Question Number	Acceptable Answer	Additional guidance	Mark
1(a)	$Q_{10} = 8 \div 4 = 2$ (1)	No mark for correct answer must have working.	**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
1(b)	An explanation that makes reference to three of the following: • increasing temperature increases {movement of both enzyme and substrate molecules / kinetic energy of molecules} (1) • therefore molecules collide {more often / with more force} causing the rate to increase (1) • resulting in {enzyme denaturation / change in bonding in the enzyme} above 30 °C (1) • which causes active site shape to change and causing the rate to decrease (1)		**(3)**

(Total for Question 1 = 4 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
2(a)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
2(b)	B		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
2(c)	B		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
2(d)	An answer that makes reference to one of the following points: • virus has a non-cellular structure whereas bacteria has a cellular structure (1) • a virus has a protein capsid whereas a bacterium has a polysaccharide cell wall (1) • viruses have one type of nucleic acid whereas a bacterium has two (1)		**(1)**

(Total for Question 2 = 4 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
3(a)	A		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
3(b)	An explanation that makes reference to the following: • mosquitoes are geographically isolated in the tunnels (1) • random genetic mutations cause variation in the population which allows some individuals to feed on rats, mice and humans (1) • these individuals {will be selected for / are more likely to survive and reproduce} (1) • the proportion of individuals in the population with this mutation will change over time (1) • over many generations these populations become genetically distinct from the above ground population (1)		**(5)**

(Total for Question 3 = 6 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
4(a)	An answer that makes reference to four of the following: (Safer) • because pure drug used rather than extract (1) • due to pre-testing on {cells / animals} before testing on humans (1) • because regulated by legislation (1) (More valid) • because a placebo is used as a comparison (1) • because modern testing may involve double-blind trials (1) • because controlling {factors / variables / eq} tested cohort e.g. age, lifestyle (1) (More reliable) • because more people are tested (1) • because results are analysed statistically (1)	No marks awarded for safer, more valid or more reliable	**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
4(b)	An answer that makes reference to the following: • the drug did improve the condition of the patients more than the placebo but it was only 6 au with a concentration of 400 mg so not much of an improvement (1) • increasing the dosage by a further 200 mg doubled the improvement over the placebo (1) Plus one from: • therefore to be effective higher doses of the drug would be required (1) • statistical tests would be required in order to comment further (1)		**(3)**

(Total for Question 4 = 7 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
5(a)	A		**(1)**

Question Number	Indicative content		
***5(b)**	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. 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. • Vaccination stimulates primary immune response • Reference to antigen presenting cells • Activation of T helper cells / reference to cytokines • Reference to B effector cells / activation of T killer cells • (Differentiation into) plasma cells that secrete antibody • Reference to memory cells • (Secondary immune response) antibody production is {sooner / faster / greater} for pathogen A • Insufficient antibody initially produced in primary response for pathogen B		
Level	Mark	Descriptor	
	0	No awardable content	
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented. Lines of argument occasionally supported through the application of relevant evidence (scientific ideas, processes, techniques and procedures).	

		The explanation shows some linkages and lines of reasoning with some structure.

Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented. Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured.

(Total for Question 5 = 7 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
6(a)	NPP = GPP – R (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(i)	A description that makes reference to the following: • use of several quadrats of stated area placed at random (1) • heather placed in drying oven until constant mass (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(ii)	• (gradient) 46.875 (g m^{-2} yr^{-1}) x 22.186 (kJ) = 1039.97 (g kJ m^{-2} yr^{-1}) (1) • (1037.97 ÷ 3 144 000) x 100 = 0.033% (1)	Example 750 g m^{-2} ÷ 16 years = 46.875 g m^{-2} yr^{-1}	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
6(b)(iii)	An explanation that makes reference to the following: • moss not all removed by burning so quickly re-grows (1) • mat grass colonises after 1 year and outcompetes moss for {light / minerals / water} so is the dominant plant after 5 years (1) • both decrease as heather colonises and becomes dominant as the heather outcompetes them both for {light / minerals / water} (1)		**(3)**

(Total for Question 6 = 8 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
7(a)	A description that makes reference to the following: • reference to PCR to include reference to {primers / DNA polymerase / nucleotides} (1) • procedure repeated {multiple times / 20 to 40 times} (1) • temperature requirements to denature and anneal (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
7(b)(i)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
7(b)(ii)	An explanation that makes reference to: • pattern of bands different between 1 and 3 and 2 and 4 (1) • so *Allolobophora chlorotica* not all one species (1)		**(2)**

(Total for Question 7 = 6 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
8(a)	• suitable time interval chosen (in range 0 to 70 s, must be on straight line portion) (1) • absorbance change calculated (1) • ans. 0.053 au s^{-1} (or as appropriate for part of graph chosen) (1)	Example: at 0 s abs = 0.4, at 60 s abs = 3.6 (1) so change is 3.6 − 0.4 = 3.2 (1) over 60 s, make rate 3.2 ÷ 60 = 0.053 au s^{-1} (1)	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
8(b)	An explanation that makes reference to three of the following: • as enzyme concentration increases the rate of reaction increases and levels off (1) • because number of active sites of the enzyme molecules is increasing (1) • because enzyme concentration is the limiting factor (1) • it levels off because the substrate concentration is limiting (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
8(c)(i)	A		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
8(c)(ii)	E		**(1)**

