis	accept meiotic division	(1) AO1 1

Total marks for question 1 = 7 marks

Question number	Answer	Additional guidance	Mark
2(a)	A description linking two from: • weak (1) • hydrogen bonds (1) • complementary bases (1) • A – T / C – G (1)	accept H bonds reject hydro bonds accept the names of the base pair	(2) AO1 1

Question number	Answer	Additional guidance	Mark
2(b)(i)	T T G A T T G C G T A A A A C T A A C G C A T T award 1 mark for all the As and Ts in the top line correctly paired (1) award 1 mark for all the Cs and Gs in the top line correctly paired (1)	accept lower case letters	(2) AO2 1

Question number	Answer	Mark
2(b)(ii)	B 4 The only correct answer is B *A is incorrect because each 3 amino acids would need 9 bases to be present* *C is incorrect 6 amino acids would need 18 bases* *D is incorrect because 12 amino acids would need 36 bases*	(1) AO2 1

Question number	Answer	Mark
2(b)(iii)	D double helix The only correct answer is D *A is incorrect because a DNA molecule is not three separate strands* *B is incorrect because the DNA molecule consists of two strands* *C is incorrect because a DNA molecule is a double helix not a single helix*	(1) AO1 1

Question number	Answer	Additional guidance	Mark
2(c)(i)	An explanation linking two from: • (protease) breaks down proteins (1) • in the {cell/nuclear} membrane (1) • destroys enzymes (that may break down the DNA) (1)	accept break down the {cell/nucleus/cell wall}	(2) AO1 2

Question number	Answer	Additional Guidance	Mark
2(c)(ii)	to precipitate the DNA / because DNA is insoluble in ethanol	accept to see the DNA	(1) AO1 2

Total marks for question 2 = 9 marks

Question number	Answer	Mark
3(a)(i)	gonorrhoea	(1) AO3 1a

Question number	Answer	Additional guidance	Mark
3(a)(ii)	(66 000 000 ÷ 1000) = 66 000 (1) (66 000) x 3.7 =244 200 (people) or (3.7 ÷ 1000) = 0.0037 (1) (0.0037) x 66 000 000 = 244 200 (people) or (66 000 000 x 3.7) = 244 200 000 (1) (244 200 000 ÷ 1000) = 244200	award full marks for correct answer no working accept answers in standard form accept 244200 to any incorrect magnitude for one mark	(2) AO2 1

Question number	Answer	Additional guidance	Mark
3(a)(iii)	Any one from: • it is {passed / spread} from person to person (1) • caused by bacteria (1)	accept spread by {sexual contact / body fluids} accept pathogen ignore caused by a virus	(1) AO1 1

Question number	Answer	Additional guidance	Mark
3(a)(iv)	Any one from: • avoid sexual contact (1) • use a {condom/femidom} (1) • screen people for an infection (1) • treat the infection/give antibiotics (1)	accept use a barrier form of contraception ignore protection / contraception	(1) AO2 1

Question number	Answer	Additional guidance	Mark
3(a)(v)	An explanation including the following: • it is {killed/inhibited} by antibiotics (1) • because chlamydia is caused by bacteria (1)	accept disrupt cell processes (in bacteria) /prevent (bacteria) reproducing accept antibiotics are used to kill bacteria for 2 marks	(2) AO2 1

Question number	Answer	Additional guidance	Mark
3(b)	An explanation linking the following: • HIV {destroys white blood cells / reduces the number of white blood cells} (1) • which compromises the immune system / making the person more susceptible to other {pathogens / infections / diseases} (1)	accept named white blood cells accept weakens the immune system ignore more susceptible to AIDS	(2) AO2 1

Total for question 3 = 9 marks

Question number	Answer	Mark
4(a)(i)	D retina The only correct answer is D *A is incorrect because the cornea does not contain light receptor cells* *B is incorrect because the iris does not contain light receptor cells* *C is incorrect because the lens does not contain light receptor cells*	(1) AO1 1

Question number	Answer	Mark
4(a)(ii)	mitochondria / mitochondrion accept phonetic spellings	(1) AO1 1