(Total for Question 8 = 8 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
9(a)	An explanation that makes reference to four of the following: • DNA unzips and one strand acts as a template (1) • ribonucleotides pair up with complementary bases (1) • RNA polymerase joins ribonucleotides together to form pre-mRNA (1) • the mRNA has fewer bases than pre-mRNA / gene (1) • as a result of removal of introns / mRNA made up of exons only (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
9(b)	An explanation that makes reference to the following: • it was assumed that one gene makes one protein (so there should be 100 000 genes but there are 25 000 genes) (1) • the diagram shows that one gene can make more than one mRNA (1) • one gene can code for several proteins (1) • due to removal of different exons (1) • reference to post-transcriptional change (1)		**(5)**

(Total for Question 9 = 9 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(i)	An answer that makes reference to the following: • {cold / buffered} to stop enzyme denaturation (1) • sucrose to stop osmotic loss of water from chloroplasts (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(ii)	• tube 3 is a control to show DCPIP does not change colour over time (1)		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(a)(iii)	An explanation that makes reference to the following: • set up tubes identical to tube 1 so that chloroplasts are available (1) • set up several tubes to ensure data is reliable (1) • tubes exposed to light of different wavelengths for same time because time affects number of electrons released / tubes exposed to light of same intensity because intensity affects number of electrons released (1) • use a colorimeter with a red filter to measure absorbance (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(b)(i)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
10(b)(ii)	A		**(1)**

(Total for Question 10 = 9 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
11(a)(i)	because there is environmental gradient (1)		**(1)**

Question Number	Indicative content	
11(a)(ii)*	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. 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. • reference to F. spir / F. ves at top and F. serr. at bottom / F. ves distributed from top to bottom / ranges of each of the three species quoted • reference to top of shore exposed to different levels of abiotic factors such as {water / temperature} than lower part of shore • reference to the F. spir / F. ves able to resist {dehydration / temperature fluctuations} more than F. serr. • reference to bare rock as an abiotic factor and that F. serr. {needs solid surface to {grow / attach} / not able to {grow / attach} in sand} • reference to competition between {Fucus species / other plants} for {space / light} on rocks in lower shore • reference to different distribution of {consumers / animals / limpets} that consume Fucus species /idea that different consumers live on rock than in sand	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one variable. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.

Question Number	Acceptable Answer	Additional guidance	Mark
11(a)(i)	because there is environmental gradient (1)		**(1)**

Question Number	Indicative content		
11(a)(ii)*	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. 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. • reference to F. spir / F. ves at top and F. serr. at bottom / F. ves distributed from top to bottom / ranges of each of the three species quoted • reference to top of shore exposed to different levels of abiotic factors such as {water / temperature} than lower part of shore • reference to the F. spir / F. ves able to resist {dehydration / temperature fluctuations} more than F. serr. • reference to bare rock as an abiotic factor and that F. serr. {needs solid surface to {grow / attach} / not able to {grow / attach} in sand} • reference to competition between {Fucus species / other plants} for {space / light} on rocks in lower shore • reference to different distribution of {consumers / animals / limpets} that consume Fucus species /idea that different consumers live on rock than in sand		
Level	Mark	Descriptor	
	0	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one variable. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	

Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both variables. The explanation shows some linkages and lines of scientific reasoning with some structure.
Level 3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Question Number	Acceptable Answer	Additional guidance	Mark
11(b)(i)	• N(N-1) = 3540 (1) • Σ n(n-1) = 704 (1) • = 3540 ÷ 704 = 5.028 / 5.03 (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
11(b)(ii)	An answer that makes reference to the following: • middle shore has higher diversity (1) • even though there are fewer individuals (1)	Allow converse argument.	**(2)**

(Total for Question 11 = 12 marks)

Question Number	Acceptable Answer	Additional guidance	Mark
12(a)(i)	An explanation that makes reference to the following: • (small pieces) provides large surface area to volume ratio (1) • (use of ethanol for a long time means) the antibacterial substance is soluble in ethanol and more will be extracted (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(a)(ii)	$\pi 2.15^2$ (1) 14.5 cm^2 (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(b)(i)	An explanation that makes reference to the following: • the *t*-test assess the significance of the difference between the means of the two treatments (1) • Chi squared not appropriate because there are no expected values (1) • correlation coefficient not appropriate because the independent variable is discontinuous / not continuous (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(b)(ii)	$2.37^2 \div 9 = 0.62$ and $3.60^2 \div 9 = 1.44$ (1) $\sqrt{(0.62 + 1.44)} = 1.44$ (1) $(27 - 25) \div 1.44 = t = 1.39$ (1)	Correct answer gains full marks	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(b)(iii)	An answer that makes reference to the following: • there is no significant difference between the clear area caused by garlic compared with that caused by chloramphenicol (1) • $p > 0.05$ (1) • difference due to chance (1) • therefore accept null hypothesis (1)	Allow marking points for the calculated value of *t* from the candidate	**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(c)(i)	An explanation that makes reference to the following: • suggests cedar wood oil has no anti-microbial effect on *E. coli* and all other oils do (1) • quoting at least two values from: rosemary 2%, geranium 0.5%, garlic 0.125% / manipulation of data to show relative effects (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(c)(ii)	An answer that makes reference to the following: • for cedar wood oil try concentrations above 4% (1) • for all the others, try concentrations below 0.0625% (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
12(c)(iii)	A description that makes reference to the following: • only one tray per species – need repeated measurements (1) • species – only used one species of bacteria / only used extracts from four plant species (1)		**(2)**

(Total for Question 12 = 20 marks)