Question number	Answer	Mark
4(a)(iii)	nucleus / nuclei accept phonetic spellings	(1) AO1 1

Question number	Answer	Additional guidance	Mark
4(a)(iv)	rods / rod cells	reject cones	(1) AO1 1

Question number	Answer	Additional guidance	Mark
4(a)(v)	A description including **two** of the following: • cell B is a cone cell (1) • involved in colour vision (1)	accept respond to bright light / high light intensities accept responds to different {wavelengths / frequencies} of light (1)	(2) AO1 1

Question number	Answer	Additional guidance	Mark
4(b)(i)	Change the subject of the equation: time = distance ÷ speed (1) Conversion of mm to m: 47 ÷ 1000 = 0.047(m) (1) Substitution: 0.047 ÷ 75 = 0.0006267 (seconds) OR Change the subject of the equation: time = distance ÷ speed (1) Conversion of m to mm: 75 x 1000 = 75000 (mm) (1) Substitution: 47 ÷ 75000 = 0.0006267 (seconds)	award full marks for correct answer no working accept answers in standard form accept any correct rounding - 0.00063 / 0.000626(recurring) / 0.0006 accept any correct rounding - 0.00063 / 0.000626(recurring) / 0.0006 accept answers in standard form	(3) AO2 1

Question number	Answer	Mark
4(b)(ii)	A cerebral hemispheres The only correct answer is A *B is incorrect because the occipital lobe is not located in the medulla oblongata* *C is incorrect because the occipital lobe is not located in the cerebellum* *D is incorrect because the occipital lobe is not located in the hypothalamus*	(1) AO1 1

Question number	Answer	Mark
4(b)(iii)	(eye)sight / vison / seeing / being able to see	(1) AO2 1

Total for question 4 = 11 marks

Question number	Answer	Additional guidance	Mark
5(a)(i)	An explanation including four of the following: • by natural selection / evolution (1) • mutation in the bacterium /variation in the population (1) • only the resistant bacteria survived treatment by antibiotics / resistant bacteria survive when people **don't finish the course** (1) • the resistant bacteria {reproduce / divide} (1) • offspring inherit the resistance / resistance passed onto future generations / process repeats increasing level of resistance (1)	accept *Klebsiella* for bacteria accept they evolve accept some bacteria have a {gene/allele} for antibiotic resistance accept non-resistant bacteria killed by antibiotics ignore offspring are identical	(4) A02 1

Question number	Answer	Additional guidance	Mark
5(a)(ii)	people not completing their course of antibiotics/overuse of antibiotics	accept acted as a selection pressure accept being used to treat viruses/examples ignore misuse unqualified	(1) AO1 1

Question number	Answer	Mark
5(a)(iii)	B it does not have a nucleus The only correct answer is B *A is incorrect because prokaryotic cells do not have chloroplasts* *C is incorrect because prokaryotic cells have ribosomes* *D is incorrect because prokaryotic cells can reproduce without a host*	(1) AO1 1

Question number	Answer	Additional guidance	Mark
5(b)	A description including three of the following: • the antibiotic would go through a development phase (1) • pre-clinical (stage / trials) (1) • testing on animals / testing *in-vitro* / on cells (1) • clinical (stage / trials) (1) • testing on (healthy) volunteers / testing on patients (1) • double-blind trials (1)	accept examples of the development phase accept named animals accept a description of double-blind trials e.g. placebo and drug	(3) AO2 1

Total for question 5 = 9 marks

Question number	Answer	Additional guidance	Mark
6(a)	milk B contains fat / milk B had a high fat content	accept milk B is less dense accept lipid / oil	(1) AO2 2

Question number	Answer		Mark
6(b)(i)	An explanation including the following: • lipase digests {fat/lipid} (1) • forming fatty acids (and glycerol) (1) • which are acidic / lowering the pH of the mixture / making the mixture more acidic (1)	 accept breakdown for digest accept removing fat makes the milk more acidic	(3) A01 2

Question number	Answer	Additional guidance	Mark
6(b)(ii)	An explanation linking two from: • milk A did not contain any/much fat (1) • fatty acids were not produced • as there was no substrate (1)	 accept lipids accept fewer fatty acids were produced	(2) A02 2

Question number	Answer	Additional Guidance	Mark
6(b)(iii)	An explanation linking three of the following: • the temperature is above the optimum (1) • the {lipase / enzyme} denatures (1) • so active site changes shape (1) • no enzyme -substrate complexes formed / no longer complementary to the substrate / cannot bind the substrate (1)	accept the temperature was high reject {enzyme / lipase} is killed accept so it could not break down the fat / no fatty acids produced	(3) A02 2

Total for question 6 = 9 marks

Question number	Answer	Additional guidance	Mark
7(a)	A description including four of the following: • use the {root tip / meristem} (1) • Soften the root (with alcohol/heat/acid) (1) • crush the root onto the slide/take a thin section (1) • Stain the root / named stain (1) • Add a drop of water to the slide (1) • Add a cover slip (1)	accept the end of the root for root tip accept description of a root squash accept use a layer of cells accept dye ignore ink accept another slide / description of a cover slip	(4) A03 3a

Question number	Answer	Additional guidance	Mark
7(b)	A description including three from: • two cells (1) • diploid cells / same number of chromosomes as parent cell (1) • genetically identical cells (1) • body cells (1)	accept 23 pairs of chromosomes / 46 chromosomes accept cells for growth / repair	(3) AO1 1

Question number	Answer	Additional guidance	Mark
7(c)	Select 45 cells in mitosis (1) (45) ÷ 89 x 100 = 50.561 (1) 50.6	Award full marks for correct answer with no working ecf for workings that show the use of an incorrect number of cells up to and including 89 cells ecf if the workings show their answer to 3 s.f.	(3) A03 2ab

Question number	Answer	Additional Guidance	Mark
7(d)	(makes cell division) uncontrolled	accept idea of cell division being rapid / increased ignore references to mutation / tumour	(1) A01 1

Total for question 7 = 11 marks

Question number	Answer	Additional guidance	Mark
8(a)	A description including three of the following: • overproduction of offspring (1) • organisms in a species have {variation / mutations} (1) • there is {a struggle for existence / selection pressure / competition} (1) • the adapted organisms survive (1) • (reproduction leads to) offspring inheriting {characteristics / gene / allele /adaptation / trait} (1) • this is repeated over many generations (1)	accept there are differences within {species/organisms} accept named selection pressure /change in the environment accept survival of the fittest accept not adapted organisms die	(3) AO2 1

Question number	Answer	Additional guidance	Mark
8(b)(i)	An explanation including the following: • (fewer bright feathers) would be less noticeable / they are camouflaged / they blend in (1) And one from: • therefore they are less likely to be eaten / by predators (1) • therefore more likely to get food / from prey (1)	ignore more likely to survive accept ideas of less likely to be hunted / killed	(2) A02 1

Question number	Answer	Additional guidance	Mark
8(bii)	An answer including the following: • female birds are those who {produce offspring / lay eggs} (1) • one male bird can reproduce with many female birds (1)	accept males do not produce the {offspring / eggs} reject males don't reproduce accept {named species/in rare cases} females can reproduce asexually	(2) AO2 1

Question number	Answer	Additional Guidance	Mark
8(c)	A description linking three of the following: • they have a pentadactyl limb (1) • suggesting a common ancestor (1) • that also had a {pentadactyl limb / this limb structure} (1) • how the structure has been adapted to different functions / description of the adaptations for a function (1)	accept they have a similar bone structure / description of the bone structure ignore similar limb structure accept unlikely to have descended from different ancestors	(3) AO1 1

Total for question 8 = 10 marks

Question number	Answer	Additional guidance	Mark
9(a)(i)	Any one from: • pig kidneys cannot be used in humans (1) • pig kidneys would be rejected (by humans) (1) • to prevent competition between the pig and the human organ (1) • so the human kidneys form properly (1)	ignore so it grows human kidneys accept so there is room for the human kidneys	(1) AO2 1

Question number	Answer	Mark
9(a)(ii)	An explanation linking two from: • stem cells {are undifferentiated / are unspecialised / can differentiate / become specialised / form any type of cell} (1) • so can produce the {kidney / kidney cells / kidney tissue} (1) • that won't be rejected (when transplanted) (1)	(2) AO1 1

Question number	Answer	Additional guidance	Mark
9(b)(i)	A comparison including three of the following: • the number of transplants needed increased rapidly but the number of donors {only increased slightly /remained low} (1) • from {2014 / 2015} the numbers of transplants required decreased (1) • the number of donors available was always lower than the number of transplants needed (1) • comparison of figures from the graph of the number of people needing an organ and donating an organ (1)	 accept peaked in {2014 / 2015} accept there are not enough donors for the transplants needed accept a comparative mathematical manipulation of the data	(3) AO3 2ab

Question number	Answer	Mark
9(b)(ii)	not enough donors are available / to increase the number of organs for donation / to meet the demand for organ transplants	(1) AO3 2b

Question number	Indicative content	Mark
9(c)	AO1 • the gene that codes for human insulin is identified • in the human DNA • this is removed using a restriction enzyme • the plasmid of a bacterial cell is removed • using lysosomes/lysozyme • the plasmid is cut open • using (the same) restriction enzyme • leaving complementary sticky ends • the human gene is inserted into the bacterial plasmid • using the enzyme ligase • the plasmid is returned to the bacterial cell • the bacterial cell multiplies	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of biological understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates biological understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or underdeveloped. (AO1) • Presents and explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant biological understanding throughout. Understanding of scientific ideas is detailed and fully developed. (AO1) • Presents and explanation that has a well developed structure which is clear, coherent and logical. (AO1)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1−2	• A brief understanding of the removal of the human gene or how the bacterial cell is altered • The process described links to the next or a key aspect of the process
Level 2	3−4	• A brief understanding of both the removal of the human gene and the use of a plasmid / bacterial DNA / vector • Linked to the use of at least one correct enzyme
Level 3	5−6	• A clear understanding of the removal of the human gene, the use of the bacterial plasmid including one correct enzyme, and insertion of the (recombinant) plasmid into a bacterium • Linked to the correct enzymes for removal of the gene and the insertion into the plasmid AND the role of sticky ends

Level	Mark	Examples of answers
	0	No rewardable material.
Level 1	1−2	• The human insulin gene is inserted into the bacterial DNA - 1 • Cut the human insulin gene from a cell and insert it into the bacteria -2 • Cut the human insulin gene leaving sticky ends - 2
Level 2	3−4	• Cut the human insulin gene and cut a plasmid. Insert the gene into the plasmid DNA - 3 • Cut the human insulin gene and cut a plasmid with restriction enzymes. Insert the gene into the plasmid DNA - 4 • Remove the insulin gene using restriction enzymes and cut the plasmid with the same restriction enzyme, Use ligase to insert the gene into the plasmid - 4
Level 3	5−6	• Cut the insulin gene using a restriction enzyme that leaves sticky ends. Cut the plasmid DNA with the same restriction enzyme and insert the gene into the plasmid. Insert the recombinant plasmid back into the bacteria - 5 (no ligase) • Cut the insulin gene using a restriction enzyme. Cut the plasmid DNA with the same restriction enzyme and insert the gene into the plasmid. Insert the recombinant plasmid back into the bacteria − 5 (no sticky ends) • Cut the insulin gene using a restriction enzyme that leaves sticky ends. Cut the plasmid DNA with the same restriction enzyme to leave complementary sticky ends. Join the gene and the plasmid using ligase. Insert the recombinant plasmid back into the bacteria − 6

Total for question 9 = 13 marks

Question number	Answer	Additional guidance	Mark
10(a)(i)	Any one from: • to prevent contamination (1) • {avoid / kill / remove} microorganisms (1) • prevent other microorganisms affecting the results (1)	accept bacteria / fungi /pathogen /virus for microorganism	(1) AO2 1

Question number	Answer	Additional guidance	Mark
10(a)(ii)	so the bacteria are not killed / so the bacteria are not {destroyed / harmed / damaged / burnt}	accept microorganism / pathogen for bacteria	(1) AO2 1

Question number	Indicative content	Mark
10(a)(iii)	AO2 & AO3 Plan • soak one filter disc in antiseptic 1 • repeat for with fresh filter disc for antiseptic 2 • repeat with fresh disc for antiseptic 3 • soak fresh filter disc in distilled water • place one disc in each quarter and / space the discs out • label the Petri dish • incubate the petri dish Results • measure radius/diameter • calculate the zone of inhibition around each disc • using πr^2 • antiseptic which killed the most bacteria will have largest zone safety/aseptic • use aseptic techniques/description of techniques • work near a Bunsen • only lift the lid slightly/keep covered most of the time • use sticky tape to seal the lid to the base of the Petri dish on each side • wash hands Controlled variables • incubation time stated • appropriate temperature stated • same size filter disc • same volume of antiseptic / soaked for same time Control • soak a fresh filter disc in water or left dry • use a known substance that kills bacteria	(6) AO2 2 AO3 3a

Level	Mark	Descriptor
	0	No awardable content
Level 1	1–2	• The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) • Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	• The plan is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	• The plan is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)

Level	Mark	Indicative content
	0	No rewardable material.
Level 1	1–2	• response gives at least one element of the plan or how the results would be measured • refers to one from a controlled variable, safety/aseptic working or a control
Level 2	3–4	• response provides a plan that would allow results to be obtained • refers to at least two points from at least one of controlled variables, safety/aseptic working or a control
Level 3	5–6	• produces an error free workable plan which includes safety/aseptic working and one variable controlled • the plan describes the use of a control

Level	Mark	Examples of answers
	0	No rewardable material.
Level 1	1−2	• Control the amount of antiseptic used − 1 mark • Spread the antiseptics on the plate and label the plate − 1 mark • Spread the antiseptics on the plate and label the plate, leave the plate to incubate for 24 hours − 2 marks
Level 2	3−4	• Soak the discs in the antiseptics and place them onto the agar plate, lift the lid only a little. After the bacteria have grown measure the zone of inhibition − 3 marks. (only one aspect from the second bullet point) • Soak the discs in the antiseptics and place them onto the agar plate, lift the lid only a little. Incubate the plate overnight. After the bacteria have grown measure the zone of inhibition − 4 marks. (two aspects from second bullet point) • Soak the discs in the antiseptics and place them onto the agar plate, add a 4th disc which is dry. Lift the lid only a little. Tape the plate and after the bacteria have grown measure the zone of inhibition − 4 marks.
Level 3	5−6	• Add the same volume of antiseptic onto the discs. Using sterile tongs place them onto the agar plate. Lift the lid only a little. Tape the plate and incubate the plate for a set time. After the bacteria have grown measure the zone of inhibition − 5 marks. • Soak the discs in the antiseptics and soak one disc in water. Using sterile tongs place them onto the agar plate. Lift the lid only a little. Tape the plate and incubate the plate for 24 hours. After the bacteria have grown measure the zone of inhibition − 6 marks. • Add the same volume of antiseptic onto the discs. Using sterile tongs place them onto the agar plate. Lift the lid only a little. Tape the plate and incubate the plate for a set time. After the bacteria have grown measure the zone of inhibition − 5 marks. • Soak the discs in the antiseptics and soak one disc in water. Using sterile tongs place them onto the agar plate. Lift the lid only a little. Tape the plate and incubate the plate for 24 hours. After the bacteria have grown measure the zone of inhibition − 6 marks.

Question number	Answer	Additional guidance	Mark
10(b)	A description linking the following: • virus inserts its genetic material into the host cell (1) • uses the host cell {machinery / organelles / resources} • virus {components /protein/genetic material} are made (1) • virus components are assembled inside the cell (1) • cell lyses to release the virus / viruses released from cell (1)	ignore the virus enters a cell accept it takes over the host cell accept appropriate named organelles accept new viruses produced/replicated inside the cell ignore the virus reproduces / divides / grows accept host cell bursts ignore the host lyses	(4) AO1 1

Total for question 10 = 12 marks